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SOME LINGUISTIC CHARACTERISTICS OF THE LANGUAGE OF DENTISTRY

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Abstract

The present study aimed at analyzing and describing certain linguistic features of the written English language used in the field of dentistry to find out whether the language of this genre is different from common-core English, on the one hand, and from other language varieties, on the other. The study sought to investigate the following aspects:

i) noun phrase structure,

ii) verb phrase structure,

iii) lexical items, and

iv) textual cohesion between sentences and paragraphs.

To obtain a linguistic corpus that could represent the language of this field, three different text levels (brows) were chosen from standard university textbooks, manuals and research journals in the field of dentistry.

The statistical analyses of the corpus upon which the study is based revealed that the following linguistic characteristics could be said to characterize the written language of dentistry:

1. the frequent use of passive and agentless passive constructions,
2. the frequent use of VPs with modal auxiliaries, especially, *should*,
3. the scarcity of perfective, past tense, and progressive verb phrase structures,
4. the meaning shift of modal auxiliaries,
5. the frequent use of pre- and post-nominal modifications,
6. the frequent use of three specialized (technical) lexical items,

7. the frequent use of the repetition of the same lexical item as a cohesive device between sentences and paragraphs instead of the use of pronoun reference,
8. the absence of substitute items and the scarcity of elliptical ones between sentences as well as between paragraphs.

Furthermore, the analysis showed that the written English language of dentistry is clearly different from common-core English and is also different from other ESP varieties in various respects.

CHAPTER ONE

INTRODUCTION

1.1 Theoretical Background

1.1.1 Language Variation

It has been long recognized that language cannot be treated as an object which can be isolated and examined in the laboratory. It is not a single variety, but rather a bundle of various varieties used in different situations. Catford (1965:83) argues that

> *The concept of a 'whole language' is so vast and heterogeneous that it is not operationally useful for many linguistic purposes, descriptive, comparative and pedagogical. It is, therefore, desirable to have a framework of categories for the classification of 'sub-languages', or varieties within a total language.*

For Gregory (1967:178), 'A variety category can be thought of as a contextual category, correlating groupings of linguistic features with recurrent situational features.' Hudson (1980:24) believes that what makes one variety of language different from another is the linguistic items that it includes. On the other hand, the term 'variety' is employed in a general sense to cover concepts such as language, dialect, and register (Corder, 1973; Hudson, 1980). It can be noticed that the term 'variety' is a flexible one in the sense that it can be thought of to characterize a multilingual speaker or community, or just a single linguistic term that characterizes a situation.

There have been different frameworks of categorization of intra-language varieties presented by different linguists. Many scholars, such as Halliday, McIntosh and Strevens (1964); Corder(1973), and Gregory and Carroll (1978), distinguish two kinds of language varieties:

i) varieties according to 'user' which are termed by Wallace(1981:287) as local, or social varieties, or dialects, and

ii) varieties according to 'use'; that is, how we speak or write. What kind of use depends not only on what we are talking about but on the use we are putting language to and other circumstances of the situation of the utterance. The style of such varieties has recently been developed using the term 'register'.

Another classification is introduced by Quirk et al. (1972:13-32). They classify varieties according to:

i) regional varieties, which are referred to as 'dialects',

ii) educational and social standing variation that stands for educated or uneducated speech(1),

iii) varieties according to subject matter, which are sometimes referred to as registers,

iv) varieties according to medium; either spoken or written modes,

v) varieties according to attitude(2),

vi) varieties according to interference, which refers to the traces left by the user's language upon his acquired L2.

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(1) This variety comes to be referred to as standard/substandard English.

(2) This class is often called 'stylistics', which is concerned with the choice of linguistic form that proceeds from formal to informal.

In the light of the aforementioned classifications, we conclude that language is not a single homogeneous entity, but rather a constellation of varieties. Naturally, all these varieties are various realizations of one language. At the same time, each variety is functioning in a particular way and is also distinct from all others depending on the particular situation each variety is used in. For example, a particular situation makes us respond with an appropriate variety of language which, in turn, changes with another situation. To investigate and discuss all varieties of language seems to be extremely hard. This justifies the need to delimit our investigation to one concept; that is, the concept of 'register' (varieties of language according to subject matter).

1.1.2 Registers

Halliday et al. (1964:87) argue that

> *The category of register is needed when we want to account for what people do with their language. When we observe language variety in various contexts, we feel differences in the types of language selected as appropriate to different types of situations.*

Within this characterization of registers, there are correlations between recurrent linguistic features, selected from the verbal repertoire of the speech community, and these different situations. This connection is not necessarily obligatory, but at the same time it is also true that there is enough of interconnection to give a feeling of the existence of a relation between the language and the situation.

1.1.2.1 The Development of the Concept of Register

In a historical review of the term' register', Draskau (1983) pointed out that the relationship between language and the context of situation was first referred to by Wegener(1885), followed by Gardiner(1932). From him, through Malinowski (1935), Firth (1937, 1950) draws the concept of situation. After that, Reid (1956) was the first to define the concept, which he termed register

> *For the linguistic behaviour of a given individual is by no means uniform;placed in what appear to be linguistically identical conditions, he will on different occasions speak (or write) differently according to what may be roughly described as different social situations: he will use a number of distinct "registers".*

1.1.2.2 The Classification of Register

The term 'register' has been used differently by different scholars. Halliday et al. (1964:90), Halliday (1978:33), and Halliday and Hassan (1985:29-39) define register as '...a configuration of meanings that are typically associated with a particular situational configuration of field, mode, and tenor(1)'. This definition reveals that they propose a three dimensional approach to registers:

i) the field of discourse,

ii) the mode of discourse, and

iii) the style of discourse.

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(1) 'style' is sometimes used instead of 'tenor'.

The term 'field' is connected with the subject matter of the communication. It refers to what is that the participants are engaged in, e.g., the language of science and technology. The 'mode' dimension of register stands for the medium or means by which communication takes place, e.g., by speech or writing. Finally, the 'tenor' or style dimension correlates with the relations between participants. It depends on who are taking part in the communication, their status and roles.

Turner (1973), following Halliday et al., classifies registers along three dimensions except for the fact that he uses alternative terminology. He proposes that in ordinary language a speaker's choices may be governed by any of the following three main elements in the situation:

i) the range of technicality;
ii) the range of formality; and
iii) the particular circumstances which direct him to speak or write (determine whether speaker and hearer are within audible range).

In his view, a variety 'register' can be defined by more than one range of variation at a time. For example, a conversation between scientists might be informal, technical and spoken, whereas a legal document is formal, technical and written.

Like Halliday and Turner, Corder (1973:62-64) identifies three similar dimensions: the first is related to the relative social status of both speaker and hearer. This status-related dimension of variability is called "style". The author quotes Joos (1962) to illustrate this dimenstion, whereby he divides up the continuum of variability into five stages of formality "frozen, formal, consultative, causual, and intimate". The second dimension of variability is what is called 'medium' (writing or speaking). There is one further dimension of use related to variability which he calls 'role - related variability', e.g., occupational roles. Thus, we identify religious language, medical language and legal language.

Hill (1958) proposes an alternative terminology (i.e., 'style', 'genre' and 'mode'). Catford (1965) and Strang (1962), on the other hand, distinguish 'register', 'style' and 'medium'. Gregory (1967) adds another dimension to these, which is 'the function of the discourse'(1) or 'functional tenor'. It is a category used to describe what language is being used for in the situation.

Chiu (1973:58) subcategorizes 'register' into 'social role' (father, mother, tutor...) and 'social attitude' (frozen, formal, consultative, casual and intimate), depending on who are taking part and the status and role of the participants. On the other hand, Widdowson (1979:16) suggests using the term 'rhetoric' to characterize 'register'. According to him, 'rhetoric' is concerned with appropriacy.

Another widely used model for the characterization of 'register' has been proposed by Hymes (1972:59). A neat acronym SPEAKING has been suggested by him as a listing for these dimensions:

(S) setting or scene

(P) participants

(E) end (goal)

(A) act sequence (message form and message content), i.e., how the message is communicated

(K) key (manner of delivery)

(I) instrumentalities:

i) channel-written or spoken.

ii) code-language, dialect or style being used

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(1) The function of the discourse is essentially what Crystal and Davy (1969) term 'modality'.

(N) norms or (interaction and interpretation) expectations concerning the conduct of interaction which governs the behaviour of the participants and their interpretation of the message

(G) genre (type of interaction readily identifiable by the language used)

The three dimensional approach to 'register' used by many scholars such as Halliday et al. to account for the features in language has been criticized by Crystal and Davy (1969:65-66) as frequently inconsistently used and as incomplete. The criticism of inconsistency is best illustrated by grouping, for example, the language of newspaper headlines, sports commentaries, advertising and football, amongst others under the same heading and by referring to them as registers in one work. On the other hand, the criticism of incompleteness is illustrated by the fact that Halliday et al.'s approach to register analysis ignores 'modality', which is a central variable.

As an alternative model, Crystal and Davy(1969) introduce stylistic analysis which, in their view, is equivalent to register analysis. The aim of this approach is to study the features of situationally-distinctive uses (varieties) of language, and to establish principles capable of accounting for the particular choices made by individuals and social group in their use of language. To accommodate this model, they put forward an eight-dimensional approach of situational constraints or variables. The role every linguistic feature plays in the text is described in terms of one or more of these dimensions:

1. Individuality (speech or writing habits which identify someone as a specific person),
2. Dialect,
3. Time (during which period he spoke or wrote it, or how old he was),
4. Discourse medium,
5. Province (specifies occupational activity the user is engaged in),

6. Status (the social relationship existing between the user and his interlocutors),
7. Modality (the purpose he had in mind when conveying the message),
8. Singularity (to tell us that the user was being deliberately idiosyncratic).

These situationally bound linguistic distinctive features are referred to as stylistic features or 'variety markers'.

Though the aforementioned scholars have made various distinctions and employed different terminology, these various terminology of register can be subsumed along the following four dimensions (each of which has subdivisions) of field, mode, style and function. The following table shows how the four dimensions 'field', 'mode', 'style', and 'function' are generalized to include most of the different terminology posited by the previously mentioned scholars.

Table (I): Classification of Register

Dimension Author	Field	Mode	Style	Function
Halliday et al. (1972)	field	mode	tenor	-----
Turner (1973)	Technicality	medium	formality	-----
Corder (1973)	Role (i.e., occupational role)	medium	status-related (style)	-----
Hill (1958)	genre	mode	style	-----
Catford (1965)	register	medium	style	-----
Strang (1965)	register	medium	style	-----
Chiu (1973)	field	mode	manner	-----
Widdowson (1979)	rhetoric	-----	-----	
Gregory (1967)	field	mode	tenor	function
Hymes (1972)	genre act sequence	instrumentality	participants & norms	ends
Quirk et al. (1972)	subject matter	medium	attitude	-----
Crystal & Davy (1969)	province	discourse/ medium	status	modality

1.1.2.3 Relations of Registers to Linguistic Features and to Each Other

Crystal and Davy(1969) realize the aim of stylistic(1) analysis by taking a text and discussing it in terms of a number of interrelated levels of description. They follow an order which moves from phonetic through phonological, and grammatical, lexical and semantic levels. They point out that the most important linguistic feature in a text will be the one which occurs more frequently within a variety in question, and that which is shared less by other varieties. They add that the majority of linguistic features in English have little or no predictable power. Crystal and Davy (ibid:63) elaborate on this, pointing out that

> *It may be convenient to posit a one-for-one correlation between a set of linguistic forms and a situation, but while this relation does sometimes genuinely exist, it would be a mistake to assume that it always exists, and to talk rigidly in terms of 'one language - one situation.*

Within this framework it is impossible to predict the forms that will be used for a register. This fact has been the basis for criticizing Halliday et al. (1964:87), who advocate correlations between recurrent linguistic features and the situations in which they happen to occur.

As an alternative Crystal and Davy suggest "a scale of predictability" with linguistic features which are totally predictable at one end and totally unpredictable features within the English speech community at the other end, and, in between the extremes, those features which show different degrees of predictability.

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(1) The term 'style' is used in the sense of 'register'.

The authors also suggest a 'scale of utilization' which ranges from uses where the total linguistic forms might occur to uses of English where only a very small number of forms may occur. Likewise Sager et al. (1980) investigate the characteristics of special languages by describing the most important linguistic features used at the syntactic, lexical and phonemic levels. Trugill (1974:101), on the other hand, believes that registers are described in terms of lexical items. He maintains that

> *Registers are usually characterized solely by vocabulary differences: either by the use of particular words, or by the use of words in particular sense.*

Other scholars such as Quirk et al. (1972), Turner (1973), Lyons (1981) add another important factor which is the "grammatical structure" to distinguish registers. To take an example, Turner(1973:181-2) acknowledges that impersonal style, (i.e., a third person style), the passive voice with elimination of active subject, and the high frequent nominalized clauses have been found to be common in technical and scientific registers.

Longe (1985), on the othe hand, maintains that since different registers are used in different contexts, it follows that these registers are marked by certain significant distinctive linguistic features. In this connection, the occurrence of some lexical items reminds the reader of the situation in which they occur. However, the occurrence of such linguistic features does not mean that they are only encountered in such situations. Longe (ibid:303) notes that

> *force and mass in the English of physics have predictable collocates which distinguish them from the force that collocates with police and mass that collocates with roit.*

In the interrelations of the four dimensions with each other, examples could be multiplied. For example, Quirk et al. (1972:29) mention that '...there are some subjects

that can scarcely be handled in writing and others (we have mentioned legal statutes) that can scarcely be handled in speech.'. They add that 'An attempt at a formal or rigid language when the subject is football would seem comic.'

Equally important is the relationship between registers. Registers may borrow their linguistic material from other registers. Turner(1973:174) states that

> *Some technical languages borrow from the technicalities(1) as phoneticians use "acoustics" in a sense developed in physics, sometimes borrowing with a change of meaning as "transformation", from mathematics is refined in linguistics.*

The aforementioned examples and others invite the reader not to think of registers as isolated little boxes of language, rather, they are interrelated to each other. For this reason, it is preferable to say that differences between these registers are in degree and not in kind. Gregory and Carrol (1978), Hudson (1980), Corder (1973), and Quirk et al. (1972) mention that instead of having clear cut divisions between registers, there may be a continuum or a cline(2). For example, there may be a gradual transition in subject matter. A conversation may start with talking about personal affairs and then gradually develop into an academic discussion.

Another relevant point is worth mentioning in this context. However remote a variety may be and however idiosyncractic, there are still many characteristics (grammatical or others) that are present in all of these varieties. This notion is termed as 'common-core' English (Quirk et al. 1972). Instead, Sager et al. (1980:1) prefer the term

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(1) The term "technicality" is used in the sense of 'register' or 'field'.

(2) The term is borrowed from natural science to describe linguistics. It means gradations (Ellis & Ure, 1969:256).

'general English'. This is not a variety by itself;rather, it is the base or reference from which all the varieties stem. In Sager et al.'s (1980) view, when we talk of registers, it does not mean that we are talking of different languages, because the lexical items and the rules of grammar found in one register are the same lexical items and grammatical rules found in the language.

A further relevant point that needs to be illustrated here is that linguists have recently begun to talk about English for Special Purposes. Although this term was introduced first in the context of T.E.F.L., there have been serious empirical studies that demonstrate that special uses of English (e.g., legal English) manifest special features (lexical, syntactic and textual) that differentiate it from common-core or general English as well as from other special uses of English (e.g., the language of engineering).

1.1.3 English for Special Purposes (ESP)

It was the late 1960s and early 1970s that witnessed a great expansion of research into the nature of particular varieties of English tailored to suit the learners' specific needs.

From its early beginnings, ESP was associated with the notion of register analysis represented by the work of Halliday et al. (1964) and that of John Swales (1971). The aim of these scholars was to analyze the linguistic features of a variety which differentiate it from other varieties as well as from common-core English. The results of register analysis, in addition to being significant for linguistic theory, are also significant for language teaching. Thus, syllabus designers and textbook writers make use of the findings of register analysis. They take register analysis as a guiding principle to produce a syllabus which gives high priority to the linguistic features the learners meet in their

studies or in their field of work. As each register has its own characteristics (e.g., syntactic, lexical or textual), ESP course designers should give precedence to these linguistic features. Consequently, the most appropriate ESP material is that which is highly tailored to meet the characteristics of the register relevant to the learners' needs. (We shall review some of these outstanding studies that dealt with register analysis in Chapter Two).

1.2 The Present Study

1.2.1 Objectives

The research incorporated in this study aims at investigating the distinctive linguistic features frequently occurring in the written English language used in the field of dentistry. Specifically, this study purports to examine in more detail the following features:

1. Syntactic features
    a. Verb Phrase Structure
    b. Noun phrase structure
2. Lexical features
    a. Technical items
    b. Semi-technical items
3. Textual Cohesion
    a. Intersentential relations
    b. Interparagraph relations

Furthermore, it seeks to investigate the features that differentiate this variety from common-core English as well as from other varieties of English.

1.2.2 Significance

Descriptive research is especially desirable in this area because the linguistic analysis of the syntactic, lexical, and textual aspects of register differentiation would have a range of possible uses. The results of such analysis, we believe, would be useful to ESP course designers who are called upon to write a representative corpus of the English language used in the field of dentistry. It is anticipated that the findings of this study would be useful to lexicologists in compiling specialized ESP dictionaries as well as to the translators in the establishment of translation equivalence. Furthermore, it is hoped that, on the theoretical level, this study will lend support to the theory of ESP, which claims that each variety has its own distinctive features that differentiate it from common-core English, and from other varieties of English.

1.2.3 Abbreviations

The list of abbreviations below represents the terms used in the following chapters.

A	Adverb
adj	Adjective
card.	Cardinal
cl.	Clause
CNP(s)	Compund noun phrase(s)
det.	Determiner
-ed part	*ed* Participle Clause
ESP	English for Specific Purposes
EST	English for Science and Technology
F	Finite
GE	General English
HN	Head noun
-ing part.	*-ing* Participle Clause
intr.	Intransitive
NF	Non-finite

N	Noun
No.	Number
NP(s)	Noun phrase(s)
P.	Phrase
part	Participle
pass.	Passive
perf.	Perfect
PP	Prepositional Phrase
prep.	Preposition
prog.	Progressive
pron.	Pronoun
rel.	Relative
-s gen.	*-s* Genitive
SE	Scientific English
TE	Technical English
V	Verb
VP(s)	Verb Phrase(s)

1.2.4 Layout

Chapter Two gives an account of the various ESP studies devoted to the analysis of the language of science and technology. Chapter Three outlines the scope and the research methodology. Chapter Four, on the other hand, exemplifies and discusses the findings of this study. A summary of the results, implications, and recommendations are provided in Chapter Five.

CHAPTER TWO

A REVIEW OF RELATED LITERATURE

2.1 English for Science and Technology (EST)

This chapter reviews the relevant ESP studies; particularly, the works done in the discipline of science and technical language (EST). This major branch of ESP embraces a number of specialized fields such as engineering, physics, chemistry, biology and medical sciences (medicine, nursing, etc.) of which dentistry is a sub-variety. The present research is meant to be a continuation of such studies, hoping to establish that each language variety has certain distinguishing features that make it different from other varieties, on the one hand, and from 'common-core' English, on the other.

It is hoped that these studies allow for a variety of findings and hence wider perspectives, and also help to gain insights to determine the selection of features to be analyzed and in what manner.

2.1.1 Barber (1962)

One of the pioneering studies in EST which is frequently referred to in the literature is that conducted by Barber (1962) entitled 'Some Measurable Characteristics of Modern Scientific Prose'. In this study, the author investigated sentence-structure and verb-forms in scientific prose. He chose three excerpts from three different textbooks: Text A is on the engineering applications of electronics;Text B is in the field of biochemistry;and Text C is on astronomy. The approximate lengths of the three passages were 7,500 words, 6,300 words, and 9,600 words respectively. The author's choice of these texts from

totally different scientific fields was in order to find out what features are common to all sub-branches of EST. And, occasionally, he compared his findings with those of similar studies.

Under sentence structure, Barber investigated sentence-length and clause-type and under the verb phrase he examined the verb-tenses and non-finite verbs.

In reviewing this study, we shall limit ourselves to those aspects characterizing the verb phrase, the focus of our study. And following is an exposition of the features which characterize the verb phrases that occurred in his data.

His findings show that finite verbs constitute 61% of the total number of the verbs employed. Of these, 16% contain modal auxiliaries, whereas 84% do not. Of these finite verbs without modal auxiliaries, 28% are passive, and 72% non-passive, whereas 58% of the verbs following the modal auxiliaries are passive and 42% non-passive. Like the findings of Rumszewicz's (quoted in Swales (1985:4) with no reference), Barber's findings confirm the common view that the passive is relatively frequent in scientific English in comparison with prose drama texts (i.e., Rumszewicz's drama texts have only 3% passive against 97% non-passive).

The analysis also shows that the only dominant tenses are the present simple active (64%) and the present simple passive (25%). The other tenses constitute only 11% with hardly any progressive form.

Barber's analysis indicates that the following modal auxiliaries occur with high frequency: *can*, *may*, and *must*. The author establishes that of the non-finite verbs, which constitute 39% of the total occurrences of verbs, 47% are *-ing* forms, 34% are past participle and 19% are infinitives.

Barber's analysis has been criticized by many scholars such as Widdowson (1979) and Swales (1985). Swales (ibid), commenting on Barber's analysis, maintains that Barber accepts the existence of 'future tense' in English and considers *shall* and *will* as the markers of this tense whereas the other researchers include *will* and *shall* with other modals. He has also been criticized by Widdowson (1979) for counting all occurrences of words ending in *-ing* as non-finite verb forms though some of these occurrences are best regarded as nouns and adjectives. As a result, researchers need to rearrange Barber's figures if they want to draw a direct comparison between Barber's results and those of others. Moreover, Barber has been criticized by Widdowson (1979) on the grounds that his analysis cannot reveal the communicative character of what is written; and he says nothing about the function of these results.

Despite the previously mentioned limitations, this study is of importance and interest. Its importance stems from the fact that it reveals some of the most frequent features that characterize EST texts and provides evidence which shows that a scientific register differs from 'common-core' English.

2.1.2 Huddleston (1971)

Another significant contribution to register analysis and one that enhanced the literature on ESP is *The Sentence in Written English* (1971) carried out by Huddleston. In this study, Huddleston aims at giving a selective grammatical description of written scientific English and investigating certain grammatical areas of 'common-core' English. The theoretical framework underlying his description is mainly that of transformational grammar.

The author's data consisted of 27 texts incorporating 5,000 words each. He classified these texts according to subject matter, namely, biology, chemistry, and physics. The texts were taken from three different 'strata' corresponding to different

'levels of brow': the 'high' stratum texts came from specialized journals,the 'mid' stratum texts came from undergraduate textbooks, and the 'low' stratum ones from popular works.

The method of presentation the author adopted was to discuss a given area of grammar, first, in 'common-core' English, and then to examine the corpus in the light of the descriptive framework so established. His primary concern was to produce an adequate pure description. The author did not attempt to compare the corpus with texts from other varieties of English except for a comparison between the relative clauses in his corpus and those in a sample of spoken (non-scientific) conversation. Huddleston's analysis was restricted to the grammar of the clause. Within the scope of the clause, the following features were investigated: mood, transitivity and voice, complementation, relativization, comparison, modal auxiliaries, and theme.

In summarizing the findings of Huddleston's study, we shall limit ourselves to those features that are related to our study.

i) Transitivity and Voice:

To investigate this topic, the author selected a transitivity corpus consisting of those clauses containing an overt 'lexical verb' as predicator, other than the verb *be* and verbs with less than nine occurrences. The relative frequency of passive and active occurrences in the selected corpus which incorporated 5,402 verb phrases taken from parts (A) and (B) is 32.1% and 67.9% respectively. A study of the passive clause occurrences showed that passive clauses with implicit human agent constituted 62%. On the other hand, the percentage of passive clauses in the corpus as a whole was 26.3%.

ii) Complement Types

In this study, Huddleston concentrated on subject and object complementation. The result of the analysis showed that with finite clauses, object complements were almost five times as frequent as subject complements, whereas in non-finite clauses there was not very much difference in frequency between object and subject complements. In the case of object complements, the proportion of finite clauses to non-finite ones was 4:2, while in the case of subject complements it was 1:3. Moreover, the most frequent non-finite complements were *to*-form followed by f-form, the *-ing* form, then the *-en* form (just one occurrence). The *to*-form was found to be about 30 times more frequent than the *-ing* form.

iii) Relativization.

In the investigated corpus, Huddleston found that restrictive relative clauses outnumbered non-restrictive ones. The author also compared his analysis of relative clauses in scientific English with that conducted by Quirk (1968) on non-scientific conversation. Register comparison of restrictive and non-restrictive relative clauses showed that the occurrence of restrictive relative clauses outnumbered the non-restrictive ones in both registers. On the other hand, their percentage and distribution in both registers were different. For example, the percentage of their occurrence in scientific English was 69% restrictive against 31% non-restrictive, whereas in spoken English their percentage was 87% and 13% respectively. These percentages show that there were more non-restrictive relative clauses in written scientific English than in spoken non-scientific English; the percentages being 31% and 13% respectively.

iv) The Modal Auxiliaries

The percentage of finite clauses containing modals constituted 17% of the overall number of finite verb phrases. The most frequent modal auxiliaries were found to be: *can* (36%), *may*(27%) *will*(22%), *must*(7%) and *shall*(6%).

By comparing Huddleston's work with that of Barber, we notice similarities as well as differences. First, both scholars restricted their analysis to the sentence level. Secondly, they made no attempt to relate form to function and failed to explain the high frequency of the occurrence of linguistic features and the non-occurrence of others in the variety of English they investigated. Thirdly, their findings in certain areas, such as the frequency of the passive and that of some modal auxiliaries, are quite similar.

On the other hand, the two studies are different in the following respects:

i) The frequency of occurrence of finite and non-finite verb phrases;

ii) Barber's study is only based on one type of text, whereas Huddleston's is based on three types (specialized journals, texbooks, and popular works); and

iii) Huddleston missed 'tense', which is an important syntactic distinguishing feature.

2.1.3 Gopnik (1972)

In her book entitled *Linguistic Structures in Scientific Texts*, Gopnik (1972) addressed herself to investigating intersentential dependencies rather than only to intrasentential ones which had been dealt with by Barber (1962) and Huddleston (1971). She analyzed 28 texts with approximately 250 words each selected from the Proceedings of the Federation of American Societies for Experimental Biology (FASEB).

In this study, the author was concerned with the discovery and description of syntactic interrelationships as well as semantic ones which are necessary requirements for texthood. The author also discussed certain patterns of syntactic structures which appeared in the corpus. Thus, she put forward syntactic criteria for distinguishing and specifying the structures among these selected scientific texts. They are:

i) the occurrence of specific transformations,

ii) the position of these transformations in the text,

iii) the non-occurrence of certain transformations,

iv) interrelationships among transformations, and

v) interrelationships among NPs and VPs.

Gopnik identified three basic types of scientific texts:

i) the 'controlled experiment' type,

ii) the 'hypothesis testing' type, and

iii) the 'technique description' type.

In the 'controlled experiment' type of text, an experiment is described in which two or more groups are compared. The author found that the structure of such type of texts follows the following pattern:

i) establishment of the experiment (i.e., the subject of the experiment and the treatment being performed on that subject);

ii) various structures characterizing methods and techniques such as:

a) measurement statements,

b) comparative structures, and

c) comparative and classes of variables; and

iii) Conclusion in the form of a container sentence in which information mentioned previously in the text is reiterated.

The 'hypothesis testing' type begins by stating one or more than one law-like statement and the rest of the text provides evidence which either confirms or disconfirms the hypothesis in case of one-law like statement, or deciding between hypotheses in case of more than one. The most common structures encountered in this type of text are:

i) hypothesis statement,

ii) intention sentence,

iii) conclusion sentence, and

iv) evidence structure.

In the 'technique-descriptine' type, the structure of these texts is determined by the temporal sequence of events.

In contrast to the works reviewed above, which are restricted to syntactic analysis on the intrasentential level, Gopnik's study deals with intersentential analysis achieved not only by syntactic interrelationships, but also by semantic requirements which are also necessary for the texture of a text. Another positive aspect of this study stems from the fact that the author relates form to function whereby she provides explanations for the occurrence of certain structures distinguishing the different types of texts and also specifies the function that the sentences have within each text.

2.1.4 Bartolic (1978)

Bartolic investigated the use of nominal compounds in technical English (TE)[1].

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(1) The term 'technical English' (TE) as used in this article refers to the field of mechanical and electrical engineering.

In a corpus incorporating 319 examples, the author found that complex nominal compounds (CNPs) were frequently used in TE. Of the total occurrences of the examples of (NPs) encountered in the study, there were 70.22% two-noun structure; 19.75% three-noun structure; 7.52% four-noun structures; 1.88% five-noun structures; and 0.63% six-noun structures.

The author ascribes the frequent use of complex nominal compounds of two-, three- and four-noun structures in TE to their shortness, directness and clarity. Thus, the information is conveyed in a more condensed form. On the other hand, five-and-six noun structures are rarely used. This rarity is due to their length and to the difficulty in uttering them when reading aloud, and to the ambiguity they may cause. To achieve clarity of meaning, the author recommends using descriptive phrases rather than long CNPs.

Like Barber's and Huddleston's, this study is restricted only to the sentence level. Although this study is limited in scope, Bartolic contribution has the advantage of pointing out one of the most dynamic, flexible and frequent features which characterizes TE. Furthermore, he provides some explanation for the occurrence of such structures in TE variety.

2.1.5 Rasch (1978)

In a research project which gave rise to a paper entitled 'Verbal Complementation in the EST Classroom', Rasch examined seven articles from scientific and technical journals for frequency of usage of verbal complements. The corpus which consisted of 32,000 words was found to contain nearly 250 complements .

This study reveals the following aspects of verbal complementation. Firstly, the gerundive construction was surprisingly rare, constituting only 3% of the overall number of verbal complements. Secondly, the study reveals the importance of the structural relationship between sentences containing infinitival complements and those containing *that*- complements: 40% of the occurrences of infinitival and *that*- complements in EST sample involved a small group of verbs which can govern either type of complement (e.g., *believe, expect* etc.). Thirdly, the *that*-complement is considered as more basic and more complete than an infinitival complement because it contains a subject and a verb specified for tense. In this context the author maintains that an infinitival complement may be thought of as a *that*-complement which has lost its subject.

This study, however, may be criticized on the grounds that it does not explain the relevant frequency of constructions and says nothing about the function of such constructions.

2.1.6 Horzella and Sindermann (1978)

Horzella and Sindermann conducted a study entitled 'Relative Clauses in EST: An Assessment of Difficulty', to find out the incidence of relative clauses in science textbooks used in the first three years at the Faculty of Physics and Mathematical Sciences at the University of Chile. The authors conducted a frequency count based on a sample incorporating the 21 most relevant chapters from the ten textbooks most frequently consulted by students. This corpus includes calculus, physics and algebra.

The frequency count revealed that in a sample of 1000 sentences, there were 210 relative clauses; that is to say one out of each five sentences in the corpus contained a relative clause. Of the total number of the occurrences of relative clauses, 76.7% were

restrictive and 23.3% non-restrictive. These findings confirm Huddleston's (1971) earlier findings

Unlike Huddleston, the authors endeavour to give explanation to the predominance of restrictive relative clauses. They attribute this to the need for textbooks to define unfamiliar terms and concepts for student readers. Moreover, the function of non-restrictive relative clauses in the sample is generally parenthetical in the sense that they are used to give examples, offer comments, or to remind the students of an assumption made previously.

2.1.7 Sager et al. (1980)

Sager et al.'s treatise represents a comprehensive description of English for science and technology, providing the reader with a clear perception of the relationship between special and general languages. In this study entitled *English Special Languages*, the authors attempt to describe and define special languages (the language of science and technology, in this case), what they are used for, and how they function. The authors conducted a three-level analysis to describe this variety:

i) the syntagmatic level,

ii) the lexical level, and

iii) the phonemic and graphemic level.

In this review, we shall be concerned with the syntagmatic and lexical levels contained in Chapters 8 and 9 of this book.

The authors' approach is neither perspective nor statistical as Barber's (1962). However, the authors refer to statistical analysis where this assists their task. Their

description, which is confined to written texts, is mainly based on their own observation and on those of the other authors they have quoted. However, they also make reference, where relevant, to the analysis of the English used in lectures on science and technology.

In the chapter dealing with the syntagmatic level, the authors confine themselves to a description of the most important syntactic features of the English used in science (mathematics and the physical sciences) and technology (engineering and other applied sciences). They proceed from a consideration of sentence types through an investigation of finite and non-finite verb forms to an examination of the structures and functions of nominal groups. They attempt to explain these features in terms of economy, precision and appropriateness, and support their remarks with representative samples from scienctific and technical publications.

The most important findings relevant to our study which may be drawn from this study are:

i) The dependence of 'special languages' on 'general language' is more marked at the syntactic level since the relatively few special syntactic features do not constitute an independent grammatical system.

ii) The nominal group plays a much more important part in special languages than finite verb forms. The authors ascribe this tendency to the fact that science and technology are concerned with the presentation of facts and theories and are concerned less with actions and events. Furthermore, nouns can be more easily modified than verbs. Thus, the heavy modification either pre-or post modifiers normally employed by the authors of science and technical texts distinguish this register from general English and other registers.

iii) Non-finite verb forms play a major role in the language of science and technology, whereas finite verb forms play a relatively unimportant role because this variety is

concerned less with actions and events. The authors attribute the high frequency of non-finite verbs to their conciseness, grammatical flexibility and economy of expressions.

iv) Like Barber (1962), the authors note that the predominant tense which characterizes this special language is the 'simple present'. The high frequency of this tense is explained by the authors on the grounds that it is the tense used to express phenomena with which science and technology are concerned (i.e., scientific laws and general truths, definitions, observations, etc.).

v) It is also noticed that the extensive use of passive constructions is a prominent characteristic of the language of science and technology, especially, when compared with their frequency in general English and other varieties.

vi) All auxiliaries in SE conform in their use to general English except for *can, could, may, might,* which are used more frequently to convey the idea of 'possibility' than to indicate 'ability' or 'permission', *should* is used to express 'recommendation' or 'specification'; and *will* is sometimes used to express 'ability', which seems to be a characteristic of SE.

The second level we are concerned with in this review is the lexical level. Special languages are considered to be most obviously distinguished on the lexical level. Some of the distinctive lexical qualities which most significantly distinguish the language of SE are listed as :

i. The language of SE is different from the general language in the distribution of word forms. For example, nouns constitute 28% of general language, whereas the figure rises up to 44% in SE. The authors (ibid: 234) maintain that:

Nouns and adjectives together occupy up to 60% in many texts. If pronouns are included, the figure may rise to 65%. Adverbs are much less frequent (4%) than in general language (8%). As a result of strong nominalisation, verbs have less communicative value and are only half or a third as frequent as in general English.

ii. Special languages heavily rely on compounds, and the main burden of information falls on two-item nominal groups.

iii. Special languages avoid synonyms and have a higher rate of repetition of lexical items than general language.

iv. The lexicon of special subjects incorporates three major groups of words:

   a. *General language items used in all disciplines (e.g., note, prove); and items appropriate to a particular discipline, (e.g., stir, shake, boil in chemistry).*

   b. *General language words used with some modification of meaning in a particular discipline, (e.g., suspend in chemistry, current in electrical engineering); and*

   c. *Technical terms specific to a discipline used only by specialists.*

(Sager et al., 1980: 242)

In contrast to the other studies reviewed above, this study seems to be the most adequate in more than one respect. First, this work embraces a three level analyses (the syntactic, the lexical and the phonemic) in contrast to the one level analyses conducted by others. Secondly, this one is characterized by relating form to function, in the sense that the authors provide explanation of the function and the use of grammatical structures. Thirdly, the authors relate the language of science and technology to general English to reveal the fact that any special use of language stems from general or 'common-core' English. Finally, a special section is devoted to account for low frequency structures in SE (e.g., idioms, personal pronouns, and contracted verb forms).

2.1.8 Salager (1980)

In an article entitled 'Non-finite Verb Forms in Technical English Literature', Salager aimed at investigating the occurrence of non-finite verbal forms in English Technical prose (TE). The study is divided into two parts: part (A) investigates the use of gerunds in TE, whereas part (B) investigates the use of infinitives.

The author presents a list of examples which testifies the different means whereby the gerund is triggered. Of these means are nouns and adjectives associated with a preposition which completes their meaning. Any verb which follows them takes the *-ing* form, e.g.,

(2:1) The condition for using the apparatus .....

The recurrent prepositions which trigger the gerund are *of, by* and *for*. The author maintains that these prepositions occur with a higher frequency in TE than in GE. Furthermore, gerunds are used in English to substitute longer clauses introduced by *as* or *since,* as exemplified in the following example:

(2:2) All the factors being the same, the temperature influence is determined by .....

Consequently, gerunds are more frequent in TE than in GE.

With regard to the use of the infinitive, the author presents the different means whereby this structure is triggered:

i) infinitives are associated with a number of lexical units, in the sense that some verbs, nouns, adjectives and adverbs frequently govern an infinitive (i.e., *attempt, fail, sufficient, enough, etc.*).

ii) Infinitives are governed by certain models such as the use of infinitives after impersonal expressions, e.g,

(2:3) It is necessary to set the deviation.

The author maintains that these types of structures and the different lexical items governing the use of infinitives have a high frequency of occurrence in TE. Their occurences explain the high frequency of infinitives in TE literature. He concludes that the use of these structural models contributes to the conciseness of technical prose.

There is a close similarity between this conclusion and that of Sager et al. (1980), who assert that non-finite verbs embody the quality of conciseness which, contributes to the economy of expressions.

2.1.9 Salager (1981)

In an article entitled 'Compound Nominal Phrases in Scientific Writing', Salager (1981) investigated the average length, the proportion and the frequency of occurrence of compound noun phrases (CNPs) in medical English (ME) in comparison to their occurrences in general English (GE).

To achieve this, the author analyzed data made up of ten ME and ten GE sample texts of 2,000 words each. For each 2000 word text, the following was recorded: the number of CNPs made up of two, three, four, five and more individual lexical items; the total number of CNPs;the average length;and their proportion. The author compared the results of the study under review with those of another study on Technical English carried out by the same author (Salager: 1977).

The results of the analysis reveal the following:

i) Compound nominal phrases are more frequently used in ME than in GE. The author recorded 751 different CNPs in ME against 69 in GE and 1179 in TE. Their percentage of occurrence in ME constitutes 9.76% (i.e., almost ten words out of one hundred are compounds) against 15.37% in TE and 0.87% in GE.

ii) Although the CNP average lengths in these different varieties do not differ, their distribution is quite different.

iii) The length of the CNP is proportional to the degree of specialization (i.e., the more specialized the text, the longer the compounds are). The average length difference lies in the use of four-and five-word CNPs. They are respectively twenty and seven times more frequent in ME than in GE.

The tendency to make ample use of CNPs in ME pertains to the need for economy, which is also mentioned earlier by Bartolic (1978) and Sager et al. (1980).

2.1.10 Heslot (1981)

In a study entitled 'Tense and Other Indexical Markers in the Typology of Scientific Texts in English', Heslot compared primary scientific articles and review scientific ones. The analysis is based on articles written by scientists for peer scientists in the domain of life science: plant pathology.

The results of this investigation show that in primary research articles, which consist of four main sections (Introduction, Materials and Methods, Results, and Discussion) the percentage of active voice is 57% . On the other hand, past tense constitutes 70% of the overall number of occurrences of finite verb phrases.

The distribution of these markers in the four different rhetorical sections is as follows:

i) 'Materials and Methods' are mostly in the passive voice.

ii) 'Results', which constitute 75% of the total past tense finite verbs, are mostly in the active voice. Furthermore, markers of first person are lacking in this section.

iii) The 'Introduction' and 'Discussion' sections incorporate almost 90% of the total occurrences of present tense finite verbs. First person markers are scarce in the 'Introduction' but appear regularly in the 'Discussion'.

Turning to review articles, we see that the following results were obtained:

i) Active voice was predominatly used (64%).

ii) Present tense forms (55%)outnumber past tense forms (28%).

iii) Modals occur in 18% of the finite verb phrases.

iv) First person markers appeared frequently.

In this study the author tried to relate the frequency of occurrence of certain linguistic features to the function they may convey. For example, she maintains that *'Present tense in the "Introduction" refers to the knowledge generally received to date'*. Past tense is used in the review articles *'... for historical parts and for mention of authors and data under review'*. (p. 37). She also maintains that the frequent use of "we" in the review articles is meant to enrol the reader in the discussion.

2.1.11 Tarone et al.(1981)

Tarone et al. (1981) undertook to examine the frequency of occurrence of the active and passive verb forms and their rhetorical functions in two papers published in *The Astrophysical Journal* .

To this end, the authors counted finite verb phrases. In addition to counting all active verb forms, they counted a sub-category of these: first person plural active verb forms. The authors' findings are presented below.

i. Frequency of Active and Passive Verb Forms

a) In both papers, active verb forms greatly outnumbered passive forms, constituting 84.4% and 15.6% respectively.

b) The occurrences of active *we* verb forms in one of the texts outnumbered the passive verb form occurrences (i.e., there were about twice as many first person plural active *we* as passive). In the other text, the authors found that there were more passive verb forms than active *we* forms.

ii. Rhetorical Functions of the Passive and Active Verb Forms

The authors outline four generalizations to account for the use of passive as opposed to *we* active verb forms in these investigated papers. The four generalizations are:

a. Writers of *The Astrophysics Journal* papers tend to use the first person plural active *we* form where they have made a unique procedural choice, whereas the passive tends to be used when the author follows established or standard procedures.

b. Passive verb forms seem to be used when the authors cite other contemporary research, whereas they use the first person plural active to describe their own work.

c. The authors make use of the passive voice when they refer to their own future work.

d. The use of active (as opposed to passive forms) seems to be conditioned by discoursal functions of focus or by the length of certain sentence elements.

The authors believe that the first three generalizations are specific to writing in this genre, whereas the fourth is commonly accepted for general English usage.

Unlike Barber's (1962) and Huddleston's (1971) analyses, Tarone et al.'s study is not only confined to statistical information, but it attempts to find explanation for the use of passive forms as opposed to the use of *we* plus active verb forms.

2.1.12 Oster (1981)

In a chapter entitled 'The Use of Tenses in Reporting Past Literature in EST', Oster discussed new features of scientific English. She examined the relationship between the rhetorical function of reporting past literature and the choice of verb tenses.

The author proposed hypotheses concerning the present perfect, past simple, and present simple tenses within the subfunction of 'reporting the conclusions of past literature'. These hypotheses have been supported by data drawn from two technical articles published in a journal entitled *Chemical Engineering Science*. The author resorted sometimes to comparing her findings with those of Selinker et al. (1972), and Lackstorm et al.(1972).

Concerning the use of verb tenses in reporting the past literature, the following findings were reported:

1.a The primary function of the present perfect tense is to indicate that some of the information in the sentence in which the present perfect occurs, will be mentioned in the ensuing discourse.

1.b A secondary use of the present perfect tense is to generalize about past literature. The author maintains that this finding does not coincide with Lackstorm et al.'s (1972) suggestion that it is the present tense that expresses generalization in TE.

2.a The past tense is used to claim nongenerality about past literature. The author maintains that this use supports the claim by Trimble and his colleagues that the past tense may be used when the author wishes 'to claim no generality for the facts given in support of a core generalization. Then he will present the information in the past tense.' (Lackstorm et al. 1973: 136)

2.b The past tense is used to report past literature results (i.e., in reporting past literature in which quantitative results do not support the work).

3.a The present tense is used in reporting past literature in which quantitative results do support the work. The author maintains that this function appears to be more limited, when it is compared to Lackstorm et al.'s (1972) claim that the present tense is seen to mean 'generalization'.

3.b The present tense is used to make reference to past literature.

In conclusion, we notice that some of Oster's conclusions coincide with those of other researchers and support them, while others do not. Moreover, though the uses of tenses reported in this chapter are not representative of all the articles written in Chemical Engineering, they contribute to the reader's awarness of the subtle distinctions in tense usage. Finally, this study has provided a functional account of tense usage in EST discourse.

2.1.13 Diab (1983)

In a thesis entitled 'Linguistic Analysis as Input to the Thinking behind ESP Material Selection for Medical and Nursing Students with Particular Reference to the Jordanian Situation', Diab investigated 'management' in terms of its linguistic features in Medical-Nursing texts. The examined texts consisted of 24,900 words incorporating 3,166 VPs, which were drawn from four major texts used in the second year nursing students at the University of Jordan.

The author concentrated on both formal and functional aspects of the texts. To this end, he reduced the study to an examination of verbs as they exemplify the chosen features:

i) verbs as lexical items,

ii) grammatical forms of verbs, namely, voice and tense (focusing on verbs without modals and verbs with modals), and

iii) the relationship between functions and forms of the verbs.

The following is a summary of his findings:

i. Verbs as Lexical Items

There exists a great deal of consistency among the four chosen texts in the sense that they use 'common-core' vocabulary as exemplified by the verbs.

ii) Grammatical Form of Verbs

a. Verbs without Modals: Voice and Tense

1. This category constitutes 82% of the entire occurrences of verb phrases.
2. Active voice and passive voice are equally frequent and equally distributed in the corpus.
3. Simple present tense is found to be highly frequent (89.1%)

4. Present perfect, present progressive and simple past have low frequency of occurrence: 5.8%, 3% and 1% respectively.

b. Verbs with Modals: (Voice)

1. Verbs with modals constitute 18% of the total number of verbs in the corpus.
2. Active and passive voice are equally frequent and are equally distributed with the exception of text (B), which has a higher frequency of passive amounting to 60.9%.
3. In each of the four texts the hierarchy of frequency of modals is as follows: *may* (43.6%), *should* (23.7%), *must* (10,9%), *can* (10%) and the least frequent is *will*.

iii) Function-Form Relationship

The following functions were found to recur in the examined corpus:

a) cause and effect,
b) description of signs and symptoms,
c) treatment,
d) top necessity and importance.

a. The following grammatical forms were used to express 'cause and effect': simple present passive, present simple active, modal plus verb (active), and modal plus verb (passive).

b. The second function (i.e., description of signs and symptoms) was found to be associated with the following forms: simple present active, simple present passive, and the modal (*can* or *may*) plus verb active.

c. Simple present passive, modal plus verb (passive), *may* plus *be* plus adjective, and imperative were employed to convey the third function, namely, 'treatment'.

d. The modals *must* or *should* plus verb (passive) were used to express 'top necessity' and 'importance'.

2.1.14 Hanania and Akhtar (1985)

In a quantitative study entitled 'Verb Form and Rhetorical Function in Science Writing: A Study of MS Theses in Biology, Chemistry, and Physics', Hanania and Akhtar (1985) investigated verb use in relation to rhetorical divisions of the discourse. The sample totalled 95,600 words, which yielded 8,275 finite verbs for analysis.

A two-way classification was used for the analysis: rhetorical and grammatical. To this end, the discourse material in each thesis was divided into five rhetorical sections:

i) introduction,

ii) review,

iii) methods,

iv) results, and

v) discussion.

On the grammatical level, the study was restricted to the use of finite verbs with respect to: voice, tense, aspect, and modality.

The following is a summary of their findings:

i) Active verbs outnumbered passive ones (54% and 46% respectively) and appeared mostly in the simple present tense.

ii) The perfective and progressive verb groups constituted a small portion (4%), which was entirely perfective.

iii) There were significant differences in the use of verbs between the different rhetorical sections, as well as between the different scientific fields as is explained below:

a. In the introduction section, the present tense had a higher frequency over the past tense (69% to 14% of the total verbs in that section). The authors argue that writers of scientific research make use of simple present in the introduction to make background generalizations, establish assumptions, and state the purpose of the work.

b. In the review section, a marked shift towards the use of past tense and a slight increase in perfective was obvious.

c. In the third rhetorical section (i.e., methods), the frequency of passive rose from about 36% for the other sections to 70%. Most of the passive voice occurrences were in the past tense. The authors ascribe the predominance of past passive in this section to the fact that it is associated with the function of describing procedures followed by the writers of scientific research.

d. The rhetorical sections on 'results' and 'discussion' were found to conform to the overall pattern of verb use. However, the authors noticed a rise in the present tense as well as of modal auxiliaries in the discussion section. Here again the explanation given to this choice of verbs is related to the communicative function associated with the rhetorical sections (i.e., the simple is used to express generalizations and conclusions based on the results of the research).

iv) Modal auxiliaries occured in 8% of the total finite verbs in the corpus of the study. The modal *can*, which was used in all rhetorical sections, was the most frequent (46% of the total number of modals). The modal *may* was found mostly in the 'review' and 'discussion' sections (22%) and *will* mostly in the 'introduction' and

the 'results' sections (22%). The modal *shall* appeared most frequently in the 'method' section constituting only (7%) and *must* appeared least (4%) of the total number of modals.

Like Tarone et al. (1981), who proposed four rhetorical determinants which govern the choice and the use of active (*we+v*) and passive constructions in reporting the author's own work, and Oster (1981), who suggested some rules of use concerning the relationship between verb tense and rhetorical functions, Hanania and Akhtar also provide valuable insights into the interdependence of grammatical form and rhetorical function.

2.1.15 Salager (1985)

In an attempt to identify and describe the most productive grammatical aspects of compound nominal phrases (CNPs) used in medical literature, Salager (1985) carried out a study based on a corpus incorporating 16.000 words taken from 16 different medical texts. The author recorded and analyzed 452 CNPs; that is to say about one CNP for each 35.4 words.

The author proposed a set of semantic relations that underlie compound nominal phrases in medical English. This restricted set, which provides the reader with paraphrases for CNPs, comprises the following categories:

i) Preposition type

a. *Of*: This preposition expresses a number of different covert relations between head and modifier, (e.g., possession, origin, etc.). The underlying structure of a CNP such as *wall thickness* will be *thickness of the wall*. This preposition accounts for (42.7%) of the CNPs underlying relations.

b. *In*: Compound nominal phrases whose underlying structure involves the preposition *in* constitute 24.7% of the total occurrences of CNPs (e.g., *chest pain* will be *pain in chest*).

c. *In + Of* or *Of + In* : Compounds made of these two linking prepositions constitute 7.7%.

d. *With* and *To*: These prepositions account for 5.5% and 2.6% respectively of the entire occurrences of CNPs.

ii) Verbal type:

This category comprises the following underlying syntactic structures:

a. *Wh*-verb deletion with an-*ing* form. This type accounts for 5.7% of the total CNPs. (e.g., *life threatening situation* has the underlying structure *situations which threaten life).*

b. *Wh+BE + ed* deletion (4.9%). (e.g., *computer assisted diagnosis* has the underlying structure *diagnosis which is assisted by a computer).*

c. *Caused by* (4.2%)

iii) Coordinate multiple head phrases:

This category, which constitutes (1.8%) of CNPs, accounts for the occurrences of CNPs which are separated from each other by *and* and *or*. (e.g. *patient age* and/or *sex*).

2.1.16 Al-Katanani (1990)

In an M.A Thesis entitled 'Some Linguistic Characteristics of the Language of Surveying', Al-Katanani (1990) investigated the following features:

i) sentence and clause structure,

ii) verb phrase structure,

iii) noun phrase structure, and

iv) connecting devices among sentences and paragraphs.

The author based her study on a corpus consisting of three surveying textbooks. The three texts consist of 907 sentences incorporating 19,455 words.

In reviewing this study, we shall concentrate on those syntactic and textual aspects that our study shall deal with. The following points give a summary of the major features that the author believes to be characteristics of the language of surveying:

i) Simple verb phrases (VPs) outnumber complex ones; constituting 62.3% and 37.2% respectively.

ii) Passive verbs constitute 34.7% of the overall number of VPs.

iii) The majority of VPs are finite (i.e., 73.7%). Non-finite VPs, on the other hand, constitute (26.3%) of the overall number of VPs. The overwhelming majority of non-finite VPs are of the *to*-infinitive form; constituting 38.3%, followed by the present participle (*v-ing*) form and finally the past participle (*v-ed*) constituting 25% of the entire number of non-finite verbs.

iv. VPs with modals constitute 24.6% of the overall number of finite VPs. The author maintains that this result confirms what is obtained by Barber (1962), Huddleston(1971), Heslot (1981) and Diab(1983). Furthermore, the author found that the modals that occurred most frequently were *can* (31%), *shall* (25.5%), *will* (18.3%), and *may* (18%)

v. The present tense is highly frequent in contrast to the past tense: 87.6% and 12.4% respectively.

vi. The perfect VPs have a remarkably low frequency of occurrence in contrast to non-perfect VPs (i.e., 1.7% and 98.3% respectively).

vii. The progressive VPs constitute only 1.2% of the overall number of VPs in the data.

viii. Prenominal modifiers rather than postnominal modifiers play a major role in complex NPs (i.e., 47.4% and 7.2% respectively).

ix. The *of*-postmodification is the commonest postnominal modifier followed by appositive.

x. Demonstrative reference has the highest frequency of occurrence constituting 74.3% of the overall occurrences of reference relations.

xi. Lexical cohesion is most frequent between sentences as well as between paragraphs, constituting 88.8% of the entire number of cohesive devices. Repetition of the same item is the most frequent cohesive lexical device.

xii. Ellipsis and substitution are infrequently used.

xiii. Cohesive devices are used less frequently on the interparagraph level than on the intersentential.

2.2 Summary

So far, the researcher has reviewed various studies devoted to the analysis of scientific English. The studies have been presented from a chronological point of view to show the line of development in the ways in which scientific language has been handled by different scholars at different times over the last three decades.

It is quite obvious that in analyzing scientific texts the early researchers were concerned with intrasentential relations rather than with intersentential ones. This era was exemplified by the two pioneering studies of Barber (1962) and Huddleston (1971). These types of studies were concerned with the frequency of occurrence of a range of

syntactic features without any attempt to correlate the occurrence/non-occurrence of these structures with their rhetorical functions.

In the seventies, a movement towards text analysis, particularly, intersentential relationships began to be observed. Studies conducted by Gopnik (1972) and Sager et al. (1980) are good examples of how text analysis began to gain more credibility than sentence analysis.

Recent studies such as Tarone et al. (1981), Hanania and Akhtar (1985), Al-Katanani, and similar ones are much more ambitious; they endeavour to offer an explanation for the use of prevalent linguistic features in a certain genre. In these studies, the authors attempt to correlate findings with different sections of texts, so the organizational and discoursal structure of their material is crucial. Moreover, the researchers show that their context explanations may lie in rhetorical function and rhetorical structure, rather than in single sentence semantics.

As pointed out earlier in this chapter, one of the aims of literature review is to help the researcher select the linguistic features to be investigated. It is unfortunate that the reviewed literature revealed that the consideration of lexis has been largely neglected, in addition to the fact that very little work has attempted to come up with a comprehensive analysis that considers register analysis at all levels; lexical, sysntactic, and textual.

Likewise, the researcher has not come across any study carried out on the language of dentistry, a subfield of medical sciences. The rarity of such studies gives the researcher an impetus to undertake this difficult task of investigating simultaneously the lexical as well as the syntactic and textual features of the language used in the field of dentistry. It is thus hoped that the present study will be in line with current research on registers/ESP.

CHAPTER THREE

SCOPE AND METHODOLOGY

3.1 Introductory

As stated above, the present study is intended to investigate certain syntactic, lexical and textual features of the written English language used in the field of dentistry. Since the written mode of this discipline incorporates different levels or 'brows' of discourse(e.g., textbooks, journal articles, reports, manuals and handouts), we chose to restrict the investigation to three different text levels (brows) taken from standard university textbooks, manuals, and research journals from the field of dentistry. The idea behind this was to obtain a linguistic corpus that could represent the written English language used in this field. To this end, three texts were chosen in consultation with specialists, in particular, teaching staff in the Faculty of Dentistry at Jordan University of Science and Technology, in Jordan.

Since the field of dentistry subsumes a wide range of sub-specialities such as Oral Histology, Oral Surgery, Restorative Dentistry, Dental Materials, Orthodontics, Prosthetic Dentistry, Preventive Dentistry, and Radiology, we chose to restrict our study to texts taken from the first three sub-specialities. This choice calls for some comments. If we choose a sample representing each of the aforementioned sub-specialities of dentistry, this necessitates a large number of chapters and articles to fulfil this task. Besides, we could assume a great deal of similarities in the way language is expressed in various chapters and articles and the language of these may be assumed to have minute differences with respect to linguistic realizations.

As an alternative and in order to obtain a sample of reasonably valid texts, specialist informants recommended three texts representing three different brows of the first four major sub-specialities referred to above. Details about the texts that were selected for each level are in the following section.

3.2 The Corpus

Below is a description of the three texts that were chosen for investigation.

i) Text (A)

The first text (henceforth Text (A)) was taken from *The Dental Science Handbook*, edited by Lon W. Morrey and Robert J. Nelson, and published in Washington by the Dental Association and the National Institute of Dental Research in 1970. This handbook is a manual of information about dental science and dental practice primarily for those in vocations other than dentistry such as physicists, engineers, chemists, pharmacologists, etc. It presents a wide spectrum of dentistry subjects such as the morphology, the structural elements; and the growth and development of teeth. In addition, it incorporates information on treatment-materials and functions of the teeth. From this handbook, Chapter 2, which is entitled 'Structural Elements of the Teeth' was chosen for investigation. This sample constitutes Text (A) in the corpus.

ii) Text (B)

The second text was taken from *The Restoration of Teeth*, written by T. R. Pitt Ford, and published in Oxford by Blackwell Scientific in 1985. The aim of this book is stated clearly at the beginning of its preface: '*This book is intended to be an introduction*

to the restoration of teeth for the undergraduate dental students ...' (p.ix). From this textbook, Chapter 12 entitled 'Aesthetic Crowns' was chosen for investigation. This chapter constitutes Text (B)in our corpus.

iii) Text (C)

The third text (henceforth Text (C)) was taken from *Dental Update*, Volume 17, Number 6,1990. This indexed journal provides dentists with in-depth clinical information on Orthodontics, Oral Surgery, Preventive Dentistry and Restorative Dentistry. It publishes research papers and articles that are '...*well-written, authorative and fully illustrated.*' (Renson, C. E., 1990). From this periodical, we chose an article entitled 'Principles of Minor Oral Surgery' (pp.234-40) to constitute Text (C) in our corpus.

The following table provides statistical information about the three texts described above.

Table II: Corpus Distribution

Text Source	No.of sentences	No. of words.
A. *The Dental Science Handbook*	76	1684
B. *The Restoration of Teeth*	136	3440
C. *Dental Update*	165	3131
Total	377	8255

For the purpose of analysis, compound words, figures, fractions, and abbreviations like *long-tapered, 555, mm* were counted as one word. Moreover, section headings, captions, topfigures and notes were not counted.

3.3 Research Methodology

The research methodology employed in this study falls into three major parts the details of which are discussed below:

i) Syntactic Analysis

Ideally, one would like to conduct a complete analysis of sentence and clause structure, but this investigation has been limited to investigating two major aspects, namely, (a) verb phrase structure, and (b) noun phrase structure. In the analysis of these syntactic features, the syntactic analysis employed in *Grammar of Contemporary English* by Quirk et al. (1972) was adopted.

ii) Lexical Analysis

The analysis is restricted to general words that occur with special meanings (i.e., semi-technical items) and 'technical items', which are items with specialized and fixed meanings used by specialists in a particular genre.

iii) Textual Analysis

On the textual level, on the other hand, intersentential relations as well as interparagraph cohesive ties were investigated. In the analysis of this section, the overall framework employed in *Cohesion in English* (by Halliday and Hasan (1976)) was adopted.

The following procedures were adopted in the analysis of the features investigated.

3.3.1 Syntactic Analysis

As pointed out above, two major syntactic aspects were investigated in depth, namely, VP structure and NP structure. The two subsections that follow give details of the specific grammatical issues that were investigated in our analysis of the use of VPs and NPs in the corpus. The terms used in the following two subsections are borrowed from Quirk et al.(1972) and are used in the sense they use them, unless stated otherwise.

3.3.1.1 Verb Phrase Structure

The verb phrase was described according to the following nine parametres:

i) **Frequency of Occurrence and Distribution:**

The total number and percentage of VPs occurring in each of the three texts were calculated.

ii) **Complexity:**

According to Quirk et al.(1972), a VP is simple when it consists of one verb and is complex when it consists of two or more verbs. All VPs in the corpus were thus grouped as either simple or complex.

iii) **Transitivity:**

Verb phrases were identified as either intensive or extensive. If intensive, the VPs were further subclassified as transitive or intransitive.

vi) **Voice:**

Each verb phrase was classified as either active or passive.

v) **Phase:**

Verb phrases were also grouped as either perfective or non-perfective.

vi) **Aspect:**

Each VP was identified as either progressive or non-progressive.

vii) **Finiteness:**

Verb phrases were classified into finite and non-finite ones. If non-finite, the VP form was further identified as:

a) infinitive,

b) present participle, or

c) past participle.

viii) **Tense:**

Since only finite VPs have tense distinction, they were further classified in terms of tense; (i.e., 'past', 'non-past').

ix) **Modality:**

Finite verb phrases were categorized into those that contain modals and those that do not.

3.3.1.2 Noun Phrase Structure

Noun phrases were accounted for in terms of the following parametres:

i) **Complexity:**

Noun phrases were divided into simple and complex. If complex, the NP was further identified as either an NP with complexity or an NP with multiple complexity.

ii) **Type of Head Noun:**

The head of a noun phrase was classified into one of the following classes:

i) common,

ii) proper,

iii) numeral,

iv) adjective with generic reference,

v) pronoun.

If pronoun, it was further grouped as either personal, demonstrative or relative.

iii) **Type of Modification:**

Noun phrases were classified into those having only premodification, postmodification, a combination of both, or zero modification.

a. Premodifiers were divided into:

1. **Adjective:** Adjectives were grouped into either simple or complex. If simple, it was further identified whether positive, comparative or superlative; and if complex it was also identified as either compound or conjoined adjective.
2. **Noun:** If a head noun was premodified by a noun, it was further identified as either common, proper, compound, verbal, or conjoined.
3. **Numerals:** Numeral premodifiers were grouped into either cardinal or ordinal.

4. **Participles:** participial premodifiers were classified into either past (*-ed*) participle or present (*-ing*) participle .
5. ***-s* genitive**
6. **Quantifiers**
7. **Adverbs**

The number of occurrences of each of these types of premodifiers was calculated. Each combination of premodifiers, either two-, three- or four- item premodification per each text was also computed.

b) Postmodification

Postnominal modifiers were classified into the following nine classes:

1) Prepositional phrases other than *of*,
2) *of* - prepositional phrase,
3) *-ed* participle,
4) *-ing* participle,
5) Relative clauses (restrictive and non-restrictive): *wh*-relative, *that*-relative, prep-*wh*-relative, and zero relative,
6) Infinitive clause,
7) Apposition,
8) Postposed Adjective,
9) Postposed Adverb.

The frequency and distribution of each category of these postnominal modifiers were further calculated.

In investigating the use of lexical items in the corpus, we drew a distinction between 'technical' and 'semi-technical' items. In what follows we shall explain the difference.

i) Technical items

Items whose use is restricted to high specialized contexts, i.e., that are not used in everyday communication and are not intelligible to the non-specialist native speakers.

ii) Semi-technical items

Items which in specialized contexts take on extended meanings and acquire a specialist sense in addition to their general meanings are considered as semi-technical items.

For purposes of analysis, it is thus convenient to divide the lexical items into the categories mentioned above. In order to isolate what is called technical and semi-technical items, the following criteria were used:

i) intuitions of team of judges,

ii) intuitions of native speakers (informants), and

iii) information gathered from general and specialized dictionaries.

i) Intuitions of Team of Judges

The researcher's initial approach was to decide whether or not a particular item is technical or semi-technical. This was made with the help of a team of three specialist professors in the field of dentistry. One of the judges was a native speaker of English, whereas the other two lived for more than fifteen years in England. The three specialist

judges were provided with the three texts and were requested to circle technical items and underline general ones which acquire a specialist sense in the corpus upon which this study is based. The responses of the three judges were compared. This comparison showed that in most cases the three judges agreed in their analysis. However, there were some differences concerning some lexical items. Therefore, the researcher isolated these controversial items and discussed each item with the team of judges together (as a group). The discussion yielded two modified lists(1) of lexical items which were classified as either technical or semi-technical.

This approach produced a basic core of material sufficient to indicate the possible stock of lexical items we have to examine.

ii) Intuitions of Native Speakers (Informants)

The researcher's second approach was to seek further information from native speakers of English in Jordan. The researcher prepared a special questionnaire(2) that was given to nine English native speakers. The questionnaire consists of two parts. Part 1 consists of instructions, whereas Part 2 comprises two lists of technical and semi-technical items agreed upon by all the judges. The instructions read:

After reading the questions below, please mark (√) or (X) in the numbered boxes next to each item listed in Part 2.

1) Have you encountered this item before?
2) Would you expect to use it in everyday communication?
3) Do you think that it acquires a special meaning when used in a specialized context?
4) Is this item used only in specialized disciplines?

---

(1) The modified lists of technical and semi-technical items agreed upon by all the judges will appear in Chapter 4.

(2) The questionnaire is contained in Appendix I.

The responses of the informants were tabulated and compared with the modified lists agreed upon by the three judges.

iii) Specialized and General Dictionaries

To further validate the findings, the researcher consulted a number of English general and specialized dictionaries. The following is a list of the dictionaries consulted:

i) *Webster's Third New International Dictionary (Unbridged)* edited by Gove et al. and published in Massachusetts by Merriam-Webster in 1986 (W.T.N.I.D);

ii) *Blakiston's Gould Medical Dictionary* edited by Gennaro et al. and published in New York by McGraw-Hill in 1979 (B.G.M.D.);

iii) *Illustrated Dictionary of Dentistry*, edited by Jablonski and published in Philadelphia by W.B. Saunders Company in 1982 (I.D.D.);

iv) *Boucher's Clinical Dental Terminology* edited by Zewemer et al. and published in London by C.V. Mosby in 1982 (B.C.D.T.).

3.3.3 Textual Cohesion

The textual analysis of the linguistic corpus adopted draws largely on Halliday and Hassan(1976). The terms used in this section are borrowed from Halliday and Hassan, and are used in the sense they use them. Four cohesive relations were found to operate on interstentential level, whereas only three operated between paragraphs. The cohesive ties identified are:

i) reference,

ii) ellipsis,

iii) conjunction, and

iv) lexical cohesion.

The first three relations are structural devices whereas the last is a semantic one. Below is a brief description of each of the four categories.

i) **Reference**:

Reference is classified into three types: personal, demonstrative, and comparative.

ii) **Ellipsis**:

Elliptical items are discussed under three headings: nominal, verbal, and clausal.

iii) **Conjunction**:

Four conjunction types were found to operate on the intersentential level: additive, adversative, temporal and causal. On the other hand, only one type of conjuction, namely, temporal construction was found to operate on the interparagraph level,

iv) **Lexical Cohesion**:

Two major types of lexical relations were found to operate on both intersentential and interparagraph levels: collocations, and reiteration. The latter was further classified into: same lexical item, synonymy, hyponymy, meronymy, antonymy, and superordinate.

Finally, it should be pointed out that textual analysis is restricted to Text (B), which comprises 35 paragraphs, and 136 sentences. The frequency and distribution of each type and even sub-type of the cohesive devices listed above were calculated.

CHAPTER FOUR

RESULTS AND DISCUSSTION

The results of this study fall into four major sections: 1) verb phrase structure, 2) noun phrase structure, 3) lexical items, and 4) textual cohesion. The findings of the analysis for each linguistic aspect are tabulated. This is followed by comments and discussion as well as authentic examples extracted from the texts upon which this study is based. Our findings are often compared with the findings of other linguists, particularly those reviewed in Chapter Two above.

4.1 Verb Phrase Structure

Verb phrases in the corpus were analyzed according to the following parametres:

i) frequency and distribution,
ii) complexity,
iii) transitivity,
iv) voice,
v) phase,
vi) aspect,
vii) finiteness,
viii) tense, and
ix) modality.

Furthermore, a subsection will be devoted to each parametre. Throughout this section, we adopt the terminology and grammatical analysis proposed by Quirk et al. (1972) in their treatment of VPs in English.

4.1.1 Frequency and Distribution of VPs

The results of the frequency count of VPs in the corpus appear in Table III below.

Table III: Frequency and Distribution of VPs

Text	No. of Sentences	No. of Words	No of VPs	Frequency per 100 words
A	76	1684	174	10.3
B	136	3440	410	11.9
C	165	3131	414	13.2
Total	377	8255	998	12.1%

As can be seen in Table III above, the total number of VPs in the corpus is 998; that is to say one VP for every 12.1 words of running texts. On the other hand, the ratio of VPs to the total number of sentences is 2.6 VPs for every sentence.

The ratio of VPs to the total number of sentences in our study is almost similar to that found in Al-Katanani's (1990) study (i.e., 2.5%). However, the ratio of VPs to the total number of words in this study is different from that found in Barber's (1962) as well as in Al-Katanani's(1990) materials; 8.1% and 8.5% respectively.

4.1.2 Complexity

The following table presents the frequency and distribution of simple and complex VPs that occurred in the data.

Table IV - a : Frequency and Distribution of Simple and Complex VPs

Text	A		B		C		Total	
VP	No	%	No	%	No	%	No	%
Simple	137	78.7	222	54.1	269	65	628	62.9
Complex	37	21.3	188	45.9	145	35	370	37.1
Total	174	100%	410	100%	414	100%	998	100%

In the entire corpus simple VPs outnumber complex ones; constituting 62.9% and 37.1% respectively. If we examine the figures in Table IV-a above, we notice that in Text (A), simple VPs remarkably outnumber complex ones: 78.7% vs. 21.3%.

A study of the uses of simple VPs in the corpus, in particular the simple present, reveals that they are employed to perform certain functions:

i) describing procedures,

ii) defining basic concepts, and

iii) stating facts.

The following three examples illustrate these three functions respectively:

(4:1) The first procedure is the placement of a suitable retractor so as to display the operation site and hold the lips, cheeks and tongue out of the way. (Text C, 61) (describing procedures)

(4:2) Dentin is bonelike tissue that forms the bulk or body of the tooth. (Text A,42) (definition)

(4:3) As general rules, teeth darken with age and the majority of teeth have a brown or yellow hue, so it is a good policy to assess the A and B shades for colour match before trying C and D shades. (Text B, 66) (Stating facts)

The remarkably high frequency of simple VPs in Text (A) can be ascribed to the nature of the text which incorporates high frequency of factual statements as well as definitions of the basic principles of dentistry.

Complex VPs in the corpus, on the other hand, were found to have various combinations. The following table shows the types and frequency of complex VPs that occurred in the data:

Table IV-b: Type and Frequency of Complex VPs

	Type	No	%
1.	Modal +V	111	30
2.	V + pass	129	34.86
3.	Modal + V + pass	103	27.84
4.	V + perf. + pass	17	4.59
5.	V + perf.	4	1.08
6.	prog. + pass	3	0.82
7.	V + prog. + pass	2	0.54
8.	V + prog.	1	0.27
	Total	370	100%

As is shown in the above table, the use of modals and the use of passive constructions or the two combined together constitute 92.7% of the total occurrences of complex VPs. The following are illustrative examples:

(4:4-a) *A special tray should be made.* (Text B,21) (Complex: Modal + V + Passive)

(4:4-b) *The periodontal ligament is attached firmly to the tooth by means of Sharpey's fibers which become embedded in the cementum as it is being formed.* (Text A,60) (Complex: Progressive + Passive)

The ratio of complex VPs to simple ones is similar to that found in Al-Katanani's (1990) material.

4.1.3 Transitivity

The following table shows the frequency and distribution of intensive and extensive (transitive and intrasitive) VPs that occurred in the present data.

Table (V): Frequency and Distribution of Intensive and Extensive VPs

Text Type	A	B	C	Total No	%
1. Intensive					
a. *be*	24	85	101	210	21
b. others	2	1	1	4	0.4
2. Extensive					
a. transitive	121	308	281	710	71.2
b. intransitive	27	16	31	74	7.4
Total	174	410	414	998	100%

It is quite evident from this table that extensive VPs are much more frequent than intensive VPs. It can also be noticed that the overwhelming majority of VPs are

transitive. Likewise, the vast majority of intensive VPs incorporate the verb *be,* which also has a relatively high frequency of occurrence in contrast with the other categories that occurred in the whole corpus.

Below are some examples of the various types of intensive and extensive VPs:

(4:5) Thorough preparation is the key to the successful surgery. (Text C,31) (intensive verb be)

(4:6) The periodontal ligament is attached firmly to the tooth by means of Sharpey's fibers which become embedded in the cementum as it is being formed. (Text A,60) (intensive VP other than verb *be*)

(4:7) The long-tapered diamond bur should groove the surface 0.2 mm deeper than the bur; ... (Text B,111) (Transitive VP)

(4:8) Difficulties arise more often from lack of planning or forethought than from any lack of manual skill. (Text C,33) (intransitive VP)

It is worth mentioning that the predominance of transitive VPs correlates with the high frequency of passive sentences (See Table VI in the ensuing subsection.). The high frequency of transitive verbs may be ascribed to the fact that 'English prefers to avoid the plain SV pattern where alternatives are available.' Quirk et al. (1972: 346).

In the present data, the percentage of occurrence of the verb *be* is relatively low when compared to that in Huddleston's (1971) study (i.e., 35.6%). On the other hand, the high frequency of transitive VPs was also noticed in Al-Katanani's (1990) study of the language of surveying.

4.1.4 Voice

The following table shows the frequency and distribution of passive and active VPs that occurred in the data.

Table VI: Frequency and Distribution of Passive and Active VPs

Text	A		B		C		D	
Voice	No	%	No	%	No	%	No	%
Passive	45	25.9	161	39.3	115	27.8	321	32.2
Active	129	74.1	249	60.7	299	72.2	677	67.8
Total	174	100%	410	100%	414	100%	998	100%

As is shown in Table VI above, active VPs (67.8%) remarkably outnumber passive ones (32.2%). On the other hand, the passive voice is more frequently used in the written language of dentistry than in the standard language (i.e., 12%)(1). In the present corpus, almost one third of the overall number of VPs are passive, and there seems to be little variation among the three texts (except slightly in Text (B)).

To find out the reason why the writers of the language of dentistry tend to use passive VPs frequently, Text (B) was chosen for further investigation of the rhetorical functions expressed by the use of this grammatical category. The investigation revealed that this grammatical feature was employed to perform certain well-defined functions. Amongst the most important are the following:

i) instructions, and
ii) describing experimental procedures and processes.

The following examples illustrate the first rehetorical function mentioned above (i.e., giving instructions):

(1) The percentage of passive VPs in standard English is taken from Wallace (1981: 279).

(4:9) A temporary crown should be constructed and luted into place with a temporary luting cement. (Text B,71)

This example illustrates how 'indirect instructions' are carried out by means of combining both modal auxiliaries and the passive mode. This combination is termed by Trimble (1985) as 'the passive modal'. The following example, on the other hand, exemplifies the rhetorical function of 'describing experimental procedures and processes":

(4:10) The intervening tooth substance between the grooves is then removed to give a tapered reduction of the labial surface (Fig. 13.3). The shoulder is then further extended until it is 0.5mm into the gingival sulcus but it is not widened in the process. (Text B, 33-34)

Our investigation of the rhetorical functions performed through the use of the passive showed that 115 passive constructions were used to give instructions, whereas only 40 were used to describe procedures(1). This noticeable high frequency of these rhetorical functions in the written language of dentistry can be ascribed to the fact that the authors are interested mainly in describing the correct way to do things and in specifying the sequence of procedures to be followed. Furthermore, what is far more important is how these procedures and processes should be carried out.

Our findings with respect to the rhetorical functions of the passive are similar to those of Trimble (1985), who states that

Both passive and stative verbs are found primarily in the rhetoric of description;we find them also in the rhetoric of instruction but less frequently.(p. 115)

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(1) The other five occurrences of passive VPs have other functions.

Huckin and Olsen (1983: 448) also take a rather similar stand. They characterize the passive as a useful and common form for describing experimental procedures, chemical processes as well as cause and effect relationships.

The high frequency of occurrence of passive constructions in our corpus does not seem to be idiosyncratic of the language of dentistry. This seems to be a distinguishing feature of most varieties in the field of EST. It is expedient to quote Herbert (1965) on this matter:

> *The majority of statements in technical writing are in the passive form, because the technical writer wants to be objective and impersonal.* (p.28)

Quirk et al.(1972: 808), on the other hand, maintain that

> *The passive has been found to be as ten times more frequent in one text than another. The major stylistic factor determining its frequency seems to be related to the distinction between informative and imaginative prose rather than to a difference of subject matter or of spoken and written English. The passive is generally more commonly used in informative than in imaginative writing, notably in the objective, non-personal style of scientific articles.*

Similar studies demonstrating the prevalence of the passive voice in English scientific prose are the following: Barber's (1962), Rumszewicz's (cited in Swales, 1985:7), White's (1974), Sager et al.'s (1980), Tarone et al.'s (1981), Wingard's (1981), Diab's (1983); Hanania and Akhtar's (1985) and Al-Katanani's (1990). The following table illustrates their findings:

Table (VII) : Distribution of Active/Passive VPs in Previous Studies

Author Voice	Barber (1962)	Huddleston (1971)	Rumszewicz ?	White (1974)	Wingard (1981)	Tarone (1981)	Diab (1983)	Hanania & Akhtar (1985)	Al-Katanani (1990)
Active	72%	73.7%	74%	75%	65%	84.4%	50%	46%	65.3%
Passive	28%	26.3%	26%	25%	35%	15.6%	50%	54%	34.7%

These figures together with the figures cited in Table (VI) above become significant when compared to the figures cited by Rumszewicz (in Swales, 1985:7). He found that passive and active VPs occurrences in his dramatic texts constituted 3% and 97% respectively. Similarly, Barber(1) obtained 2.2% passive against 97.8% active VPs for literary works. This comparison, thus, affirms Quirk et. al's (1972) assumption that the passive occurs less often in imaginative prose than in EST.

Another point is worth mentioning with respect to the use of passive VPs, namely, the fact that agentless passive clauses occurred more frequently in our corpus. The analysis revealed that agentless passives were the most likely to occur; constituting a percentage of 95.3% of the overall number of passive VPs. The following example illustrates this:

(4:11) A straight chisel (2mm wide) should be placed sideways in the groove and rotated. (Text B,132)

The use of agentless passive sentences is justified on the grounds that the identification of the agent is less important than the action itself. On this matter, Royds-Irmak (1975:7) argues that '*In science, a sentence is often written in the passive form because the important thing is not who did something, but what was done.*' Sager et al. (1980:209), on the other hand, maintain that the use of covert subject permits the writer

(1) The percentage of passive VPs obtained by Barber is taken from Sager et al. (1980:209).

to avoid repetition of the subject. Other writers take a rather different stand. Blicq (1981), for instance, condemns the overuse of passive and argues that the majority should be active on the grounds that passive constructions only describe what was done without telling the reader who did what.

On the whole, the high frequency of occurrence of passive VPs and agentless passive constructions can be considered as characteristic features of the written language of dentistry.

4.1.5 Phase

The following table shows the frequency and distribution of the grammatical category of phase.

Table (VIII): Frequency and Distribution of Phase in the Corpus

Text	A		B		C		Total	
Phase	No	%	No	%	No	%	No	%
Perfect	-	-	17	4.1	3	0.7	20	2
Non-Perfect	174	100	393	95.9	411	99.3	978	98
Total	174	100	410	100	414	100	998	100

Table (VIII) above clearly reveals that perfective verb phrases have a very low frequency of occurrence; constituting only 2% of the total number of VPs in the whole corpus. As a matter of fact, most of these occurrences were found in Text (B) (17 instances) in contrast to 3 instances in Text (C), and none in Text (A).

A study of the aggregation of this grammatical aspect in Text (B) in contrast to the other two reveals the following: Firstly, the whole text pertains to describing the processes to be followed in order to restore destroyed crowns. Thus, this rhetorical

function, 'process description' is fairly achieved by using the present perfect. It is also noticed that all occurrences of perfect VPs are in the present perfect rather than in the past. Secondly, a few occurrences of present perfect impart the meaning of 'current relevance(1)'. Thirdly, a few other instances have the rhetorical function of reference to diagrams and actions that have already preceded the action to be carried out. The following examples illustrate the three rhetorical functions mentioned above respectively:

(4:12) After the crown has been made it is returned from the laboratory for trial insertion and the procedure is similar to that already described for a porcelain jacket crown. (Text B,129)

(4:13) An anterior tooth may be restored with a veneer crown of a tooth-coloured material where a considerable amount of the clinical crown has been destroyed by caries or trauma, or where the appearance is unsatisfactory (Text B,1)

(4:14) When the preparation has been completed, an elastic impression is taken, of which details have already been covered in Chapter 12 (Page 202) (Text B,61).

The first and the third rhetorical functions mentioned above seem to be in agreement with the findings of Sager et al. (1980: 208) who maintain that

> *A specifically SE use of the present perfect is in the description of a process which is illustrated in the text by means of diagrams. The combination of present perfect and simple present permits each stage of the procedure shown in the diagrams to be explained by reference to the action which has immediately preceded it.*

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(1) Current relevance is used to indicate *"...a period of time that began before, but continued right up to a point of time (either present or past, according to the tense)"*. Palmer (1974:49)

In comparison with the results obtained by other researchers in the field of ESP, we notice that Al-Katanani's scientific texts have a fairly similar frequency of perfective VPs (1.7%), whereas Barber's (1962) and Diab's (1983) record 3.1% and 5.8% respectively. It is apparent that the ratio of perfective VPs in the present study as well as in the abovementioned ones which are based on the language of surveying and nursing is very low when compared to that dealing with the language of editorials reported by Qara'een(1988) (i.e., 14.8%).

4.1.6 Aspect

Table (IX) below presents the frequency and distribution of progressive/non-progressive VPs in the present study.

Table (IX): Frequency and Distribution of Aspect in the Corpus

Text	A		B		C		Total	
Aspect	No	%	No	%	No	%	No	%
Progressive	1	0.6	2	0.5	-	-	3	0.3
Non-Progressive	173	99.4	408	99.5	414	100	995	99.7
Total	174	100	410	100	414	100	998	100

The above Table (IX) reveals that progressive VPs have a remarkably low frequency of occurrences, constituting only 0.3% of the entire number of VPs in the corpus. Furthermore, all of these occurrences were found to be in the present progressive. The following is an illustrative example:

(4:15) The periodontal ligament is attached firmly to the tooth by means of Sharpey's fibers which become embedded in the cementum as it is being formed. (Text A, 60)

As the language of dentistry is characterized by the prominence of certain syntactic features, it is also characterized by the rarity and even the absence of others. The figure (0.3%) cited above, which constitutes the percentage of progressive VP occurrences, does support this claim.

Our finding regarding the rarity of progressive VPs is similar to those of Barber (1962) and Al-Katanani (1990), who found a relatively low frequency of progressive VPs; 1% and 1.2% respectively.

4.1.7 Finiteness

The frequency and distribution of finite and non-finite VPs in the corpus upon which this study is based are given in Table X below. This table also shows the occurrence and distribution of the different types of non-finite VPs.

Table X: Frequency and Distribution of Finiteness

Text	A		B		C		Total	
Finiteness	No	%	No	%	No	%	No	%
1. Finite	139	79.9	286	69.8	279	67.4	704	70.5
2. Non-Finite	35	20.1	124	30.2	135	32.6	294	29.5
a. Present Part.	11	6.3	37	9	37	8.9	85	8.6
b. Past Part.	11	6.3	27	6.6	41	9.9	79	7.9
c. Infinitives	13	7.5	60	14.6	57	13.8	130	13
Total of Finiteness	174	100	410	100	414	100	998	100

Table X above reveals that finite VPs remarkably outnumber non-finite ones. However, non-finite VPs are frequently used. They constitute 29.5% of the overall number of VPs in the corpus. The distribution of this percentage of non-finite VPs is as

follows: the infinitive (13%), the present participle (8.6%), and the past participle (7.9%).

Below are some examples of the various types of non-finite VPs encountered in the data.

(4:16) However, if the colour is very close when the tooth is examined wet, surface stains may be added to reduce the brightness by a light general application, and to alter the colour more significantly by heavier application in particular areas such as the neck. Stains may also be used to simulate restorations, cracks and hypoplasia. (Text B, 98-99)

(4:17) Relief, when it comes, tends to be rapid, and this lends weight to the suggestion that the mechanism is reflex inhibition of movement provoked by a painful stimulus. (Text C,155)

(4:18) Other constitutional or environmental factors such as weaning, summer and winter seasons or severe illness occurring during the time of enamel formation are recorded by the incremental lines of Ritzius. (Text A,27)

(4:19) Treatment planning must be responsive to the practical day-to-day realities of economic and social factors, and successful patient management depends on acheiving the right balance. (Text C, 14) (*-ing* participle governed by a preposition).

Further investigation of the various types of non-finite VPs in our corpus reveals the following:

1. No less than 66.9% of the infinitive VPs are used to introduce 'purpose or result' clauses (See example (4:16) above). This finding lends support to Sager et al.'s (1980:214) view that

Also characteristic of SE text - in view of their greater need to inform the reader about the reasons for and the effects of actions - is the use of infinitive to express purpose or result.

The preponderant use of infinitive VPs to express purpose or result can be considered an evident characteristic of the language of dentistry.

2. Most of the *-ing* participle occurrences are governed by prepositions. The thirty-six instances of this type occurred in the corpus constitute 42.4% of the total occurrences of *-ing* participle forms. Typical prepositions governing *-ing* forms are the following: *by, in, for*, and *of*. These findings are similar to Barber's (1962) and those of Huddleston's (1971). The latter found that the majority of *-ing* clauses governed by prepositions occurred mainly after *by*, followed in descending order of frequency by *of, in*, and *for*. (See example (4:19) above)
3. Most of the *-ed* participle instances (68.4%) result from the reduction of relative clauses (See example (4:17) above). This finding seems to be in agreement with the findings of other researchers. In this respect, Sager et al. (1980:214) state that *'Reduction of relative clauses is extremly common in scientific English because it gives a more concise wording.'* Quirk et al. (1972:723), on the other hand, maintain that *-ed* participles are very rare in comparison to other forms.

It is interesting to compare our results with respect to the use of non-finite VPs with those of other researchers.

1. Barber (1962), Huddleston (1971), Sager et al. (1980), Diab (1983), and Al-Katanani (1990) reported ratios of non-finite VPs ranging between (26.6 - 39%).
2. Rumszewicz (cited in Swales (1985)), found that literary texts incorporated a percentage of 17% of non-finite VPs.

To conclude this subsection, we may claim that the use of non-finite VPs, particularly the use of *to* - infinitive, which is associated with the rhetorical function of expressing purpose or result, seems to characterize the written language of dentistry.

4.1.8 Tense

Table XI below shows the frequency and distribution of tense (past/non-past) in the three texts.

Table (XI): Frequency and Distribution of Tense

Text	A		B		C		Total	
Tense	No	%	No	%	No	%	No	%
Past	1	0.7	2	0.7	7	2.5	10	1.4
Non-past	138	99.3	284	99.3	272	97.5	694	98.6
Total	139	100	286	100	279	100	704	100

Table (XI) above clearly shows that the present tense has a remarkably high frequency of occurrence, accounting for (98.6%) of all instances of finite VPs.

It is apparent that the past tense plays a relatively small part in this kind of writing. In our material, the ten instances of the past tense are employed to describe past events. In addition, the past refers to what people used to believe in the past. The following is a typical example:

(4:20) It was formerly considered sufficient to believe that if a patient was fit enough to come to the surgery, they were fit to receive treatment - and the cautious sited their premises at the top of a flight of stairs! (Text C,22)

The noticeably frequent use of the simple present in the written language of dentistry, on the other hand, can be explained with reference to factors other than 'time'. A study of the uses of this feature in the corpus reveals that this tense is employed to

perform certain well-defined rhetorical functions. Amongst the most important ones are the following:

i) reporting scientific laws and general truths,

ii) definitions,

iii) procedures and steps to be followed, and

iv) describing the properties of substance and materials.

The following examples illustrate the four rhetorical functions mentioned above respectively:

(4:21) During firing the porcelain shrinks and may lift the foil from the shoulder, therefore the foil should be readapted to the model before further firing to ensure good marginal fit of the restoration. (Text B, 76) (scientific statements; instructions)

(4:22) Enamel is the hardest tissue in the body, being composed, almost entirely (97 percent by weight) of mineral salts. (Text A, 12) (definition)

(4:23) In any surgical operation there are four stages: diagnosis and treatment planning, pre-operative preparation, the operation, and post-operative care. (Text C, 5) (describing procedures and steps)

(4:24) The odontoblasts consist of a columnar body that contains the nucleus and a long protoplasmic process. (Text A, 45) (describing properties)

As far as this dominant tense is concerned, comparisons and contrasts with other works on ESP reveal that the written language of dentistry extensively overworks this grammatical structure, while others make use of this tense less often. Table XII below illustrates this point.

Table (XII): Distribution of Tense in Previous Studies

Author Tense	Barber (1962)	Lotte (quoted in Sager et al. 1980:207)	Diab (1983)	Qara'een (1988)	Al-Katanani (1990)	Present Study (1992)
Present tense	89%	77.9%	89.1%	71.9%	87.6%	98.6%
Past tense	11%	22.1%	10.9%	28.1%	12.4%	1.4%

Although Sager et al. (1980:207) state that 'SE conforms to general usage with regard to tenses'; our findings contradict this statement, showing a frequency of 98.6% of non-past. On these grounds we can claim that the written language of dentistry is characterized by a high frequency of occurrence of the present tense, notably the simple present.

4.1.9 Modality

Finite VPs were also divided into those which contain modal auxiliaries and those that do not. The following table shows the frequency and distribution of the various modal auxiliaries that occurred in the three texts.

Table (XIII): Distribution of Modal Auxiliaries

Text Modal	A No	B No	C No	Total No	 %
Should	-	51	23	74	35.4
May	5	15	13	33	15.8
Can	-	7	23	30	14.35
Must	-	9	21	30	14.35
Will	2	10	22	34	16.3
Could	-	1	-	1	0.5
Would	-	3	-	3	1.4
Has to	1	1	1	3	1.4
Need to	-	1	-	1	0.5
Total	8	98	103	209	100%
%	3.8%	46.9%	49.3%	100%	

Table (XIII) above shows that there are 209 instances of finite verb phrases containing modal auxiliaries. This number constitutes 29.7% of the overall number of finite VPs. Of all modals, *should* is used most frequently (74 times). The overall rank ordering of the modal auxiliaries in the present data is as follows: *should* (35.4%); *will* (16.3%); *may* (15.8%); *can* and *must* (14.35% each); *would* and *has to* (1.4% each); and *could* and *need to* (0.5% each).

A study of the various uses of the modal auxiliaries encountered in our materials reveals that each type of modals is used to express different meanings. Table (XIV) below shows the distribution of these modal auxiliaries and the major meanings which they express in the data.

Table XIV Meanings of the Modal Auxiliaries

Modal Auxiliaries	Text A	Text B	Text C	Total No	%
1. Should					
1. recommendation or specification of what needs to be done	-	22	6	28	
2. indirect instructional information	-	9	7	16	
3. strong advice	-	17	9	26	
4. logical expectation	-	3	1	4	
2. Must					
1. Top necessity	-	7	17	24	
2. Indirect instructional information	-	2	3	5	
3. logical necessity	-	-	1	1	
3. May					
1. possibility	2	14	9	25	
2. recommendation or specification of what needs to be done	-	-	4	4	
3. qualified generalization	3	1	-	4	
4. Can					
1. possibility	-	3	15	18	
2. ability	-	4	7	11	
3. permission	-	-	1	1	
5. Could (possibility)	-	1	-	1	
6. Will					
1. Prediction or logical expectation	-	6	18	24	
2. futurity	2	3	1	6	
3. recommendation	-	1	1	2	
4. probability	-	-	2	2	
7. Would					
1. possibility	-	1	-	1	
2. logical expectation	-	1	-	1	
3. willingness	-	1	-	1	
8. Has to (top necessity)	1	1	1	3	
9. Need to (recommendation or specification of what needs to be done)	-	1	-	1	
Total	8	98	103	209	

Below are some representative examples of the various meanings expressed by the modal auxiliaries that occurred in the data. The meanings of the modals were arrived at with the assistance of an experienced linguist who is a native speaker of English.

i) Should

a) Recommendation or specification of what needs to be done (28 instances)

(4:25) The long - tapered diamond bur <u>should</u> groove the surface 0.2 mm deeper than the bur;at the occlusal of the buccal surface the depth of the preperation <u>should</u> be 1.5 mm tapering to 1.0 mm at the gingival. (Text B,111)

b) Indirect instructional information: (16 instances)

(4:26) All cuts <u>should</u> be judged so as to remain within tooth substance, and to avoid damage to the neighbouring structures. (Text C,87)

As is shown above, when *should* is used to convey this function the reader is always provided with information marked by the use of non-imperative verb form such as the passive modals. Furthermore, the reader is always provided with the reasons why this instruction has to be carried out.

c) Strong advice (26 instances)

(4:27) The restoration <u>should</u> also be avoided in patients who grind their teeth or have lost their posterior teeth. (Text B,15)

d) Logical expectation (4 instances)

(4:28) If all the laboratory stages have been carried out correctly, the crown <u>should</u> seat home fully; however, if the approximal contacts have been overbuilt, it will fail to seat. (Text B, 83)

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ii) Must

a) Top necessity (24 instances)

(4:29) A patient must consent, at least verbally, to the planned treatment. (Text C, 37)

It seems that there is no clear-cut distinction between the meanings of *must* and *should* with respect to 'strong advice' and 'top necessity'. In such cases, the meaning of *must* seems to be close to 'strong advice' (expressed by *should)*, but with much force and insistence.

b) Indirect instructional information (5 instances)

(4:30): The extent and degree of alteration in sensation must be carefully recorded so that recovery can be monitored accurately. (Text C,160)

iii) May

a) possibility (25 instances)

(4:31): Short clinical crowns provide inadequate retention of the restoration on the preparation, and thin teeth particularly with a deepened overbite may have insufficient room on the palatal surface for the necessary thickness of porcelain. (Text B, 12)

b) Recommendation or specification of what needs to be done or how things can be carried out (4 instances).

(4:32) Persistent oozing may respond to packing with oxidized cellulose gauze. (Text C,146)

c) Qualified generalization (1) (4 instances)

(4:33): Clusters of cementocytes may be connected to one another by channels in the cementum. (Text A, 58)

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(1) Qualified generalization is intended to suggest that the generalization expressed in the clause is said to apply to at least some members of the relevant population, but it is not guaranteed to hold for all members.' (Huddleston, 1971:298)

The meaning of *may* here does not indicate that the author is not certain whether or not the cementocytes are connected but rather that some of them are actually connected.

iv) Can

a) Possibility (18 instances)

(4:34): When the root form is complicated, and there is marked curvature in more than one plane, withdrawal with forceps may be easier, if they <u>can</u> be applied. (Text C, 92)

b) Ability (11 instances)

(4:35): when the crown is being made by an experienced technician it is very valuable if he <u>can</u> participate in taking the shade, or if he <u>cannot</u> see the patient, he should be given full written details. (Text B, 70)

c) Permission (One instance)

(4:36): The clinician <u>can</u> never allow him or herself the certainty which patients demand, and a minor oral surgical operation is only one item in a patient's continuing dental care. (Text C,13)

v) Will

a) Prediction or logical expectation (24 instances)

(4:37): If all the laboratory stages have been carried out correctly, the crown should seat home fully; however, if the approximal contacts have been overbuilt, it <u>will</u> fail to seat. (Text B, 83)

b) Futurity (6 instances)

(4:38): Dentinogenesis begins at individual growth centers along the dentinoenamel junction and proceeds toward what <u>will</u> become the pulp chamber of the tooth. (Text A, 47)

c) Recommendation or specification of what needs to be done (2 instances)

(4:39): The operator will find it particularly helpful in preparing the shoulder to retract the free gingiva with a flat plastic instrument. (Text B, 35)

d) Probability (2 instances)

(4:40): Generally speaking, those cases where some recovery is apparent in a few days will probably return to normal in a few months. (Text C, 161)

The findings above indicate that most of the meanings conveyed by *will* in the present corpus are also found in 'general English' (See Quirk et al. (1972: 94-104)).

vii) Has to

Top necessity (3 instances)

(4:41): The shape of the incision has to be planned with the needs of both exposure and closure in mind. (Text C, 65)

As can be noticed from the abovementioned findings, it is obvious that the different meanings cited by Quirk et al. (1972) do not hold for all the modals encountered in the present study. Yet, instances of some modals cannot be subsumed under any of the familiar meanings defined by Quirk et al. (1972). For example, most of the occurrences of *should* were used to convey meanings not listed by Quirk et al. such as recommedation and specifications of what needs to be done, indirect instructional information, and strong advice. Furthermore, most of the meanings expressed by *may* in the present corpus (i.e., recommendation and specification of what needs to be done, and qualified generalization) are not cited by Quirk et al.

These findings lend support to Trimble's (1985:18) claim that '*The commonly taught meanings for should and sometimes can and may do not fit the context of the*

discourse.' As a result we find a meaning shift with most of the aforementioned modal auxiliaries.

On the other hand, most meanings expressed by *will* in the present data are similar to those listed by Quirk et al. (1972).

It is interesting to note that the meaning of 'giving instructions' was found to be predominant in the present study. The minor uses (recommendation, indirect instructional information, strong advice, and top necessity) encountered in the data are considered as various realizations of this major category (i.e., 'giving instructions'). The prominence of this category may be attributed to the fact that the rhetoric of 'giving instructions' provides the reader with information telling him what to do and how, as well as giving reasons why an instruction is to be carried out as recommended or as specified. Since *should* and *must* are the best vehicles to carry out these various types of instructions, it is expected, as well as justified, to encounter a high proportion of these modal auxiliaries.

In this connection, it is worth pointing out that Diab (1983), in his study of the language of nursing, obtained similar findings concerning the use of *should* and *must*. On the other hand, the overall rank ordering of the nine modal auxiliaries which occurred in the present study is different from that obtained by Barber (1962), Huddleston (1971), Diab (1983), and Al-Katanani (1990).

On the whole, it could be claimed that most of the modal auxiliaries (i.e., *must*, *should*, and *may*) shift from their standard use in common-core English, when used in the written language of dentistry. Another observation is that *should* and *must* are heavily

employed in this genre in the rehetoric of instructions, especially when the reader is being warned to do or not to do something.

4.2 Noun Phrase Structure

As mentioned in Chapter Three above, NPs in the corpus were analyzed according to the following parametres:

i) complexity (complex and multiple-complex vs. simple),

ii) types of head noun, and

iii) types of modification, (premodification; postmodification; pre- and post-modifications; and zero modification).

Throughout this section, we adopt the terminology and grammatical analysis proposed by Quirk et al. (1972) in their treatment of NPs in English.

4.2.1 Complexity

Noun phrases in the corpus were classified as follows:

1. Simple NPs,
2. Complex NPs, and
3. Multiple - complex NPs.

Thus, a count of the structures of all NPs resulted in the figures contained in Table (XV) below:

Table (XV): Frequency and Distribution of Simple, Complex, and Multiple-complex NPs

Text NP Structure	A	B	C	Total No	 %
1. Simple	179	291	287	757	43.2
2. Complex	139	282	260	681	38.8
3. Multiple-complex	88	112	116	316	18
Total	406	685	663	1754	100

The picture that emerges from the analysis of the figures in Table (XV) above is that of complexity. Whereas complex and multiple-complex NPs comprise between them 56.8% of the total NPs, simple NPs account for 43.2% of the total NPs in the corpus. Illustrative examples of these different types of NPs are the following:

(4:42) However, fracture of jacket crowns is still a common cause of failure, particularly where there are errors in the shape of the tooth preparation, as well as errors in the occlusal contacts of the restoration. (Text B,8) (multiple-complex NPs)

(4:43) Teeth have (different shapes) because they have (different functions). (Text A,9) (The underlined NPs are simple, whereas the bracketed ones are complex)

As is shown in the examples above, a multiple-complex NP may comprise constructions such as: **simple + complex + simple NPs** or may have other realizations. Within multiple-complex NPs, we see that the simple or basic NP is modified in turn by a series of prepositional groups.

This register would therefore seem to compare with scientific writing, which according to Quirk et al. (1972:934) '*...differs greatly from other styles in having a distinctly higher proportion of noun phrases 'with complexity' (and multiple complexity)*'.

Our findings in this connection are similar to those of Al-Katanani (1990) who investigated the language of surveying.

4.2.2 Types of Head Noun

The following table shows the frequency and distribution of the various types of HNs that occurred in the data.

Table (XVI): Frequency and Distribution of the Types of HNs

Text Type of HN	A	B	C	Text No	%
1. Noun				**1971**	**87.8**
a. common noun	436	751	738	1925	97.7
b. proper noun	6	-	-	6	0.3
c. compound noun	3	4	7	14	0.7
d. verbal noun	-	7	19	26	1.3
2. Adjective	**8**	**6**	**3**	**17**	**0.8**
3. Numeral				**23**	**1**
a. cardinal	5	6	8	19	82.6
b. ordinal	-	1	1	2	8.7
c. fractions	2	-	-	2	8.7
4. Pronoun				**235**	**10.4**
a. *there*	1	8	10	19	8.1
b. reflexive	-	1	2	3	1.3
c. person	11	7	18	36	15.3
d. non-person(*it*)	20	21	12	53	22.6
e. expletive(*it*)	2	18	8	28	11.9
f. demonstrative	5	16	8	29	12.3
g. relative	27	12	15	54	23
h. others	5	2	6	13	5.5
Total HNs	**531**	**860**	**855**	**2246**	**100**

As is shown in Table (XXI) above, the great bulk of HNs falls into two types only: the 'noun' (87.8%) and the 'pronoun' (10.4%), leaving only (1.8%) divided among the other two types. It can also be noticed that the 'noun' was found to subsume the following categories: common noun, proper noun, and compound noun. Of these categories, the vast majority are common nouns (97.7%), and only (0.3%) being proper nouns. When we turn to the categories subsumed under the category 'pronouns', we find that the pronoun *it* is the most frequently occurring pronoun; constituting 34.5% of the entire number of pronouns .

Here are some examples of the different types of HNs taken from the corpus. The type of HN is indicated between brackets:

> *(4:44) It* (expletive *it*) *was formerly considered sufficient to believe that if a patient (common noun) was fit enough to come to the surgery (common noun), they (person pronoun) were fit to receive treatment (common noun)- and the cautious (adjective) sited their premises (common noun) at the top (common) of a flight (common) of stairs (common noun)!* (Text C, 22)

A careful study of the different types of HNs reveals the following:

1. The largest group of HNs is the common nouns, whereas the personal pronouns occur with a remarkably low frequency. This tendency may be ascribed to the fact that writers of this genre resort to repetition or insertion of common nouns instead of personal pronouns as a means of informing. This finding lends support to Sager et al.'s results (1980: 226) who state that 'technical literature accounts for the infrequent occurrence of most personal pronouns....'. Moreover, Sager et al. (1980) list personal pronouns among the low frequent structures in SE.

2. The pronoun *it* in comparison with other pronouns has the highest frequency of occurrence. The dominance of this pronoun is not really surprising, since writers make use of *it* so as to bring out an impersonal and objective style.

4.2.3 Types of Modification

Table (XVII) below presents the various types of HN modifiers that occurred in the data.

Table (XVII): Frequency and Distribution of HN Modifiers

Text	A		B		C		Total	
Modification	No	%	No	%	No	%	No	%
Premodification	82	20.2	216	31.5	182	27.5	480	27.4
Postmodification	67	16.5	94	13.7	129	19.5	290	16.5
Pre-and post-Modif.	78	19.2	84	12.3	65	9.8	227	12.9
Zero Modification	179	44.1	291	42.5	287	43.2	757	43.2
Total	406	100	685	100	663	100	1754	100%

As can be seen from the table above, no less than 56.8% of the overall number of occurrences of NPs in the corpus were modified in one of three ways:

i) Premodification + HN + ϕ (27.4%);

ii) ϕ + HN + Postmodification (16.5%), and

iii) Premodification + HN + Postmodification (12.9%).

On the other hand, NPs that have zero modification (except for the occurrence of determiners) account for (43.2%) of the entire occurrences of NPs. This type of NP is either, a proper name, a numeral, a pronoun or a compound noun.

Below are some examples of the various types of nominal modifications:

(4:45) *Opposing Walls of the preparation should have a 6º taper.* (Text B, 23) (Premodification + HN + Postmodification)

(4:46) *The dentist who extracts teeth must be prepared to meet these complications.* (Text C, 2) (HN + Postmodification).

(4:47) *Teeth have (different shapes) because they have (different functions).* (Text A, 9) (The underlined NPs represent zero modifications whereas the bracketed ones represent premodification + HN).

It should be noticed that, nominal modifiers do play a relatively major role in contributing to NP complexity in this genre (i.e., dentistry). When we turn to these types of nominal modifications, we find that the prenomoninal modification at (27.4%) is a relatively frequent type.

It should also be emphasised that it was expected to find a high frequency of occurrence of prenominal modification. This did not turn out to be the case. Conversely, HNs with zero modifications were found to have a high proportion. This difference, however, is due to the method of analysis. In this study, premodification by determiners was not accounted for in the analysis despite the fact that determiners constitute the largest proportion of pre-modifiers.

4.2.3.1 Premodifications

Premodifications were investigated in terms of the following:

i) type and frequency of prenominal modifiers,

ii) structure of prenominal modification, and

iii) length of prenominal modification.

4.2.3.1.1 Types and Frequency of Prenominal Modifiers

The following table shows the frequency and distribution of the various types of modifiers that occurred in the corpus.

Table XVIII Types and Frequency of Prenominal Modifiers

Text Premodifiers	A	B	C	Total No	 %
1. Adjectives	**149**	**271**	**253**	**673**	**59.1**
a. simple					
1. positive	136	253	225	614	
2. comparative	2	10	4	16	
3. superlative	1	-	2	3	
b. Complex					
1. compound	1	2	12	15	
2. conjoined	9	6	10	25	
2. Nouns	**60**	**125**	**84**	**269**	**23.6**
a. common	57	109	75	241	
b. proper	-	1	1	2	
c. compound	1	8	6	15	
d. verbal	2	5	2	9	
e. conjoined noun	-	2	-	2	
3. Numerals	**26**	**26**	**34**	**86**	**7.6**
a. cardinal	20	26	33	79	
b. ordinal	6	-	1	7	
4. Participle	**20**	**17**	**11**	**48**	**4.2**
a. *-ed* participle	9	5	-	14	
b. *-ing* participle	11	12	11	34	
5. *-s* genitives	**7**	**-**	**2**	**9**	**0.8**
6. Quantifiers	**19**	**6**	**3**	**28**	**2.5**
7. Adverbs	**9**	**10**	**6**	**25**	**2.2**

Total	No	%	No	%	No	%	No	%
	290	**25.5**	**455**	**40**	**393**	**34.5**	**1138**	**100%**

As can be seen from Table (XVIII) above, the most frequent premodification type is the 'adjective' followed by the 'noun' constituting; 59.1% and 23.6% respectively. The *-s* genitive premodification is the least frequent, accounting only for 0.8% of the entire premodifications. Illustrative examples are the following, with the prenominal modification underlined:

(4:48) The dental pulp occupies the pulp chamber and root canal or canals of the tooth. (Text A, 62)

(4:49) In case of concern, it is prudent to discuss potential problems with the patient's physician. (Text C, 24)

The high frequent use of adjectives as premodifiers in our data arise from the fact that the topics discussed deal mainly with description. As a result, we notice an overuse of adjectives since they are the best vehicles that contribute a great deal towards the descriptive precision of these texts. Another interesting relevant point is that there seems to be a tendency amongst writers of this genre to coin new adjectival compounds such as *slow-to-moderate speed handpiece*; *the practical day-to-day realities*; *high-vacuum/low-volume type*, etc.

The relatively high frequency of nouns as prenominal modifiers, on the other hand, may be explained, partly, as an alternative to the use of prepositional phrases as postmodifiers. This seems to be the reason why the writers of this genre tend to use structures, such as, the ones in column (B) below, which occurred in our data, rather than those in column (A).

(A)	(B)
The preparation of the tooth	*the tooth preparation*
models for study	*study models*
the damage of the tissue	*the tissue damage*

To quote Quirk et al. (1972:914) on this issue

> .... *prepositional phrase postmodifiers generally, correspond to noun premodifiers, often becoming so closely associated with the head as to be regarded as part of a compound noun.*

In case of *-s* genitive, the picture is reversed. The rarity of this type of prenominal modifiers in this register is compensated by the high frequent use of *of-* postmodification, which will be dealt with in the ensuing subsection. This very low frequency of *-s* genitive in the present study is ascribed to the restriction on the type of HN. Concerning this issue, Quirk et al. (1972:198) maintain that: '*Mainly personal HNs (proper names, higher animals.....) admit the -s genitive.*'

4.2.3.1.2 The Structure of the Prenominal Modifications

A study of the figures in Table (XVII) above reveals that there were 707 instances of premodifications and of pre- and postmodifications, whereas Table (XVIII) shows that the total number of premodifiers is 1138. This means that some HNs are preceded by more than one item premodification. The following tables, (Table (XIX-a) and Table (XIX-b)) show the structure and the frequency of occurrence of prenominal modifications.

Table (XIX-a): One- and Two- Item Premodification

One-Item Premodification	No	Two-Item Premodification	No
1. adj	**464**	1. adj + adj	44
a. simple	456	2. conjoined adj	21
b. compound	8	3. adj + N	27
2. N	**154**	4. N + N	18
a. simple	143	5. A + adj	7
b. compound	11	6. *-ed* part + N	7
3. Numerals	**47**	7. quan. + adj	6
a. car.	44	8. card-to-card	4
b. ord.	3	9. card + adj	3
4. *-ing* part	**10**	10. *-ed* part + adj	3
5. *-ed* part	**9**	11. card + N	3
6. *-s* gen.	**6**	12. A + *-ed* part	2
7. quan.	**17**	13. *-s* gen. + N	2
8. A	**6**	14. adj + *-ed* part	2
		15. adj + *-ing* part	2
		16. N + *-ed* part	2
		17. Miscellaneous(1)	6
Total	713		159

(1) The following are some types of premodifications included under 'miscellaneous' having one occurrence each 1. A + quan. 2. A + card. 3. *-s* gen. + adj.

Table (XIX-b): Three-and Four-Item Premodification

Three-Item Premodification	No	Four-Item Premodification	No
1. adj + adj + N	7	1. A + card + N + adj	3
2. adj + adj + adj	3	2. card + N + adj + adj	2
3. A + adj + adj	2	3. adj + N + N + N	1
4. N + N + N	1	4. A + *-ed* part + adj + adj	1
5. quan. + A + *-ed* part	1	5. A + *-ed* part + N + N	1
6. A + A + *-ed* part	1	6. quan. + *-ing* part + adj + N	1
7. N + N + *-ed* part	1	7. adj + adj + *-ed* part + N	1
8. card + N + adj	1	8. quan. + adj + adj + N	1
9. adj + adj + ord	1		
10. *-s* gen. + *-ing* part + adj	1		
11. adj + N + N	1		
12. conj adj + *-ed* part	1		
Total	21		11

Table (XIX-c) below sums up the structure and frequency of prenominal modifiers that occurred in the examined texts.

Table (XIX-c): Frequency of Occurrence and Number of Prenominal Modifications

No. of Premodifiers	No	%
1. One-Item Premodification	713	78.9
2. Two-Item Premodification	159	17.6
3. Three-Item premodification	21	2.3
4. Four-Item Premodification	11	1.2
Total	904	100

As is shown in Tables (XIX-a), (XIX-b), and (XIX-c) above, the most frequent type of prenominal modification is the 'one-item premodification' constituting (78.9%) followed by 'two-item premodification' (17.6%). On the other hand, three-, and four-item premodifications occur much less frequently. Furthermore, the percentage of occurrence of prenominal modification constitutes 10.95% (i.e., almost 11 words out of 100 are premodified NPs). Illustrative examples of the various structures of prenominal modifications are the following:

(a) Two-item prenominal modifications

(4:50) minute enamel rods (Text A, S:14)

(adj + N)

(4:51) dentin porcelain powder (Text B, S:77)

(N + N)

(b) Three-item prenominal modifications

(4:52) a small round diamond point (Text B, S:50)

(adj + adj + N)

(4:53) tungsten carbide tipped burs (Text C, S:86)

(N + N + *-ed* participle)

(c) Four-item prenominal modification

(4:54) The commonly used local anaesthetic solutions (Text C, S:28)

(A + -ed + adj + adj)

(4:55) minute sheathed segmented enamel rods (Text A, S:34)

(adj + adj + adj + N)

The low frequency of occurence of three-and four-item premodifications is due to the ambiguity they may create. To avoid ambiguity, Bartolic (1978) recommends using descriptive phrases rather than very long compounds.

Comparison with other ESP studies reveals the following:

1. In her analysis of TE, Salager (1977) found that 15 words out of 100 are premodified NPs. Salager (1981), on the other hand, points out that the percentage of occurrence of prenominal modifiers in ME constitutes 9.76% (against 0.87% in GE).
2. Premodifiers play a major role in the language of mechanical and electrical engineering as reported by Bartolic (1978).
3. In his study of the language of science and technology, Sager et al. (1980), maintain that premodifiers have a high frequency of occurrence.

Thus, in the light of these studies, it can be argued that the written language of dentistry seems to be similar to the language of science and technology with respect to the frequent use of premodifiers. In contrast, premodifiers play a very small role in General English (Salager: 1981).

4.2.3.1.3 Length of Premodifications per Text Level (Brow)

The following table shows the frequency as well as the length of premodifications and their distribution per text level.

Table (XX): length of Premodifications Per Text Level (Brow)

No. of premodifiers / Text level or (Brow)	one-item premodification No	%	two-item premodification No	%	Three-item premodification No	%	Four-item premodification No	%	Total
A (1)	176	83.8	30	14.3	2	0.95	2	0.95	210
B (2)	300	81.5	57	15.5	7	1.9	4	1.1	368
C (3)	237	72.7	72	22.1	12	3.7	5	1.5	326
Total	713	78.9	159	17.6	21	2.3	11	1.2	904

Table (XX) above shows that the frequency of one-item premodification in Text (A) (i.e., Level 1) occurred with a percentage of (83.8%). In Text (B) (i.e., Level 2), it decreased to (81.5%), and it further decreased to (72.7%) in Text (C) (i.e., Level 3). So, the frequency of one-item premodification reversely decreases in proportion according to text level or 'brow'. The frequency of occurrence of two-, three-, and four-item premodification, on the other hand, directly increases in proportion according to text level or 'brow' (i.e., the higher the 'brow', the more frequent and longer the premodification. For example, the percentage (14.3%) of two-item premodification in 'Brow' or Level One rises to 15.5% in Level Two and to 22.1% in Level Three. Likewise, the frequency 0.95% of three-item premodification in Level One rises to 1.9% in Level Two and to 3.7% in Level Three.

The abovementioned results obtained from Table (XX) may be explained by the nature of the text level or 'Brow'. Text (A) is addressed to the layman who does not have

an idea about the discipline, whereas Text (B) is addressed to undergraduate students, who have an increase of conceptual knowledge which enables them to cope with the increase of frequency and complexity of two-, three- and four- item premodification in level Two. This is also aplicable to Text (C) (i.e., Level Three) which is mainly addressed to graduate students and researchers.

Our findings with respect to the complexity of prenominal modifiers are similar to those of Salager (1981), who found that the length of compound NPs(1) is proportional to the degree of specialization (i.e., the more specialized the text, the longer the compound NPs are). In this respect, Swales (1974: 129) states

> *Indeed, the more technical and specialized the subject, the more frequent and more complicated the compound nouns. Generally speaking, scientific journals contain more compound nouns than university text-books, and university text-books contain more than school books.*

The same contention is also shared by Horsella and Pe'rez (1991: 136)

> *Nominal compounds become increasingly frequent and larger because scientists in the higher level of academic work communicate shared knowledge in a particular shorthand or jargon that reflects the growing complexity in the frames of knowledge.*

4.2.3.2 Postmodification

A headnoun may be postmodified by one or more than one postmodifier. Postmodifiers are commonly classified into five classes (see Quirk et al. (1972):

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(1) Compounding is mainly acheived through premodification.

i) Prepositional group,

ii) Non-finite clauses,

iii) Relative clauses,

iv) Appositive, and

v) Postposed adjectives and adverbs.

Table (XXI) below shows the frequency and distribution of the various types of postmodifiers obtained from the three analyzed texts.

Table (XXI): Frequency and Distribution of Postmodifiers

Text Type of modification	A	B	C	Total No	%
1. Prepositional group	**123**	**171**	**193**	**487**	**74%**
a. *of* postmodification	88	104	130	322	48.9%
b. other prepositions	35	67	63	165	25.1%
2. Non-Finite clauses	**20**	**18**	**23**	**61**	**9.3%**
a. *to* - infinitive	--	4	3	7	1.1%
b. *-ing* participle	6	4	6	16	2.4%
c. *-ed* participle	14	10	14	38	5.8%
3. Relative Clauses	**26**	**13**	**19**	**58**	**8.8%**
a. *wh* - relative	18	8	13	39	5.9%
b. *that* - relative	7	2	5	14	2.1%
c. prep. + *wh* - relative	1	2	--	3	0.5%
d. zero relative clause	--	1	1	2	0.3%
4. Appositives	**18**	**12**	**11**	**41**	**6.2%**
a. Appositive NP	17	12	8	37	5.6%
b. Appositive rel. cl.	1	--	3	4	0.6%
5. Postposed elements	**--**	**9**	**2**	**11**	**1.7%**
a. adverb	--	3	--	3	0.5%
b. adjective	--	6	2	8	1.2%
				658	**100%**

4.2.3.2.1 Prepositional Group

The figures in Table (XXI) reveal that the prepositional group constitutes 74% of the overall number of postmodifiers. Of this type, the preposition *of* has the highest frequency of occurrence constituting 66.1% of the total occurrences of prepositions and 48.9% of the total percentage of the postmodifying elements. The following are typical examples:

(4:56) Division of a tooth may resolve the conflicts of the paths of withdrawal, or relieve impaction. (Text C, 84) (-of postmodification).

(4:57) Deficiencies in fit are difficult to correct and unless they are of a very minor nature require the crown to be remade. (Text B, 87) (Postmodification by the preposition *in*)

A study of the occurrences of *of* postmodification in the corpus indicates that most of the instances of this type are simply resultants of nominalization either of *have* sentences, in which the underlying object becomes the head of the noun phrase;or of *be* paraphrases. The following examples illustrate this point:

(4:58-a) However, fracture of jacket crowns is still a common cause of failure, particularly where there are errors in the shape and sharpness of the tooth preparation, as well as errors in the occlusal contacts of the restoration. (Text B, 8)

The underlined constructions, in the above example, are respectively nominalizations of:

(4:58-b) Jacket crowns have fracture.

and

(4:58-c) The restoration has occlusal contacts.

In example (4:58-a), the underlying objects *occlusal contacts* and *fracture* have become the heads of the noun phrases. In the following example,

(4:59-a) A sheet of platinum foil is swaged onto the die; particular care must be taken not to damage the model during this procedure. (Text B,74)

the underlined prepositional phrase is a nominalization of the following sentence whose main verb is *be*:

(4:59-b) A platinum foil is a sheet.

As is shown in the above examples, the overuse of *of*- postmodification may be justified on the grounds that writers of this genre prefer to convey concepts by using nominal groups. As maintained by Sager et al. (1980: 205-220), since the most appropriate device to shorten or avoid finite clauses is nominalization, it is expected to encounter a high frequency of occurrences of *of*-postmodification.

It is interesting to compare our findings in this connection with similar ESP studies and common-core English:

1. Quirk et al. (1972:883) maintain that

   A preposition phrase is by far the commonest type of postmodification in English; it is three or four times more frequent than either finite or non-finite clausal postmodification.

2. As in our study, Al-Katanani (1990) found that the dominant postmodification type in the language of surveying is *of* postmodification.
3. Qara'een (1988) found that postmodification by the prepositional phrases is the most frequent type in the language of editorials.
4. Longe's (1985) study shows that the preposition group is the most occurring modifier in the language of public administration.

Table (XXII) below shows the frequency of prepositional groups in the studies referred to above:

Table (XXII): Frequency of Preposition Group in Previous Studies

Author Preposition Group	Longe (1985)	Qara'een (1988)	Al-Qatanani (1990)	Present Study (1992)
1. Preposition Group	**61%**	**60.2%**	**61%**	**74%**
a. prep. *of*	-	32.8%	44%	48.9%
b. prep. other than *of*	-	27.4%	17%	25.1%

Since prepositional phrases, particularly *of*-phrases, contribute greatly to NP postmodification, they could be regarded as a characteristic feature which distinguishes the language of dentistry.

4.2.3.2.2 Non-finite Clauses

The figures in Table (XXI) indicate that non-finite clauses constitute 9.3% of the entire number of postmodifiers. The vast majority of these clauses are *-ed* participle clauses. Infinitive clauses and *-ing* participial clauses occurred in the data, but less frequently. Typical examples of these types are the following:

(4:60) Enamel is formed by epithelial cells termed ameloblasts which disappear after the tissue is completed. (Text A, 18) *-ed* participle clause)

(4:61) Before treatment is commenced it is necessary to have established that the pulp is alive and that there is no radiographic evidence of disease affecting the tooth. (Text B,17) (*-ing* participle postmodifier)

(4:62) To illustrate the normal operative sequence, Figures 4-11 show the stages of an operation to remove an impacted lower third molar that was causing pericoronitis. (Text C, 60) (*to*-infinitive postmodifier)

The high frequency of *-ed* participle clauses in comparison to the other two non-finite clauses seems to be linked with the high frequency of passive voice in our source material. Thus, the dominance of passive in the written language of dentistry, as stated above, suffices to explain the high frequency of *-ed* participle clauses in contrast with *-ing* participle, and *to*-infinitive clauses. Added to this is the fact that most of *-ed* participle occurrences are a result of relative clause reduction.

4.2.3.2.3 Relative Clauses

As we have seen earlier in Table (XXI), relative clauses constitute 8.8% of the overall number of postmodifiers in the corpus. The vast majority of the relative clauses have *wh-* relative pronouns. On the other hand, clauses with *zero (ϕ)* relative pronouns as well as clauses with relative pronouns initiated by prepositions are rarely used (i.e., 0.3% and 0.5% respectively).

A frequency count of relative clauses revealed that one out of 15 sentences in the corpus contains a relative clause. Of the total number of occurrences of relative clauses, 48 are restrictive and 10 are non-restrictive. Illustrative examples of the various types of relative clauses encountered in the data are the following:

(4:63) Two fundamental requirements, which cannot be overemphasized, are effective lighting and suction. (Text C, 47) (non-restrictive)

(4:64) When the preparation has been completed, an elastic impression is taken, of which details have already been covered in Chapter 12. (Text B, 61) (non-restrictive prepositional relative clause)

(4:65) When such a crown is well made, it gives a durable and pleasing result; however, in addition to all the usual attention that has to be given to the fit, contour and occlusion of a crown in metal, the appearance is dependent on the way the variously pigmented powders are blended during construction. (Text B,3) (*that* - restrictive relative clause and zero restrictive relative clause)

The frequent ratio of relative clauses notably *wh*-relative and *that*-relative, in Text (A) in contrast to the other two texts may be explained by the nature of the text level or 'Brow'. Text (A), which is an introductory one is mainly addressed to those who still do not have an idea about the genre under discussion (i.e., dentistry). The authors of such texts resort to the frequent use of restrictive relative clauses as the result of the need to define the new terms and to introduce new concepts.

Comparison and contrast with other studies reveal the following:

1. Our findings regarding the frequency of restrictive and non-restrictive relative clause occurrences are similar to those of Huddleston (1971); Horzella and Sindermann (1978); and Al-Katanani (1990).
2. Concerning the scarcity of zero (ϕ) relative clause occurrences, our results are similar to those of Huddleston (1971), who pointed out that zero relative clauses rarely occur in SE.

3. With regard to relative clauses initiated by prepositions, these forms are scarcely used in our source material, whereas they play a major part in common-core English. Quirk et al. (1972: 869) argue that *'... wh-pronouns with preceding prepositions are used predominantly in formal English and may be avoided in more informal use.'*

On the whole, it can be noticed that postmodification by either zero relative clauses or relative clauses initiated by prepositions are rarely used in the written language of dentistry.

4.2.3.2.4 Appositives

The figures contained in Table (XXI) above show that appositives constitute (6.2%) of the total occurrence of postmodifiers. This type incorporates NP apposition and relative clause apposition; constituting (5.6% and 1.6%) respectively.

A detailed study of NP appositive occurrences in our source material revealed that the encountered instances of this type can be categorized as follows:

i) identification (17 instances),

ii) exemplification (12 instances),

iii) attribution (7 instances), and

iv) designation (one instance).

The following examples illustrate the above mentioned categories respectively:

(4:66) A tooth is divided into two parts: a root or roots which anchor it in the jaw and a crown, the part which is visible in the mouth. (Text A, 2) (identification).

(4:67) Very often on a posterior tooth such as an upper premolar, the buccal cusp is restored in ceramic with the palatal cusp being in metal. (Text B,106) (exemplification).

(4:68) A tooth is composed of four different tissues: (1) Enamel, (a hard, brittle substance which covers the crown);(2) dentin, (a bonelike substance which forms the body of the tooth);(3) cementum, (a bonelike substance which covers the tooth root); and (4) pulp, (which occupies the central cavity of the tooth called the pulp chamber and the root canals)(1). (Text A, 3).

Appositive nominal clauses, on the other hand, are rarely used in the present study. The only located instances of this type are *that*-nominals preceded by factive abstract HNs. The following is a typical example of this type:

(4:69) Relief, when it comes, tends to be rapid, and this lends weight to the suggestion that the mechanism is reflex inhibition of movement provoked by a painful stimulus. (Text C, 155).

The high frequency of exemplification and identification in comparison to the other two categories of NP apposition may be explained on the grounds that writers are concerned with presenting facts, ideas and theories in an accurate and clear way so as to achieve effective transfer of the subject matter. The rarity of *that*-nominal clauses, on the other hand, can be attributed to the restrictions on the type of the postmodified HN.

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(1) This example shows that each bracketed clause is an attributive of its immediate preceding underlined items, whereas each of the underlined items following the first underlined one are identification of the first one (*four different tissues*).

Quirk et al. (1972:874-5) state that the postmodified HN must be a factive abstract noun such as *fact*, *remark*, *answer* ... etc.

4.2.3.2.5 Postposed Adjectives and Adverbs

Table (XXI) above reveals that the postposed adjectives and postposed adverbs are the least frequent postmodifiers used in the data; constituting (1.2% and 0.5%) respectively. If we examine postposed adjectives, we cannot fail to notice that most of their occurrences in the data can be regarded as reduced relative clauses. The following example illustrates this:

(4:70) Excessive irrigation washes away adherent clotted blood, which is the best dressing material available. (Text C, 99) (i.e., that is available)

Other instances of postposed adjectives are susceptible to objective measure including those denoting size or shape. For example,

(4:71) A straight chisel (2mm wide) should be placed sideways in the groove and rotated. (Text B, 132)

A study of postposed adverbs encountered in the data reveals that this type signifies either place or manner. The following is an illustrative example of adverbs signifying 'place':

(4:72) Three grooves are placed in the labial surface to the full depth of the bur such that the depth of each groove incisally is 1.3mm tapering to 0.8mm at the gingival level. (Text B, 29) (place)

With regard to postposed adjectives and adverbs, a similar picture is presented by Quirk et al. (1971:892), who list these types amongst the minor types of NP postmodifications, as being infrequently used in common-core English.

4.3 Lexical Analysis

As mentioned in Chapter Three above, the following criteria were adopted to isolate technical and semi-technical items in the corpus:

i) intuitions of a team of judges,

ii) intuitions of non-specialist native speakers, and

iii) information gathered from general and specialized dictionaries.

This section incorporates an analysis of technical and semi-technical items, in addition to an account of the types of technicality encountered in the examined corpus.

4.3.1 Team of Judges

As stated earlier in Chapter Three, the three judges specializing in dentistry were given the texts upon which this study is based and were requested to circle the technical items and to underline the semi-technical ones that occurred in the corpus. The responses of the three judges were compared. The comparison of their responses resulted in the following lists which are arranged alphabetically:

i) Technical Items, and

ii) Semi-technical Items

4.3.1.1 Technical Items

The following are the items which were marked by the three judges as technical items which are only used by specialists in the field of dentistry and related sub-specialities. Analysis of the responses of the three judges resulted in three groups as follows: i) technical items agreed upon by the three judges, ii) technical items agreed upon by two judges, and iii) technical items marked by just one judge. Below is an account of these three minor lists:

List (IA): Technical Items Agreed upon by the Three Judges

The following is a list of 39 items which were marked by the three judges as being 'technical items':

buccal; cementoblasts; cementoclasts; cementocyte; cementogenesis; dental pulp; denticles; dentin; dentinoblast; dentinocemental; dentinoenamel; dentinoenamel junction; dentinogenesis; dento-alveolar; dry socket; endodontics; gingiva; gingival; gingival sulcus; incisal; incisally; inciso-gingivally; incisors; maxillary; mental foramen; mental nerve; metal ceramic crown; mucoperiosteal flap; osteoblasts; osteoclasts; odontoblast; periodontal ligament; peridontics; porcelain jacket crown; premolar; pulp chamber; pulp stone; secondary dentin; transseptal fibers.

List (IB): Technical Items Agreed upon by Two Judges

The following is a list of 46 items that were marked by two judges (but not by the third) as being technical items:

ameloblast; apical fibers; apical foramen; ariticulating paper; bony socket; bridge retainer; caries; cementoenamel junction; cementum; disto-buccal; disto-buccal cusp; disto-labial; disto-lingual; enamel rod; free gingiva; gingival fibrils; histocytes; horizontal fibers; Howarth's nasal raspatory; Howarth's periosteal elevator; inferior dental block; intercuspal; intercuspal occlusion; interprismatic substance; ionomer; jacket crown; lignocaine; line angle; lingual nerve; mesenchymal cells; mesio-labial; Mitchell's trimmer; mucoperiosteal; neonatal line;occlusal wear; overbite; pulpal; protoplasmic process; root canal; sclerosis; straight handpiece; subgingival; supragingivally; trismus; turbine handpiece; veneer crown.

List (IC): Technical Items Marked by just One Judge

The following is a list of 50 items that were marked by just one judge (but not the other two) as being technical items.

acid-etch; alveolar crest; alumina based ceramic; amalgam core; binangle; buccal cusp; cast gold restoration; cervical line; clinical crown; composite resin; Coupland's chisel; Cryer's elevator; deciduous; enamel fissure; enamel lamella; enamel pit; enamel tuft; epithelial cell; flat plastic; foramen; gingival contour; gingival papilla; gingival recession; haemostasis; high alumina porcelain core; hypoplasia; incremental lines of Retzius; Kilner cheek retractor;

mandible; mastication; mental foramen; mucosa; occlusal; oblique fibers; oral pathology; oral surgery; palatal cusp; papilla; pericoronitis; plaque; protrusive occlusion; pulp; tactors; resistance form; retained root; Sharpey's fibers; study model; tapered fissure bur; temporary crown; trial wax-up.

4.3.1.2 Semi-technical Items

The following are the items which were marked by the team of judges as being 'semi-technical'; that is to say, these are commonly used items in everyday communication but they change their meaning to acquire a special one when used in a particular specialized context. As in the case of technical items listed above, analysis of the responses of the three judges resulted in three groups as follows:

i) items agreed upon by the three judges

ii) items agreed upon by two judges (but not the third)

iii) items marked by one judge (but not the other two)

List (II A): Semi-technical Items Agreed upon by the Three Judges

Below is a list of 32 items which were marked by the three judges as being semi-technical items:

apex; apical; attrition; bond; bridge; ceramist; chamfer; chamber; coronal; crown; cusp; distal; dressing; enamel; eruption; excavator; finishing; jacket; impaction; impression; mesial; molar; nucleus; pulp; restoration; retainer; root; shoulder; skirt; stone; sulcus; wear.

List (IIB): Semi-technical Items Agreed upon by Two Judges

The thirty-eight items listed here were marked by two judges (but not by the third) as being semi-technical items:

amalgam core; approximal surface; bone file; butt joint; clearance; decay; diamond wheel; die-stone; elevator; erosion; fissure bur; forceps; fossae; glaze; groove; handpiece; imbrication; injection; lamellae; lateral; ligament; lute; matrix band; occlusion; protrusive; retention; rongeur; sedation; sheathed; socket; sterilized; suction; surgical kit; swage; tray; tubules; vital; wax-up.

List (IIC): Semi-technical Items Marked by Just One Judge

The following is a list of 53 items which were marked by just one judge (but not the other two) as being semi-technical:

abrasive; acid-etch; alumina based ceramic; alumina porcelain core; bevel; bur; caries; cast gold restoration; cervical; chisel; convoluted; core; crack; debris; delivery; enamel rod; extraction; fissure; flat plastic instrument; haemorrhage; hybrid; hypocalcified; hypoplasia; incremental lines; inflamation; junction; mandible; matrix; mucosa; neonatal; occlusal wear; oozing; overextension; pin; pit; plaque; platinized foil; prematurity; prenatal; point; postnatal; recession; resistance form; retained root; rubber wheel; sintered diamond bur; spicules; straight handpiece; sutured; temporary crown; translucency; trial wax-up; tungsten carbide bur.

The following table sums up the number of technical and semi-technical items contained in the above lists:

Table (XXIII): Marking by Judges

Variety	Three Judges	Two Judges	One Judge	Total
Technical	39	46	50	135
Semi-technical	32	38	53	123
Total	71	84	103	258

As is shown in Table (XXIII) above, the responses of the judges vary with respect to both technical and semi-technical items. However, there is a considerable number of items either technical or semi-technical agreed upon by the three judges. For example, 39 items were marked by the three judges as technical items and 32 as semi-technical.

In view of the differences in the responses of the three judges, the writer invited the three judges to meet with him in order to discuss the matter, in particular, the differences in their responses. The three judges were kind enough to accept the invitation, and in view of the lengthy discussion that took place, it was possible to narrow the differences and to arrive to a new modified list of technical items and another new modified list of semi-technical items.

4.3.1.3 Modified List of Technical Items

The discussion with the team of judges as a group yielded the following modified list of 127 items which were agreed upon by the three judges as being 'technical items':

alveolar; alveolar crest; amalgam; ameloblast; apical fibers; apical foramen; binangle; bone file; buccal; butt joint; caries; cementoblast; cementoclast; cementocyte; cementoenamel junction; cementogenesis; cementum; cervical line; clinical crown; composite resin; Coupland's

chisel; Cryer's elevator; deciduous; dental pulp; denticle; dentin; dentinoblast; dentinocemental; dentinocemental junction; dentinoenamel; dentinoenamel junction; dentinogenesis; dento-alveolar; disto-buccal; disto-buccal cusp; disto-labial; disto-lingual; dry socket; enamel fissure; enamel lamella; enamel pit; enamel rod; enamel tuft; endodontics; epithelial cells; fissure bur; flat plastic; free gingiva; gingiva; gingival; gingival fibrils; gingival papilla; gingival recession; gingival sulcus; haemorrhage; high alumina porcelain core; histocyte; horizontal fibers; Howarth's nasal raspatory; Howarth's periosteal elevator; hypocalcified; hypoplasia; incisal; incisally; inciso-gingival; incisor; incremental lines of Retzius; intercuspal; interprismatic substance;ionomer; jacket crown; Kilner cheek retractor; lamella; line angle; lignocaine; lingual nerve; mandible; mastication; maxillary; mental foramen; mental nerve; mesenchymal cells; mesio-labial; metal ceramic crown; Mitchell's trimmer; mucoperiosteal flap; mucosa; neonatal line; oblique fibers; occlusal wear; odontoblast; oral surgery; osteoblast; osteoclast; overbite; palatal; palatal cusp; pericoronitis; periodontal; periodontal ligament; periodontics; platinized foil; porcelain crown; porcelain jacket crown; protrusive occlusion; premolar; protoplasmic process; pulp chamber; pulp stone; pulpal; resistance form; retained root; rongeur; root canal; sclerosis; secondary dentin; Sharpey's fibers; straight handpiece; study model; subgingival; supragingivally; tapered fissure bur; temporary crown; transseptal fibers; trial wax-up; trismus; veneer crown.

4.3.1.4 Modified List of Semi-technical Items

The following is a modified list of 60 items which were agreed upon by the three judges as being 'semi-technical'.

apex; apical; approximal; articulating paper; attrition; bevel; bond; bridge; bur; ceramist; chamber; chamfer; clearance; core; coronal; crown; cusp; delivery; die-stone; dressing; enamel; erosion; eruption; excavator; extraction; finishing; fissure; forceps; fossa; glaze; groove; imbrication; impaction; impression; jacket; ligament; lute; mesial; matrix; nucleus; papilla; plaque; point; prematurity; protrusive; pulp; recession; restoration; retainer; retention; root; sheathed; shoulder; skirt; socket; stone; sulcus; swage; tray; wear.

As is show in Table (XXIII) above, the judges marked 258 lexical items. After the lengthy discussion with the team of judges as a group, 127 items were agreed upon by the three judges as being technical items and 60 as being semi-technical items. This makes the total number of technical and semi-technical items in the new modified lists 187. This means that there were 71 items not agreed upon after the discussion; therefore, the team of judges decided to discard them.

4.3.2 Non-specialist Native Speakers

As mentioned in Chapter Three above, a written questionnaire(1) was given to nine non-specialist native speakers in Jordan. One of these native speakers is British, whereas the rest are American. Their occupations are as follows: five undergraduate students, three graduate, and one expert linguist. Of these native speakers, seven returned the completed copies of the questionnaire.

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(1) The questionnaire appears in Appendix I.

A close analysis of the responses of the informants revealed that the two new modified lists that were agreed upon by the team of judges after the discussion were basically sound. Of the Modified List of Technical Items which contains 127 items, 117 were retained because they were marked by the respondants as being technical items. In the view of the informants' responses, 10 items which were originally considered by the three judges as being technical ones were excluded by the non-specialist native speakers. Of the ten items excluded, the following seven items were discarded; *deciduous; haemorrhage*; *incisor*; *mandible*; *mastication*; *premolar*; and *sclerosis*. It must be pointed out that these items were discarded due to the unanimous agreement on the part of the respondants that these items are commonly used in everyday communication, and that they are not used in a special way. The other three items that were excluded, namely, *caries*, *study model*, and *temporary crown* were agreed upon as semi-technical ones used in everyday communication (i.e., they acquire specialized meanings when used in technical contexts). These three items were therefore added to the Mododified List of Semi-technical Items. This addition, therefore, brought the number to 60 plus 3.

Likewise, forty-seven of the original sixty items contained in the Modified List of Semi-technical Items were accepted by the informants as being semi-technical. The remaining thirteen items(1), on the other hand, were considered by the informants as technical items. The results of the analysis indicated that these items are not used in everyday communication, although the respondants have been exposed to these items. The respondants marked them as technical items used in specialized contexts. These thirteen items were thus added to the 117 items, which were agreed upon by the team of judges and the non-specialist native speakers as technical items. These additions and deletions thus brought the number of technical items to 117 plus 13, (i.e., 130 technical items), whereas the finalized number of semi-technical items becomes 47 plus 3, (i.e., 50 semi-technical items).

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(1) The thirteen items are: *approximal; articulating paper; attrition; bevel; chamfer; coronal; die-stone; fossa; imbrication; mesial; papilla; sulcus;* and *swage.*

Thus, the net results of technical and semi-technical items that resulted from the procedures described above are included in two lists below, which are arranged alphabetically. The following finalized lists represent the closest approximation to the actual corpus of both technical and semi-technical items in the examined texts.

4.3.2.1 Finalized List of Technical Items

The following is a finalized list of 130 technical items which were obtained as a result of the procedure described above:

alveolar; alveolar crest; amalgam; ameloblast; apical fibers; apical foramen; approximal; articulating paper; attrition; bevel; binangle; bone file; buccal; butt joint; cementoblast; cementoclast; cementocyte; cementoenamel junction; cementogenesis; cementum; cervical line; chamfer; clinical crown; composite resin; coronal; Coupland's chisel; Cryer's elevator; dental pulp; denticle; dentin; dentinoblast; dentinocemental; dentinocenamel junction; dentinoenamel; dentinoenamel junction; dentinogenesis; dento-alveolar; die-stone; disto-buccal; disto-buccal cusp; disto-labial; disto-lingual; dry socket; enamel fissure; enamel lamella; enamel pit; enamel rod; enamel tuft; endodontics; epithelial cells; fissure bur; flat plastic; fossa; free gingiva; gingiva; gingival; gingival fibrils; gingival papilla; gingival recession; gingival sulcus; high alumina porcelain core; histocyte; horizontal fibers; Howarth's nasal raspatory; Howarth's periosteal elevator; hypocalcified; hypoplasia; imbrication; incisal; incisally; inciso-gingival; incremental lines of Retzius; intercuspal; interprismatic substance; ionomer; jacket crown; Kilner cheek retractor; lamella; lignocaine; line angle; lingual nerve; maxillary;

maxillary; mental foramen; mental nerve; mesenchymal cells; mesial; mesio-labial; metal ceramic crown; Mitchell's trimmer; mucoperiosteal flap; mucosa; neonatal line; oblique fibers; occlusal wear; odontoblast; oral surgery; osteoblast; osteoclast; overbite; palatal; palatal cusp; papilla; pericoronitis; periodontal; periodontal ligament; periodontics; platinized foil; porcelain crown; porcelain jacket crown; protrusive occlusion; protoplasmic process; pulp chamber; pulp stone; pulpal; resistance form; retained root; rongeur; root canal; secondary dentin; Sharpey's fibers; straight handpiece; subgingival; sulcus; supragingivally; swage; tapered fissure bur; transseptal fibers; trial wax-up; trismus; veneer crown.

4.3.2.2 Finalized List of Semi-technical Items

This is a list of 50 semi-technical items obtained as a result of the procedure mentioned above:

apex; apical; bond; bridge; bur; caries; ceramist; chamber; clearance; core; crown; cusp; delivery; dressing; enamel; erosion; eruption; excavator; extraction; finishing; fissure; forceps; glaze; groove; impaction; impression; jacket; ligament; lute; matrix; nucleus; plaque; point; prematurity; protrusive; pulp; recession; restoration; retainer; retention; root; sheathed; shoulder; skirt; socket; stone; study model; temporary crown; tray; wear.

4.3.3 General and Specialized Dictionaries

Each lexical item in the Finalized List of Technical Items, and in the Finalized List of Semi-technical Items mentioned above was looked up in *Webster's Third New International Dictionary (Unbridged) (W.T.N.I.D)* and in the following specialized dictionaries: *Blakiston's Gould Medical Dictionary (B.G.M.D); Illustrated Dictionary of Dentistry (I.D.N);* and *Boucher's Clinical Dental Terminology (B.C.D.T).* This task brought forth the following various subgroups of technical and semi-technical items:

4.3.3.1 Technical Items

The Finalized List of Technical Items which incorporates 130 was found to comprise the following groups of lexical items:

A. Single Items Having the Technical Meaning Listed First in *Webster's T.N.I.D.* and in the Specialized Dictionaries.

These items are listed in *Webster's T.N.I.D* and the specialized dictionaries. They appear to have a very precise reference and their technical meanings are listed first. The following is a list of these technical items:

alveolar; amalgam; ameloblast; approximal; bevel; buccal; cementoblast; cementogenesis; cementum; chamfer; dental pulp; denticle; dentin; dentinoblast; dentinogenesis; enamel rod; endodontics; epithelial; fossa; gingiva; gingival; histocyte; hypocalcified; hypoplasia; incisal; incisally; ionomer; jacket crown; lamella; maxillary; mesenchymal; mesial; mucosa; odontoblast; oral surgery; osteoblast; osteoclast; overbite; palatal; papilla; pericoronitis; periodontal; periodontics; pulp chamber; pulpal; rongeur; subgingival; sulcus; swage; trismus.

B. Compound Words Listed in the Specialized Dictionaries as Compounds but not Listed in *Webster's T.N.I.D.*

Below is an account of these compound technical items and the titles of the specialized dictionaries in which they are listed:

alveolar crest **(B.G.M.D.);** ***apical fibers*** **(B.C.D.T and I.D.D);** ***apical foramen*** **(B.G.M.D);** ***bone file*** **(I.D.D.);** ***butt joint*** **(B.C.D.T);** ***cementoenamel junction*** **(B.G.M.D);** ***cervical line*** **(B.G.M.D);** ***clinical crown*** **(B.G.M.D);** ***composite resin*** **(B.C.D.T);** ***Cryer's elevator*** **(I.D.D);** ***dentinocemental junction*** **(B.G.M.D);** ***dentinoenamel junction*** **(B.G.M.D);** ***dento-alveolar*** **(B.G.M.D);** ***die-stone*** **(I.D.D);** ***disto-buccal*** **(B.G.M.D);** ***disto-labial*** **(B.G.M.D);** ***disto-lingual*** **(B.G.M.D);** ***dry socket*** **(B.G.M.D.);** ***enamel fissure*** **(I.D.D);** ***enamel lamella*** **(B.G.M.D);** ***enamel tuft*** **(I.D.D);** ***fissure bur*** **(I.D.D);** ***free gingiva*** **(B.G.M.D);** ***gingival fibrils*** **(I.D.D);** ***gingival papilla*** **(I.D.D);** ***gingival recession*** **(I.D.D);** ***gingival sulcus*** **(B.G.M.D);** ***horizontal fibers*** **(B.C.D.T);** ***incremental lines of Retzius*** **(B.G.M.D);** ***interprismatic substance*** **(B.G.M.D);** ***line angle*** **(I.D.D);** ***lingual nerve*** **(B.G.M.D);** ***mental foramen*** **(B.G.M.D);** ***mental nerve*** **(B.G.M.D);** ***mesio-labial*** **(B.G.M.D);** ***metal ceramic crown*** **(I.D.D);** ***mucoperiosteal flap*** **(I.D.D);** ***neonatal line*** **(B.G.M.D);** ***oblique fibers*** **(B.C.D.T);** ***occlusal wear*** **(B.C.D.T);** ***periodontal ligament*** **(B.G.M.D);** ***platinized foil*** **(I.D.D);** ***porcelain crown*** **(B.C.D.T);** ***protrusive occlusion*** **(B.G.M.D);** ***protoplasmic process*** **(B.G.M.D);** ***pulp stone*** **(B.G.M.D);** ***resistance form*** **(B.G.M.D);** ***retained root*** **(B.C.D.T);** ***root canal*** **(I.D.D);** ***secondary dentin*** **(B.G.M.D);** ***Sharpey's fibers*** **(I.D.D);** ***straight handpiece*** **(I.D.D);** ***tapered fissure***

bur **(I.D.D);** ***transseptal fibers*** **(B.C.D.T);** ***trial wax-up*** **(B.C.D.T);** ***veneer crown*** **(B.G.M.D).**

C. Single Word Items Listed in the Specialized Dictionaries but not Listed in Webster's T.N.I.D.

The following items are listed in the specialized dictionaries but are not listed in Webster's T.N.I.D:

binangle; cementoclast; cementocyte; dentinocemental; dentinoenamel; imbrication; intercuspal; lignocaine; supragingivally.

D. Technical Items not Listed in Webster's T.N.I.D. nor in the Specialized Dictionaries:

The items listed here are not listed in Webster's T.N.I.D. or in the specialized dictionaries:

articticulating paper; Coupland's chisel; disto-buccal cusp; enamel pit; flat plastic; high alumina porcelain core; Howarth's nasal raspatory; Howarth's periosteal elevator; inciso-gingival; Kilner cheek retractor; Mitchell's trimmer; palatal cusp; porcelain jacket crown.

4.3.3.2 Semi Technical Items

The Finalized List of Semi-technical Items, on the other hand, was found to comprise the following groups of items:

A) Common Words Having the Specialized Meaning Listed in Webster's T.N.I.D.

These items have a range of meanings but they keep the specialized one when they are used in a particular technical context. Below is a list of these items and the rank of their special use when used in technical contexts.

apex: **5(c)*; apical:* 2*; bridge:* 4(e)*; bur:* 9*; caries:* 1(b)*; chamber:* 2*; clearance:* 2(c)*; crown:* 3(h)*; cusp:* 2(d)*; delivery:* 3b*; dressing:* 3(a)*; enamel:* 6*; erosion:* 1 a(2)*; eruption:* 1b(2)*; excavator:* 1(c)*; extraction:* 1*; finishing:* 2(f)*; fissure:* 2(b)*; forceps:* 1*; glaze:* 4*; groove:* 2(b)*; impaction:* 1*; impression:* 2 a(3)*; lute:* 5*; matrix:* 5(c)*; nucleus:* 2(k)*; plaque:* 2(c)*; point:* 6(2)*; pulp:* 1(d)*; restoration:* 4(f)*; retainer:* 4(d)*; retention:* 1(f)*; root:* 2(b)*; sheathed:* 2*; shoulder:* 5*; skirt:* 3*; socket:* 1*(b); stone : 2; tray:* 5*; wear:* 8.

B) Items with Common Meaning Only (Listed in Webster's T.N.I.D.)

The common meanings of the following group of items are listed in Webster's T.N.I.D., whereas their special uses are not cited. On the other hand, they have technical uses listed in the specialized dictionaries. This group includes the following items:

bond; ceramist; core; jacket; ligament; prematurity; protrusive; recession; study model; temporary crown.

The following specimen entries from Webster's T.N.I.D show how the general items change their common meanings to acquire a semi-technical one when they are used in a specialized technical context. The rank of the specialized meaning is indicated between square brackets, whereas the rank of the general meaning is indicated between parentheses:

1.a bridge: (1) a structure erected over a depression or an obstacle to travel

[4.2.e] a partial denture held in place by anchorage to adjacent teeth

2.a crown: (2) a royal or imperial headdress or a cap of sovereignty worn by monarchs

[3.h.1] the part of the tooth external to the gum

3. enamel: (1) a usual opaque or semiopaque vitreous composition applied by fusion to the surface of metal, glass or pottery for ornament or protection or as a basis for decoration

[6] the intensely hard calcareous substance that forms a thin layer capping or partly covering the teeth of most mammals (as/man)

4. impression: (1) the act or process of impressing. (an afffecting by stamping)

[3] a negative imprint in plastic material of the surfaces of the teeth and adjacent portions of the jaw from which a positive likeness may be produced in dentistry

5. root: (1) the portion of the plant body of a seed plant . . .

[2.a] the part of a tooth lying within the socket

As can be seen from the above specimen enteries, semi-technical items can be considered as 'discipline independent items' in the sense that each item has various extended meanings in addition to its general one. They tend to occur with high frequency across disciplines acquiring special meanings, each of which depends on the variety in which it is used. For example, the general meaning of a word such as *crown* is extended in terms of **shape** and **position**. The shape of that portion of enamel present on the coronal part of the tooth in the oral cavity is similar to the cap worn on the head. With respect to **position**, both of the above mentioned meanings whether general or specialized refer to caps worn on the head. Likewise, when a general item such as *a root* is used in a specialized context, such as the field of dentistry, it is extended to resemble the root of a tree in position and in function .

Our findings concerning the categorization of lexical items into technical and semi-technical are very similar to those of Trimble (1985). According to him, the lexical items could be divided into three areas: technical vocabulary, sub-technical vocabulary, and noun compounds. Similarly, the lexicon of special subjects, according to Sager et al. (1980), incorporates three major groups of words consisting of:

i) general language words used with modification of meaning in a particular discipline,

ii) technical terms specific to a discipline used only by specialists, and

iii) general words used in all registers without distinction.

4.3.4 Types of Technicality

Further investigation of the technical items that occurred in the data revealed that the aforementioned finalized list of technical items can be divided into two types of technicality:

i) genre specific items, and

ii) technical items not restricted to dentistry.

The decision whether or not a particular technical term is genre specific was made jointly by a team which comprised two specialist professors in dentistry and a specialist in engineering.

4.3.4.1 Genre Specific Items

This type of technical items seems to be mostly used by technical subject experts and the participants within the same discipline. Wherever the reader encounters any item of such type, he gets the impression that it is indicative of the speciality of the text in

which it is found. The following list of technical items that were encountered in the examined data represents this type:

alveolar crest; ameloblast; apical fibers; apical foramen; articulating paper; binangle; buccal; cementoblast; cementoclast; cementocyte; cementoenamel junction; cementogenesis; cementum; clinical crown; Coupland's chisel; Cryer's elevator; dental pulp; denticle; dentin; dentinoblast; dentinocemental; dentinocemental junction; dentinoenamel; dentinoenamel junction; dentinogenesis; dento-alveolar; disto-buccal; disto-buccal cusp; disto-labial; disto-lingual; dry socket; enamel fissure; enamel lamella; enamel pit; enamel rod; enamel tuft; endodontics; fissure bur; flat plastic; free gingiva; gingiva; gingival; gingival fibrils; gingival papilla; gingival recession; gingival sulcus; high alumina porcelain core; incisal; incisally; inciso-gingival; incremental lines of Retzius; intercuspal; interprisamatic substance; jacket crown; Kilner cheek retractor; mesio-labial; metal ceramic crown; Mitchell's trimmer; mucoperiosteal flap; occlusal wear; odontoblast; oral surgery; palatal cusp; pericoronitis; periodontal; periodontal ligament; periodontics; porcelain crown; porcelain jacket crown; protrusive occlusion; pulp chamber; pulp stone; retained root; root canal; secondary dentin; Sharpey's fibers; subgingival; supragingivally; tapered fissure bur; trial wax-up; trismus; veneer crown.

The technical items listed above appear to have a relatively fixed and unique meaning in the field of dentistry. Thus this meaning is only familiar to those who are specialized in this discipline. This type can be termed as 'discipline dependent items', in the sense that their occurrences are restricted to certain disciplines; (i.e., rarely occur

across genres other than dentistry). The following specimen entries from Webster's T.N.I.D further support the point under discussion:

1. *dentin:: a calcareous material similar to bone but harder and denser that composes the principal mass of tooth, is formed by the odontoblasts of the surface of the dental papilla, and consists of a matrix containing minute parallel tubules which open into the pulp cavity and during life contain processes of the cells of the pulp*
2. *enamel rod (n): one of the elongated prismatic bodies making up the enamel of a tooth*
3. *cementum: the specialized external bony layer enclosing the dentin of the part of a tooth normally within a gum*
4. *ameloblast: one of the columnar cells of the inner layer of the enamel organ that produce and deposit enamel on the surface of a developing tooth*
5. *jacket crown: an artificial crown that is placed over the remains of a natural tooth*
6. *periodontics: a branch of dentistry that is concerned with diseases of the supporting structures of the teeth*

4.3.4.2 Technical Items not Restricted to Dentistry

The technical items listed below are not used exclusively in the field of dentistry, but are also used in other related restricted subspecialities.

alveolar; amalgam; approximal; attrition; bevel; bone file; butt joint; ceramist; cervical line; chamfer; composite resin; coronal; dento-alveolar; die-stone; epithelial cells;fossa; histocyte; horizontal fibers;

Howarth's nasal raspatory; Howarth's periosteal elevator; hypocalcified; hypoplasia; imbrication; ionomer; lamella; lignocaine; line angle; lingual nerve; maxillary; mental foramen; mental nerve; mesenchymal cells; mesial; mucosa; neonatal line; oblique fibers; osteoblast; osteoclast; palatal; papilla; platinized foil; protoplasmic process; pulpal; resistance form; rongeur; straight handpiece; sulcus; swage; transseptal fibers.

Unlike genre specific technical items, this type is less genre dependent. The following specimen entries from Webster's T.N.I.D. illustrate this point:

1. *rongeur: a heavy duty forceps for removing small pieces of bone or tough tissue*
2. *osteoclast: one of the large mutinucleate cells in developing bone that are considered to function in the disolution of unwanted bone (as in the formation of canals or the healing of fractures).*
3. *osteoblast: a bone-forming cell*
4. *swage:*

   1. a decorative border of grooving or molding

   2. any of several variously shaped or grooved tools:

      a: a tool used by metal-workers to shape material to a desired form

      b: a tool used to set the teeth of a circular or band saw

As is clear from the entries listed above, a *rongeur* is a term that is not only used by dentists but also by orthopedists. Likewise, *osteoblasts* is a term that refers to cells responsible for forming the bone not only of teeth but it also refers to bone-formation in

general. The technical term *swage* is also used by mechanical engineers besides its employment by orthodontists.

Our findings regarding the types of technicality are similar to those of Maley (1987:34) whose study investigated the language of law. Maley (ibid) argues that: *'Technicality in vocabulary of the law generally has two aspects: technical terms and terms of art(1)'*.

4.3.5 The Distribution of Word Class of Technical and Semi-technical Items

Table (XXIV) below shows the distribution of word classes of technical and semi-technical items that occurred in the corpus.

Table (XXIV): Distribution of Word Class of Technical and Semi-technical Items

Items	N No.	%	adj No.	%	A No.	%	V No.	%	Total No.	%
Technical	103		23		2		2		130	72.2
Semi-technical	46		3		-		1		50	27.8
Total	149	82.8%	26	14.4%	2	1.1%	3	1.7%	180	100%

The figures in Table (XXIV) reveal that nouns occupy up to 82.8% of the entire number of technical and semi-technical word classes, followed by adjectives, which constitute 14.4%. Verbs and adverbs, on the other hand, are the least frequent. As far as the above table is concerned, it is obvious that technical items outnumber semi-technical ones; constituting 72.2% and 27.8% respectively.

(1) A 'term of art' as defined by Mellinkoff (1963:17) refers to a technical word with a specific meaning.

With regard to the high frequency of nouns, the dominance of this word-class is not really surprising, since the main burden of information falls on this type of word class, which in turn, contributes to the informative function of this register. The high number of technical items found in the corpus is likely to be a direct response to the demands of this register in order to keep pace with the growing body of knowledge. The reasonable number of semi-technical items, on the other hand, explains the dependence of the language of dentistry on general language (i.e., A term is taken from general language and extended in different ways to designate the new materials or discoveries).

To conclude this section, the lexical analysis has revealed that the written language of dentistry includes three types of lexical items, namely,

i) context free items having general meanings and which in technical context, such as dentistry, take on specialized meanings,
ii) specialized items used in restricted and related varieties, and
iii) genre dependent items used only in a particular discipline.

These findings reflect how the lexicon of the language of this genre is related to and dependent on that of common-core English at the one hand, and how it is related to other restricted but related sub-specialities such as medicine and engineering, on the other. Despite this fact, this variety also has its own lexicon comprising items which are likely to be encountered only in this genre. Therefore, it can be legitimately argued that the language of dentistry is different from common-core language and other specialized varieties of English in the use of vocabulary items.

4.4 Textual Cohesion

4.4.1 What is 'cohesion'?

In Halliday and Hassan view (1976), cohesion is a primary concept. It refers to those features or cohesive relationships within and between sentences or between larger units of discourse, which create texture: 'A text has texture and this is what distinguishes it from something that is not a text' (1976:2). Cohesive relationships within a text are set up

> *... where the interpretation of some element in the discourse is dependent on that of another. The one presupposes the other in the sense that it cannot be effectively decoded except by recourse to it (1976:4).*

Halliday and Hassan outline five ways by which cohesion is created in English:

i) reference,

ii) substitution,

iii) ellipsis,

iv) conjunction, and

v) lexical cohesion.

This section deals with cohesion relations which were found to operate within the text but not within the sentences. As stated in Chapter Three above, Text (B) was chosen for the investigation of cohesive relations in the present study. The different mechanisims of textual cohesion devised by Halliday and Hassan (1976) which were found to operate on the intersentential and interparagraph levels were:

i) reference,

ii) ellipsis,

iii) conjunction, and

iv) lexical cohesion.

Substitution, on the other hand, was not encountered in the text.

4.4.2 Cohesion between Sentenses

Table (XXV) below sums up the distribution of the various types of intersentential relations that occurred in Text (B):

Table (XXV): Summary of the Intersentential Cohesive Relations

	Ref.	Ellips.	Subs.	Conj.	Lexical	Total
No.	99	2	0	21	426	548
%	18.07	0.36	0	3.83	77.74	100%

4.4.2.1 Reference

Reference forms are items which

> *instead of being interpreted semantically in their own right .... make reference to something else for their interpretation. In English these items are personals, demonstratives and comparatives.* (Halliday and Hassan, 1976: 31)

These forms direct the hearer/reader elsewhere for their interpretation. Their interpretation lies either within the text or outside the text, in the context of situation. The first is called **exophoric** relationships which plays no part in textual cohesion (1976: 18), whereas the latter is called **endophoric** and does form cohesive ties within the text. Endophoric relations are of two kinds. Those which point back to some previous items in the text for their interpretation are called **anaphoric** relations, and those which look forward in the text for their interpretation are called **cataphoric** relations (c.f. Halliday & Hassan, 1976).

The table below shows the frequency of occurrence and the direction of the various types of reference relations between sentences.

Table (XXVI): Frequency of Occurrence and Direction of Reference Relations on the Intersentential Level

Direction	Anaphoric	Exophoric	Total	
Type of Reference	No	No	No	%
1. Personal	**4**	-	**4**	**4**
2. Demonstrative	**83**	**3**	**86**	**86.9**
a. definite Article	67	3	-	-
b. near	16	-	-	-
c. far	-	-	-	-
3. Comparative	**9**	-	**9**	**9.1**
Total	**96**	**3**	**99**	**100%**
% of Total	**97%**	**3%**		

It can be seen from (Table XXVI) above that anaphoric reference occurrences outnumber exophoric ones - constituting 97% and 3% respectively. All the exophoric occurrences pertain to demonstratives, particularly, the definite article *the*. Regarding the different types of reference, it is noticed that the demonstrative reference relations, especially the definite article *the*, constitute the overwhelming majority of reference relations (86.9%) followed by comparatives (9.1%) and then personal pronouns (4%).

The following are illustrative examples showing the various reference relations and their direction. The presupposed and presupposing items are underlined and indicated between square brackets, whereas the reference type and its direction is indicated at the end of the text.

(4:73) Overextension, however, should be corrected by trimming [presupposed item] back excess with a diamond wheel; for this procedure the crown should be held on the die. This trimming [presupposing item] may have to be repeated several times before the overextension is completely eliminated. (Text B, 88-89) (anaphoric demonstrative reference).

(4:74) Porcelain jacket crowns [presupposed item] are not usually used on posterior teeth because they are too often brittle. In these cases metal-ceramic crowns would be used because they have greater strength [presupposing item], although their colour match is likely to be less good. (Text B, 14,16) (anaphoric comparative reference).

(4:75) When such a crown [presupposed item] is well made, it gives a durable and pleasing result; however, in addition to all the usual attention that has to be given to the fit, contour and occlusion of a crown in metal, the appearance is dependent on the way the variously pigmented powders are blended during construction. For this reason it [presupposing item] presents a great challenge to the operator and too often the results fall below expectations, especially in inexperienced hands. (Text B, 3-5) (anaphoric personal reference).

Our findings reveal the scarcity of personal reference occurrences. Within this category of reference, it has been noticed that pronominals, except for four occurrences

of the singular neuter *it*, are completely absent. This characteristic can be connected with the need to avoid ambiguity. Avoidance of the use of pronominals may be also attributed to the fact that this text incorporates a very high frequency of passive voice occurrences (i.e., 39%) which has the effect of reflecting an impersonal style.

With respect to the scarcity of pronominals, the written language of dentistry shares common ground with other varieties such as SE, reported by Sager et al. (1980). They list personal pronouns amongst the low frequent structures in SE, whereas these forms do play a major part in common-core English. On the other hand, there is a much greater degree of contrast between the written language of dentistry and the language of newspaper reporting and editorials reported by Crystal and Davy (1969:185), and Qara'een (1988:143) respectively. They found that personal reference is abundantly used in their source material to link sentences.

It is quite obvious that the absence of pronominals in Text (B) is compensated by the extensive use of demonstrative reference, namely, the definite article *the*. This type of reference marks the head noun phrase as an element whose interpretation depends on an earlier presupposed item. This head noun may stand as an explicit repetition of such a presupposed item. By repeating the noun in question and not allowing in pronouns, the writer is able to avoid the possibilities of misinterpretation.

Regarding the excessive use of the definite article in our source material, there is a much degree of overlap between the language of written dentistry and that of the legal language. For example, Crystal and Davy (1969: 212-14) and Gustafsson (1975:24), in their analyses of the language of legal documents, reported similar results.

Comparative reference relations, on the other hand, have a very low frequency. Al-Katanani (1990), in her analysis of the language of surveying, reported similar findings.

Another significant point that needs mentioning here is the fact that seven instances of the 16 occurrences of demonstrative relations have antecedents that are not noun phrases but an independent clause, a sentence or a couple of sentences. Illustrative example of this is the following:

> *(4:76) A straight chisel (2mm wide) should be placed sideways in the groove and rotated [presupposed]. This [presupposing] will crack the porcelain on the palatal side of the restoration and break the cement lute; the pieces of porcelain will normally lift off.* (Text B, 132-133).

Such tendency is also encountered in the EST texts investigated by Tyma (1981), who maintains that selecting a sentence or more as an antecedent for a noun phrase represents a slight deviation from the treatment of noun phrase coreference found in Quirk et al. (1972).

In their analysis of the language of legal documents, Crystal and Davy share the same contention. They maintain that

> *....the demonstratives this and that are commonly used to refer to considerable stretches of language, perhaps comprising a number of sentences (1969: 202).*

4.4.2.2 Ellipsis and Substitution

Halliday (1985:288) defines ellipses as

> *... a clause or part of a clause, or a part of a verbal or nominal group, may be presupposed at a subsequent place in the text by the device of positive omission - that is, by saying nothing, where something is required to make up the sense.*

A substitute item, on the other hand, is defined as

> *... a sort of counter which is used in place of the repetition of a particular item. It follows that the substitute item has the same structural function as that for which it substitutes.* (Halliday and Hassan, 1976:89).

Ellipsis, as a cohesive relation, was found to operate only twice, whereas substitution cohesion relations were completely absent in the examined text. The following is one of these instances of ellipsis:

> *(4:77) Where it is intended to crown a number of teeth or to reshape teeth extensively, a trial wax-up with beeswax should be carried out on a duplicate model [presupposed]. Reference can be made to this [presupposing] during construction of the crowns to ensure they are of the correct proportions and their incisal edges are situated in the right place.* (Text B, 19-20).

Halliday (1985:303) maintains that '... ellipsis - substitution is largely limited to the immediately preceding clause'. Likewise, Halliday and Hassan (1976) acknowledge that ellipsis is a characteristic of question and answer or similar adjacency pairs in dialogue. They also maintain that verbal ellipsis cannot be used at all where the verb is passive. Since there are such constraints on the use of ellipsis as a cohesive device, it is unlikely

to find ellipsis occurrences across sentence boundaries in the examined text which has a high frequency of passive voice constructions.

4.4.2.3 Conjunction

Another form of cohesion relations that occurred in the corpus upon which this study is based is achieved by the use of conjunctions. A conjunction relates what is about to be said to what has been said before. Halliday and Hassan (1976: 227) define conjunction relations as '...a specification of the way in which what is to follow is systematically connected to what has gone before'. They also provide a taxonomy of types of explicit markers of conjunctive relations, namely, i) temporal, ii) additive, iii) adversative, and iv) causal.

Table (XXVII) below shows the number and percentage of occurrence of the four conjunction relations that occurred in Text (B).

Table (XXVII): Frequency of Conjunctive Relations

Conjunction	No	%
1. Temporal	10	47.60
2. Additive	4	19.05
3. Adversative	4	19.05
4. Causal	3	14.30
Total	21	100%

As can be seen from the above table, temporal conjunctions have a high frequency of occurrence; constituting 47.60% of the overall number of the occurrences of conjunctive relations. It is also worth pointing out that the temporal conjunction that occured most frequently is *then* (six instances). The commonest types of conjunctions that

occurred in the data are illustrated in the following examples. The conjunctions to link sentences are underlined, whereas their types are indicated between square brackets.

(4:78) The incisal length should be assessed with the patient being examined in the sitting position. For this, [causal] reference to the original study model, or trial wax-up model, may be particularly valuable. Then [temporal] the labial contour is assessed and adjusted as required. (Text B, 92-94)

(4:79) If the wrong shade has been chosen, it is necessary to remake the crown. However, [adversative] if the colour is very close when the tooth is examined wet, surface stains may be added to reduce the brightness by a light general application, and to alter the colour more significantly by heavier application in particular areas such as the neck. Stains may also [additive] be used to simulate restorations, cracks and hypoplasia. (Text B, 97-99)

The high frequency of temporal relations in comparison to other conjunctions in our source material could be ascribed to the nature of the text. Text (B) is characterized by a series of sequential steps leading to a predetermined goal. These steps are realized through the use of temporal relations which act as semantic bridges between sentences.

However dominant the temporal sequential relations may be, the other relations are normally present between sentences though with a lesser degree. The writer of the investigated text amalgamates three other types of conjunctions, namely, additives, causal, and adversative to contribute to the progression of the text. In order to indicate a continuous train of thought, the writer resorts not only to explicit sequential temporal connectors but also to implicit ones. It happens that the successive sentences of this text are also connected through the use of semantic relationships which are clearly felt to be present in the text, although unexpressed. The following is an illustrative example.

(4:80) To remove a porcelain jacket crown, a groove should be placed in the middle of the labial surface using a diamond bur in the turbine handpiece with copious waterspray to prevent overheating. A straight chisel (2 mm wide) should be placed sideways in the groove and rotated. (Text B, 131-132)

As is shown in the above example, texture between these two sentences is achieved through implicit underlying semantic temporal relations. This finding lends support to Halliday's claim that

It often happens, especially with temporal and causal sequences, that the semantic relationship is clearly felt to be present but is unexpressed (1985:308).

In conclusion, one could say that the nature and the particular function of the text explain the preponderance of some conjunctive relations, either explicit or implicit, rather than others.

4.4.2.4 Lexical Cohesion

As pointed out by Halliday and Hassan (1976), lexical cohesion is achieved through the choice of lexical items that are related in various ways to those that have gone before. The following is the classification of lexical cohesion devices put forward by Halliday and Hassan (1976), and Halliday (1985):

i) collocation, and

ii) reiteration which comprises the following:

1. repetition of the same lexical item,
2. synonymy,
3. hyponymy,
4. meronymy,

5. antonymy, and

6. superordinate.

The sub-types, 'hyponymy' and 'meronymy' only appear in Halliday (1985). The frequency of these types and sub-types of lexical items are shown in tables (XXVIII) and (XXIX) below:

Table (XXVIII): Frequency of Cohesive Lexical Items

Type	No	%
Reiteration	290	68.1
Collocation	136	31.9
Total	426	100%

Table (XXIX): Frequency of Reiterate Lexical Items

Type	No	%
1. Same Item	223	76.9
2. Synonymy	5	1.7
3. Antonymy	6	2.1
4. Hyponymy	21	7.2
5. Meronymy	18	6.2
6. Superordinate	17	5.9
Total	290	100%

Table (XXVIII) above indicates that 'reiterate' items have a noticeable frequency of occurrence. Whereas collocation comprises 31.9% of the total lexical items on the intersentential level, reiteration accounts for 68.1%. Likewise, Table (XXIX) above reveals that the 'repetition of the same lexical item' is the most frequent cohesive sub-type, constituting (76.9%). The following text illustrates how the sentences are cohesively connected through the use of lexical items:

(4:81) The porcelain jacket crown is less suitable for young patients whose teeth still have large pulps, so these restorations are not commonly provided for teenagers. Usually the labial margin is placed in the gingival sulcus to give a good aesthetic result. However, in a young patient, normal gingival recession can cause the margin to become visible within a year or two; this is often unsightly and yet another reason for not making this type of restoration in young patients. Short clinical crowns provide inadequate retention of the restoration on the preparation, and thin teeth particularly with a deepened overbite may have insufficient room on the palatal surface for the necessary thickness of porcelain. Small upper teeth and most lower incisors rarely provide sufficient room for these crowns. (Text B, 9-13).

The following taxonomy illustrates how the occurrences of reiterate items and collocational referents in the above cited text contribute to textual cohesion:

A. Reiteration

1. repetition of the same item:*young patients, restoration, teeth, porcelain, gingival, crown.*
2. synonymy: *young patient/teenagers*
3. antonymy: *sufficient/ insufficient*
4. hyponymy: *porcelain jacket crown/ clinical crown*
5. meronymy: *pulp, crown/ tooth*
6. superordinate: *Teeth are at a higher level of generality than incisors.*

B. Collocation:

porcelain jacket crown, teeth, pulps, labial margin, gingival sulcus, clinical crowns, overbite, palatal surface, incisors, crowns.

The high frequency of repetition of the same lexical item obtained from the analyzed text may be attributed to the fact that writers of this variety prefer to mention explicitly the same presupposed item in describing the procedures to be followed by the practioners in order to maintain a high degree of precesion and to avoid ambiguity.

A comparison of our findings with those of other researchers reveals the following:

1. Crystal and Davy (1969: 202), in their analysis of the written language of legal documents, found that

   The only formal linkage to be found between the long sentences is the repetition of lexical item, and of this there is a good deal.

2. Sager et al. (1980), whose study investigated the language of SE, share the same contention in the sense that the repetition of lexical items is one of the two main techniques which operate across sentence boundaries.
3. Al-Katanani (1990), in her analysis of the written language of surveying, reported similar results.

On the other hand, the language variety under discussion (i.e., dentistry) as well as the varieties mentioned above contrast with common-core English and other varieties with respect to the high frequency of the repetition of the same lexical item. In this respect, Crystal and Davy (1969: 202) state that 'In almost all other varieties too much repetition is regarded as tiresome.'

4.4.3 Cohesion between Paragraphs

As stated in Chapter Three above, Text (B) (which was chosen for the investigation of lexical cohesion) comprises 35 paragraphs. This sub-section deals with the following cohesion relations which were found to operate on interparagraph level:

i) reference,

ii) conjunction, and

iii) lexical cohesion.

The other two relations, namely, ellipsis and substitution are not discussed here due to the fact that no instances occured in the text. Cohesion relations on the interparagraph level are illustrated in the following table.

Table (XXX): Frequency of Cohesion Relations on Interparagraph Level

Cohesion Relation	No	%
1. Reference	152	11.96
2. Conjunction	4	0.31
3. Lexical Cohesion	1115	87.73
4. Ellipsis	0	0
5. Substitution	0	0
Total	1271	100%

4.4.3.1 Reference

Table (XXXI) below shows the frequency of occurrence and the direction of the various types of reference relations between paragraphs.

Table (XXXI): Frequency and Direction of Reference Relations between Paragraphs

Direction / Type of Reference	Anaphoric No	Exophoric No	Total No	%
1. Personal	1	-	1	0.7
2. Demonstrative (Definite Article)	138	4	142	93.4
3. Comparative	9	-	9	5.9
Total	148	4	152	100%
% of Total	97.4%	2.6%		

Table (XXXI) above reveals that there is an extensive use of anaphoric reference. It constitutes 97.4% of the entire number of reference relations. All the instances of exophric reference relations are achieved through the use of the definite article *the*. On the other hand, the total number of instances of demonstrative reference is larger than the total number of instances of comparative reference and personal reference respectively: demonstrative reference (93.4%); comparative reference (5.9%), and personal reference (0.7%).

The following is an illustrative text showing the various reference relations. Discussion of these types and their direction is provided immediately after the text.

(4:82) The most widely used crown is made from dental porcelain and is known as a porcelain jacket crown[1].

When such a crown[2] *is well made, it gives a durable and pleasing result; however, in addition to all the usual attention that has to be given to the fit, contour and occlusion of a crown in metal, the appearance is dependent on the way the variously pigmented powders are blended during construction. For this reason it*[3] *presents a great challenge to the*

operator[4] *and too often the results fall below expectations, especially in inexperienced hands.*

The[5] *porcelain jacket crown is less suitable for young patients whose teeth still have large pulps, so these restorations are not commonly provided for teenagers.* (Text B, paragraph 1,2,4; sentences 2,3,4,9).

The example above reveals the following:

1. The second paragraph is linked to the previous one by the use of anaphoric comparative reference *such a crown.*
2. The underlined personal pronoun *it* represents anaphoric personal reference of the presupposed item a *porcelain jacket crown* in the contiguous previous paragraph.
3. The fourth underlined item *the operator* is not determined text-internally, so it is an instance of exophoric demonstrative reference.
4. The fifth underlined item *the* is an instance of definite article anaphoric reference which refers back to the first underlined item *the porcelain jacket crown* mentioned in the first paragraph.

Our findings in this connection (i.e., reference relations) are similar to those obtained in our analysis of intersentential relations, particularly with respect to the frequency of comparative relations and the scarcity of personal reference. As pointed out above the rarity of personal reference may be ascribed to the need to avoid ambiguity, especially when the presupposing and the presupposed items are not contiguous. Indeed, only four instances of the personal pronoun *it* were found to function on the intersentential level, whereas we found only one on the interparagraph level.

Consequently, one may conclude that the more distant the presupposed item is, the less infrequent the pronominal reference is likely to be.

Concerning the high frequency of the definite article *the*, Trimble (1985: 121) maintains that the preponderance of the definite article may be attributed to the rhetoric of description with which our examined text is entirely concerned (i.e., the description of the restoration of clinical crowns). On the other hand, reliance on the use of the definite article as a technique of reference across paragraph boundaries enables the writer to make absolutely clear what is being referred to.

Our findings regarding the rarity of personal reference are similar to those of Al-Katanani (1990), who found that this type of reference did not occur at all between paragraphs in the written language of surveying. On the other hand, this finding seems to be different from that of Madanat (1988: 155), who states that: *'One of the noticeable features of business letters is the excessive use of personal reference.'*

Another observation that merits mentioning in this connection is the contribution of exophoric reference relations to text cohesion in our source materials, although Halliday and Hassan (1976: 53) rule out the contribution of all exophric reference to text cohesion. The authors (ibid) argue that this type of reference refers to an environment or situation outside the text. In the examined text, the underlined item *the operator* in example (4:82) above does not prevent the formation of cohesive ties, but it invites the reader to interpret this item exophorically, since it did not appear previously in the text.

4.4.3.2 Conjunction

As is shown in Table (XXV) above, conjunctive devices between paragraphs are very low in frequency. Furthermore, conjunctive relations (other than four instances of temporal conjunctions) have not been encountered in the examined text. The following example illustrates this type of cohesion.

(4:83) Then the labial contour is assessed and adjusted as required. If the crown is undercontoured or an incisal angle is too rounded, the crown can be returned to the laboratory for the addition of more porcelain.

Finally the colour is assessed. If the wrong shade has been chosen it is necessary to remake the crown.... (Text B, paragraphs 22-23; sentences 94-97)

4.4.3.3 Lexical Cohesion

Types and sub-types of lexical cohesive items between paragraphs are shown in the following tables.

Table (XXXII): Frequency of Cohesive Lexical Items between Paragraphs

Type	No	%
Reiteration	673	60.4
Collocation	442	39.6
Total	1115	100%

Table (XXXIII): Frequency of the Different Reiterate Lexical Items between Paragraphs

Type	No	%
1. Same Item	509	75.6
2. Synonymy	4	0.6
3. Antonymy	20	3
4. Hyponymy	48	7.1
5. Meronymy	20	3
6. Superordinate	72	10.7
Total	673	100%

As is shown in Table (XXXII) above, reiterate lexical items occur more frequently than those establishing collocational relationship; 60.4% and 39.6% respectively. It can also be seen that the repetition of the same lexical item at (75.6%) in Table (XXXIII) is the commonest reiterate lexical item used in the analyzed text.

The following text illustrates the types and sub-types of lexical cohesion encountered between paragraphs:

(4:84) The indications for jacket crowns have declined since the introduction of composite resin and acid-etch technique, but the porcelain jacket crown is the restoration of choice for restoring a very heavily filled or unsightly vital anterior tooth because it gives a superior aesthetic result to the only satisfactory alternative, the metal-ceramic crown. Porcelain possesses good colour stability but its weakness is its brittleness. This has been overcome to some extent with the use of alumina-based ceramics which were introduced in the late 1960s. However, frature of jacket crowns is still a common cause of failure, particularly where there are errors in the shape and sharpness of the tooth preparation, as well as errors in the occlusal contacts of the restoration.

The porcelain jacket crown is less suitable for young patients whose teeth still have large pulps, so these restorations are not commonly provided for teenagers. Usually the labial margin is placed in the gingival sulcus to give a good aesthetic result. However, in a young patient, normal gingival recession can cause the margin to become visible within a year or two; this is often unsightly and yet another reason for not making this type of restoration in young patients. Short clinical crowns provide inadequate retention of the restoration on the preparation, and thin teeth particularly with a deepened overbite may have insufficient room on the palatal surface for the necessary thickness of porcelain. Small upper teeth and most lower incisors rarely provide sufficient room for these crowns. Porcelain jacket crowns are not usually used on posterior teeth because they are too brittle. (Text B, Paragraphs 3-4)

If we examine the above text, we cannot fail to notice the following types and sub-types of lexical cohesion which contribute to the texture of this text:

A. Reiteration:

1. repetition of the same item: *porcelain jacket crown, the restoration, unsightly, aesthetic results, porcelain, jacket crown, tooth, preparation, brittle.*
2. antonymy: *anterior teeth/ posterior teeth; strength/weakness*
3. hyponymy: *porcelain jacket crown/ jacket crown; metal-ceramic crown/clinical crown*
4. meronymy: *pulp, crown/ tooth; posterior teeth, anterior teeth/ teeth*
5. superordinate: *teeth/ incisors*

B. Collocation:

jacket crown; porcelain jacket crown; restoration; clinical crowns; composite resin; acid-etch; anterior teeth; metal-ceramic crown; porcelain, alumina-based ceramic; occlusal contacts; pulps; labial margin; gingival sulcus; gingival recession; teeth; overbite; incisors; palatal surface; posterior teeth;

If we examine Table (XXVIII) and Table (XXXIII), we notice that the frequency of the repetition of the same lexical item on the interparagraph level is higher than that encountered on the intersentential level. The increasing occurrence of the repetition of the same lexical item between paragraphs seems to serve as a compensation for the rarity of pronominal occurrences, and as a technique to avoid ambiguity in order to maintain precision.

Comparison and contrast with other ESP studies reveal that lexical cohesive devices in our source materials are more frequently used between paragraphs than those between sentences. This finding does not agree with the results obtained by other researchers such as Al-Katanani (1990), Madanat (1988), and Qara'een (1988), which show that lexical cohesive relations on the intersentential level outnumber those on the interparagraph level. Likewise, our findings also seem to contradict with Halliday and Hassan's (1976: 296-7) assumption that

> *In principle, we should expect to find a greater degree of cohesion within a paragraph than between paragraphs, as is generally found in written English.*

CHAPTER FIVE

Summary of Results, Implications and Recommendations

5.1. Summary of Results

In the preceding chapter, we have attempted to identify the linguistic features (syntactic, lexical, and textual) which seem to characterize the written English language used in the field of dentistry. The statistical method adopted in the investigation of this genre yielded useful results in identifying characteristic features of this variety, on the one hand, and in indicating how this genre is different from common-core English and other varieties of English, on the other.

In the ensuing section, we list the major characteristics which were found to mark the written language used in the field of dentistry as obtained from the data upon which the study is based:

I. Nominal Character

The nominal character of the written language used in the field of dentistry is quite evident. This feature is achieved through the frequent use of the following structures and processes:

a) prepositional phrases that function as postmodifiers, and

b) prenominal modifiers.

Though the nominal style is complex and may cause ambiguity and difficulty in the reading of dentistry texts, it does contribute to economy, which is the second characteristic of this genre.

II. Brevity

Dentistry writers tend to utilize a variety of devices to achieve economy and hence brevity. Among these devices are the following:

a) frequent use of non-finite VPs instead of finite ones,

b) extensive use of prenominal modification, which proves to be more economical than the corresponding phrases,

c) frequent use of postnominal modification,

d) frequent use of agentless passive clauses and sentences.

III. Clarity

To avoid ambiguity, dentistry writers tend to avoid the use of ellipsis and substitution. They resort, instead, to the repetition of the same lexical item initiated by the definite article *the* (on the textual level).

IV. Modality

Modality is another feature that marks this register. It is one of the modes by which the rhetoric of 'giving instructions' is expressed. This is evident through the frequent use of *should* and *must*.

V. Rhetorical Functions.

The dominant rhetorical functions, namely, 'giving instructions' and 'describing procedures and processes' are signalled by the frequent use of certain structures: c.f.

a. Giving Instructions

Indirect instructional information, strong advice, top necessity and recommendation or specification of what needs to be done are considered as various realizations of the major rhetorical function of 'giving instructions'. To achieve this, dentistry writers make use of the following linguistic features and categories:

1. The use of modal verbs such as *should* and *must*, passive voice or combination of both (i.e. passive modals) to express indirect instructional information.
2. The frequent use of *must* to express top necessity, *should* to express 'strong advice', and *will* to convey recommendation or specification of what needs to be done.

b) Describing Procedures and processes

Linguistic features such as passive constructions, the definite articles *the,* non-past VPs, the frequent use of adjectives, and the use of temporal relations (either explicit or implicit) contribute a great deal to the description of the procedures and processes to be followed by the practitioners.

VI. Lexical Cohesion

Textual cohesion is mainly achieved through the choice of lexical items, particularly the repetition of the same lexical item.

VII. Prenominal Modification

The length of prenominal modifiers is proportional to the degree of text level (i.e. the higher the text level, the longer the prenominal modification).

VIII. Lexical Items

In addition to general language words used in all disciplines, the lexicon of the language of dentistry includes three types of lexical items:

a. semi-technical items,

b. specialized items used in restricted and related subspecialities, and

c. genre dependent items used only in this register.

IX. Contrast with Common-core English

The following linguistic features which were found to mark the written language of dentistry are uncommon or not favoured in common-core English:

a. The high frequency of passive and agentless passive constructions,

b. The relatively frequent use of non-finite VPs,

c. The very low frequency of perfective VPs,

d. The rarity of progressive VPs,

e. The scarcity of past VPs,

f. The meaning shift of modal auxiliaries,

g. The high proportion of complex and multiple-complex NPs,

h. The predominance of pre-and postnominal modification,

i. The dominance of *of* - postmodification,

j. The scarcity of *wh*-pronouns with preceding prepositions in relative clauses,

k. The use of three different types of technical lexical items,

l. The avoidance of personal reference relations and the recourse to the frequent use of the repetition of the same lexical item,

m. The absence of substitute item relations between sentences and paragraphs, and

n. The rarity of ellipsis.

X. Contrast with other Genres

The written language of dentistry was found to be different from the other varieties of English with respect to the degree of frequency of the following linguistic features:

a. Voice,

b. Phase,

c. Tense,

d. Meaning shift of modals,

e. Lexical cohesion between paragraphs,

f. Pronoun reference, and

g. The absence of substitution

5.2 Implications

In the light of the summary of the results listed above, it could be concluded that the written language of dentistry is definably distinct, with respect to the degree of occurrence/nonoccurrence of a variety of linguistic features, from other registers within the language of English and from common-core English. Thus, this study lends support to the theory of ESP on the theoretical level.

On the other hand, this study would have the following range of possible pedagogical implications on the practical level:

1. The first step in any language teaching programme is to identify the most frequent linguistic features and the rhetorical functions that tend to recur in the language of the particular science to be taught. ESP course designers then can take these recurrent linguistic features and functions as an important part of the syllabus.

Therefore, the analysis of this register could be of interest to material designers who are called upon to write ESP teaching programmes.

2. It is presumed that this type of research will be of considerable help to teachers, in the sense that they will be given some idea about the degree of frequency and distribution of linguistic features the students would meet in their texts. Thus the more frequent features need to be given a great deal of time, whereas infrequent ones could be given low priority.
3. It is hoped that this piece of research would be of some help to lexicologists in compiling specialized dictionaries which should incorporate the types of technicality discussed in this study. Such dictionaries could be consulted in the establishment of translation equivalence and in minimizing troubles when faced with confusing lexical items.
4. Finally, it is hoped that the methodology adopted in this study to define the different types of lexical items could benefit compilers of ESP dictionaries.

5.3 Recommendations

To provide a fully fledged analysis of all the linguistic features that could be said to characterize the English language used in the field of dentistry, it is recommended that further research be carried out to investigate other aspects of the language of dentistry. Amongst the areas that need further investigation are the following:

1. This research can be expanded to include a wider coverage of data (either written or spoken authentic texts) that represents all the other sub-specialities which were not included in this work (i.e. orthodontics, periodontics, etc.).
2. Further research should include other syntactic and textual features such as sentence and clause structure, and cohesion devices within sentences.

3. Another feature that could be addressed is the identification of the rhetorical functions. In order to determine what rhetorical functions condition the choice of the linguistic features, it becomes necessary to use the original author as specialist informant. If it is difficult to establish personal communication with the author, it is possible to consult other specialists in the field, if possible native speakers of English.

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Appendices

Appendix I

Questionnaire

Name: . . . . . Nationality: . . . . . .

Education: . . . . . .

Part I

After reading the listed questions below, please mark (√) or (X) in the numbered boxes next to each item listed in Part II. The numbers of these boxes are equivalent to those of the questions below:

1. Have you encountered this item before?
2. Would you expect to use it in everyday communication?
3. Do you think that it acquires a special meaning when used in specialized context?
4. Is this item used only in a specialized disciplines?

Part 2

Items	**1**	**2**	**3**	**4**
alveolar	[ ]	[ ]	[ ]	[ ]
alveolar crest	[ ]	[ ]	[ ]	[ ]
amalgam	[ ]	[ ]	[ ]	[ ]
ameloblast	[ ]	[ ]	[ ]	[ ]
apical fibers	[ ]	[ ]	[ ]	[ ]
apical foramen	[ ]	[ ]	[ ]	[ ]
binangle	[ ]	[ ]	[ ]	[ ]
bone file	[ ]	[ ]	[ ]	[ ]
buccal	[ ]	[ ]	[ ]	[ ]
butt joint	[ ]	[ ]	[ ]	[ ]

Items	1	2	3	4
caries	[ ]	[ ]	[ ]	[ ]
cementoblast	[ ]	[ ]	[ ]	[ ]
cementoclast	[ ]	[ ]	[ ]	[ ]
cementocyte	[ ]	[ ]	[ ]	[ ]
cementoenamel junction	[ ]	[ ]	[ ]	[ ]
cementogenesis	[ ]	[ ]	[ ]	[ ]
cementum	[ ]	[ ]	[ ]	[ ]
cervical line	[ ]	[ ]	[ ]	[ ]
clinical crown	[ ]	[ ]	[ ]	[ ]
composite resin	[ ]	[ ]	[ ]	[ ]
Coupland's chisel	[ ]	[ ]	[ ]	[ ]
Cryer's elevator	[ ]	[ ]	[ ]	[ ]
deciduous	[ ]	[ ]	[ ]	[ ]
dental pulp	[ ]	[ ]	[ ]	[ ]
denticle	[ ]	[ ]	[ ]	[ ]
dentin	[ ]	[ ]	[ ]	[ ]
dentinoblast	[ ]	[ ]	[ ]	[ ]
dentinocemental	[ ]	[ ]	[ ]	[ ]
dentinocemental junction	[ ]	[ ]	[ ]	[ ]
dentinoenamel	[ ]	[ ]	[ ]	[ ]
dentinoenamel junction	[ ]	[ ]	[ ]	[ ]
dentinogenesis	[ ]	[ ]	[ ]	[ ]
dento-alveolar	[ ]	[ ]	[ ]	[ ]
disto-buccal	[ ]	[ ]	[ ]	[ ]
disto-buccal cusp	[ ]	[ ]	[ ]	[ ]
disto-labial	[ ]	[ ]	[ ]	[ ]
disto-lingual	[ ]	[ ]	[ ]	[ ]
dry socket	[ ]	[ ]	[ ]	[ ]
enamel fissure	[ ]	[ ]	[ ]	[ ]
enamel lamella	[ ]	[ ]	[ ]	[ ]
enamel pit	[ ]	[ ]	[ ]	[ ]
enamel rod	[ ]	[ ]	[ ]	[ ]
enamel tuft	[ ]	[ ]	[ ]	[ ]
endodontics	[ ]	[ ]	[ ]	[ ]
epithelial cells	[ ]	[ ]	[ ]	[ ]
fissure bur	[ ]	[ ]	[ ]	[ ]
flat plastic	[ ]	[ ]	[ ]	[ ]
free gingiva	[ ]	[ ]	[ ]	[ ]
gingiva	[ ]	[ ]	[ ]	[ ]
gingival	[ ]	[ ]	[ ]	[ ]
gingival fibrils	[ ]	[ ]	[ ]	[ ]
gingival papilla	[ ]	[ ]	[ ]	[ ]
gingival recession	[ ]	[ ]	[ ]	[ ]

Items	1	2	3	4
gingival sulcus	[ ]	[ ]	[ ]	[ ]
haemorrhage	[ ]	[ ]	[ ]	[ ]
high alumina porcelain core	[ ]	[ ]	[ ]	[ ]
histocyte	[ ]	[ ]	[ ]	[ ]
horizontal fibers	[ ]	[ ]	[ ]	[ ]
Howarth's nasal raspatory	[ ]	[ ]	[ ]	[ ]
Howarth's periosteal elevator	[ ]	[ ]	[ ]	[ ]
hypocalcified	[ ]	[ ]	[ ]	[ ]
hypoplasia	[ ]	[ ]	[ ]	[ ]
incisal	[ ]	[ ]	[ ]	[ ]
incisally	[ ]	[ ]	[ ]	[ ]
inciso-gingival	[ ]	[ ]	[ ]	[ ]
incisor	[ ]	[ ]	[ ]	[ ]
incremental lines of Retzius	[ ]	[ ]	[ ]	[ ]
intercuspal	[ ]	[ ]	[ ]	[ ]
interprismatic substance	[ ]	[ ]	[ ]	[ ]
ionomer	[ ]	[ ]	[ ]	[ ]
jacket crown	[ ]	[ ]	[ ]	[ ]
Kilner cheek retractor	[ ]	[ ]	[ ]	[ ]
lamella	[ ]	[ ]	[ ]	[ ]
line angle	[ ]	[ ]	[ ]	[ ]
lignocaine	[ ]	[ ]	[ ]	[ ]
lingual nerve	[ ]	[ ]	[ ]	[ ]
mandible	[ ]	[ ]	[ ]	[ ]
mastication	[ ]	[ ]	[ ]	[ ]
maxillary	[ ]	[ ]	[ ]	[ ]
mental foramen	[ ]	[ ]	[ ]	[ ]
mental nerve	[ ]	[ ]	[ ]	[ ]
mesenchymal cellS	[ ]	[ ]	[ ]	[ ]
mesio-labial	[ ]	[ ]	[ ]	[ ]
metal ceramic crown	[ ]	[ ]	[ ]	[ ]
Mitchell's trimmer	[ ]	[ ]	[ ]	[ ]
mucoperiosteal flap	[ ]	[ ]	[ ]	[ ]
mucosa	[ ]	[ ]	[ ]	[ ]
neonatal line	[ ]	[ ]	[ ]	[ ]
oblique fibers	[ ]	[ ]	[ ]	[ ]
occlusal wear	[ ]	[ ]	[ ]	[ ]
odontoblast	[ ]	[ ]	[ ]	[ ]
oral surgery	[ ]	[ ]	[ ]	[ ]
osteoblast	[ ]	[ ]	[ ]	[ ]
osteoclast	[ ]	[ ]	[ ]	[ ]
overbite	[ ]	[ ]	[ ]	[ ]
palatal	[ ]	[ ]	[ ]	[ ]
palatal cusp	[ ]	[ ]	[ ]	[ ]
pericoronitis	[ ]	[ ]	[ ]	[ ]

Items	1	2	3	4
periodontal	[ ]	[ ]	[ ]	[ ]
periodontal ligament	[ ]	[ ]	[ ]	[ ]
periodontics	[ ]	[ ]	[ ]	[ ]
platinized foil	[ ]	[ ]	[ ]	[ ]
porcelain crown	[ ]	[ ]	[ ]	[ ]
porcelain jacket crown	[ ]	[ ]	[ ]	[ ]
protrusive occlusion	[ ]	[ ]	[ ]	[ ]
premolar	[ ]	[ ]	[ ]	[ ]
protoplasmic process	[ ]	[ ]	[ ]	[ ]
pulp chamber	[ ]	[ ]	[ ]	[ ]
pulp stone	[ ]	[ ]	[ ]	[ ]
pulpal	[ ]	[ ]	[ ]	[ ]
resistance form	[ ]	[ ]	[ ]	[ ]
retained root	[ ]	[ ]	[ ]	[ ]
rongeur	[ ]	[ ]	[ ]	[ ]
root canal	[ ]	[ ]	[ ]	[ ]
sclerosis	[ ]	[ ]	[ ]	[ ]
secondary dentin	[ ]	[ ]	[ ]	[ ]
Sharpey's fibers	[ ]	[ ]	[ ]	[ ]
straight handpiece	[ ]	[ ]	[ ]	[ ]
study model	[ ]	[ ]	[ ]	[ ]
subgingival	[ ]	[ ]	[ ]	[ ]
supragingivally	[ ]	[ ]	[ ]	[ ]
tapered fissure bur	[ ]	[ ]	[ ]	[ ]
temporary crown	[ ]	[ ]	[ ]	[ ]
transseptal fibers	[ ]	[ ]	[ ]	[ ]
trial wax-up	[ ]	[ ]	[ ]	[ ]
trismus	[ ]	[ ]	[ ]	[ ]
veneer crown.	[ ]	[ ]	[ ]	[ ]
---				
apex	[ ]	[ ]	[ ]	[ ]
apical	[ ]	[ ]	[ ]	[ ]
approximal	[ ]	[ ]	[ ]	[ ]
articulating paper	[ ]	[ ]	[ ]	[ ]
attrition	[ ]	[ ]	[ ]	[ ]
bevel	[ ]	[ ]	[ ]	[ ]
bond	[ ]	[ ]	[ ]	[ ]
bridge	[ ]	[ ]	[ ]	[ ]
bur	[ ]	[ ]	[ ]	[ ]
ceramist	[ ]	[ ]	[ ]	[ ]
chamber	[ ]	[ ]	[ ]	[ ]
chamfer	[ ]	[ ]	[ ]	[ ]
clearance	[ ]	[ ]	[ ]	[ ]
core	[ ]	[ ]	[ ]	[ ]
coronal	[ ]	[ ]	[ ]	[ ]

Items	1	2	3	4
crown	[ ]	[ ]	[ ]	[ ]
cusp	[ ]	[ ]	[ ]	[ ]
delivery	[ ]	[ ]	[ ]	[ ]
die-stone	[ ]	[ ]	[ ]	[ ]
dressing	[ ]	[ ]	[ ]	[ ]
enamel	[ ]	[ ]	[ ]	[ ]
erosion	[ ]	[ ]	[ ]	[ ]
eruption	[ ]	[ ]	[ ]	[ ]
excavator	[ ]	[ ]	[ ]	[ ]
extraction	[ ]	[ ]	[ ]	[ ]
finishing	[ ]	[ ]	[ ]	[ ]
fissure	[ ]	[ ]	[ ]	[ ]
forceps	[ ]	[ ]	[ ]	[ ]
fossa	[ ]	[ ]	[ ]	[ ]
glaze	[ ]	[ ]	[ ]	[ ]
groove	[ ]	[ ]	[ ]	[ ]
imbrication	[ ]	[ ]	[ ]	[ ]
impaction	[ ]	[ ]	[ ]	[ ]
impression	[ ]	[ ]	[ ]	[ ]
jacket	[ ]	[ ]	[ ]	[ ]
ligament	[ ]	[ ]	[ ]	[ ]
lute	[ ]	[ ]	[ ]	[ ]
mesial	[ ]	[ ]	[ ]	[ ]
matrix	[ ]	[ ]	[ ]	[ ]
nucleus	[ ]	[ ]	[ ]	[ ]
papilla	[ ]	[ ]	[ ]	[ ]
plaque	[ ]	[ ]	[ ]	[ ]
point	[ ]	[ ]	[ ]	[ ]
prematurity	[ ]	[ ]	[ ]	[ ]
protrusive	[ ]	[ ]	[ ]	[ ]
pulp	[ ]	[ ]	[ ]	[ ]
recession	[ ]	[ ]	[ ]	[ ]
restoration	[ ]	[ ]	[ ]	[ ]
retainer	[ ]	[ ]	[ ]	[ ]
retention	[ ]	[ ]	[ ]	[ ]
root	[ ]	[ ]	[ ]	[ ]
sheathed	[ ]	[ ]	[ ]	[ ]
shoulder	[ ]	[ ]	[ ]	[ ]
skirt	[ ]	[ ]	[ ]	[ ]
socket	[ ]	[ ]	[ ]	[ ]
stone	[ ]	[ ]	[ ]	[ ]
sulcus	[ ]	[ ]	[ ]	[ ]
swage	[ ]	[ ]	[ ]	[ ]
tray	[ ]	[ ]	[ ]	[ ]
wear	[ ]	[ ]	[ ]	[ ]

CHAPTER 2

Structural Elements of the Teeth

TEETH are highly calcified structures set in the alveolar (bony) sockets of the upper and lower jaws. A tooth is divided into two parts, a root or roots which anchor it in the jaw and a crown, the part which is visible in the mouth. A tooth is composed of four different tissues: (1) Enamel, a hard, brittle substance which covers the crown: (2) dentin, a bonelike substance which forms the body of the tooth; (3) cementum, a bonelike substance which covers the tooth root; and (4) pulp, which occupies the central cavity of the tooth called the pulp chamber and the root canals.

Connecting the root and the wall of the alveolar socket is the periodontal ligament which holds the tooth in place and transforms the pressure on the crown into traction on root and bone during mastication (fig. 2–1).

Man has two sets of teeth: a first or deciduous set and a second or permanent set. They are arranged in an upper and lower arch. The decidu-

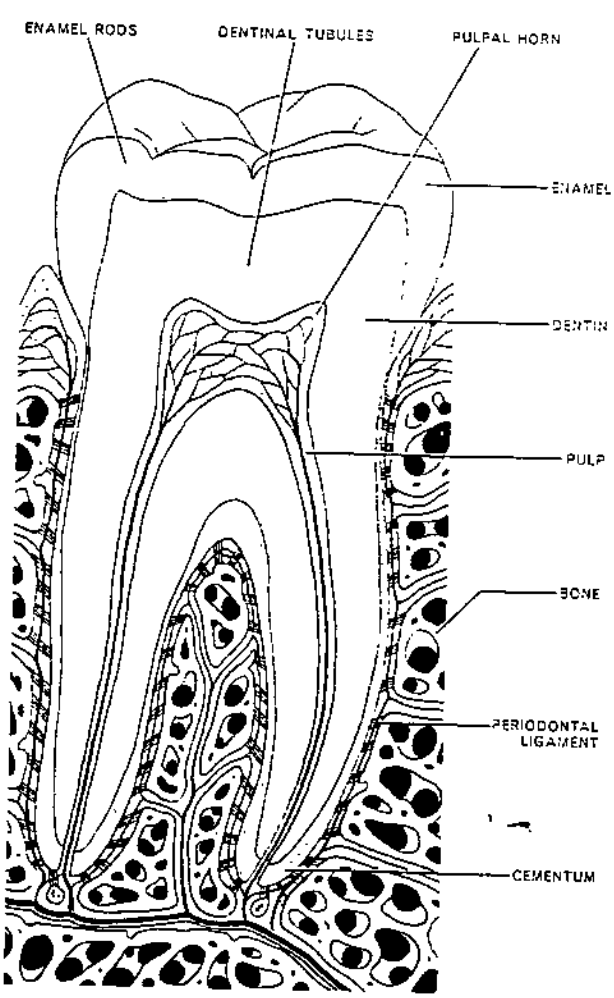

Figure 2–1. Longitudinal Section of Lower Molar

Diagrammatic illustration of crown and roots: enamel rods, dentinal tubules, cementum, pulp, periodontal ligament, and bone.

ous set consists of 20 teeth, 10 in the upper arch and 10 in the lower arch. The permanent set consists of 32 teeth, 16 in the upper arch and 16 in the lower arch. (See pp. 16 and 17, figs. 1–26 and 1–27.)

Teeth have different shapes because they have different functions. Their principal function is to masticate the food and mix it with saliva. Their secondary function is to aid in speech. (See ch. 5, Function.)

ENAMEL

ENAMEL is the hardest tissue in the body, being composed, almost entirely (97 percent by weight) of mineral salts. It covers the coronal portion of the tooth and protects it from the abrasive actions of mastication. Structurally it is composed of millions of minute enamel rods which extend from the dentinoenamel junction to the tooth surface. In most sections the rods appear to be slightly wavy. In the occlusal section of the crown, however, they may be extremely convoluted. They are about 4 microns in diameter and, it is estimated, their numbers range from a low of 5 million to a high of 12 million per tooth depending on the type and size of the crown (figs. 2–1 and 2–2).

Incremental Lines of Retzius

Enamel is formed by epithelial cells termed ameloblasts which disappear after the tissue is completed. The formation begins at growth centers along the dentinoenamel junction and proceeds daily in successive or incremental cone-shaped layers to what will become the surface of the tooth crown. The number of growth centers corresponds to the number of cusps on a particular tooth. Incremental cones of enamel are laid down one above the other until the enamel reaches the height of the cusp. When that occurs, the margins of the adjacent enamel cones normally unite to form a solid protective covering for the tooth.

The demarcations between the incremental layers of enamel are called incremental lines of Retzius. They may be compared to the growth rings in a tree and, like those rings, they reflect variations in structure that occur during the growth of enamel. For example, the enamel of the deciduous teeth develops partly before and partly after birth. The boundary between the two portions of enamel in the deciduous teeth is marked by an accentuated incremental line

Figure 2–2. Fluorophotomicrograph of Lower Molar Tooth

The developmental lines in the dentin are sharply outlined. The enamel rods are less clear.

Figure 2-3. Fluorophotomicrograph of Enamel Lamellae

Microscopic faults or separations in the enamel which extend inward from the surface of the tooth, sometimes reaching the dentin. They have a high organic content and some scientists think caries-producing bacteria attack the teeth through them as well as through larger pits and fissures. Magnification approximately ×600. (Used with permission from Dickson, G., and others. Fluorescence of teeth: a means of investigating their structure. JADA 45: 661, December 1952.)

of Retzius called the neonatal line or neonatal ring. Other constitutional or environmental factors such as weaning, summer or winter seasons or severe illness occurring during the time of enamel formation are recorded by the incremental lines of Retzius. (Schour, I., ed. Noyes' oral histology and embryology, ed. 8. Philadelphia, Lea & Febiger, 1960. Sicher, H., ed. Orban's oral histology and embryology, ed. 5. St. Louis, C. V. Mosby Co., 1962.)

Enamel Lamellae

Enamel is penetrated at different points of tension by thin leaflike structures that extend at times into the dentin. They contain considerable organic material and less mineral than the adjacent enamel (fig. 2–3). There are three types of lamellae: (1) Those composed of poorly calcified enamel rod segments; (2) those consisting of degenerated cells, and (3) those arising in erupted teeth where the cracks are filled with organic matter. (Sicher, H., ed. Orban's oral histology and embryology, ed. 5. St. Louis, C. V. Mosby, 1962, pp. 572–575.)

Enamel Tufts

These narrow ribbonlike structures arise at the dentinoenamel junction and extend into the enamel to about one-fifth to one-third of its thickness (fig. 2–4). They consist of hypocalcified enamel rods and like the lamellae they extend in the direction of the long axis of the crown. (Sicher, H., ed. Orban's oral histology and embryology, ed. 5. St. Louis, C. V. Mosby Co., 1962, pp. 572–575.)

Concepts of Enamel Structure

Much has yet to be learned about the ultrastructure of tooth enamel. Prior to the advent of the electron microscope, many researchers subscribed to the theory that enamel is composed of a myriad of minute, sheathed, segmented enamel rods cemented together by an interprismatic substance. Some investigators are still of that opinion. A growing number of investigators, however, after studying the tissue under the

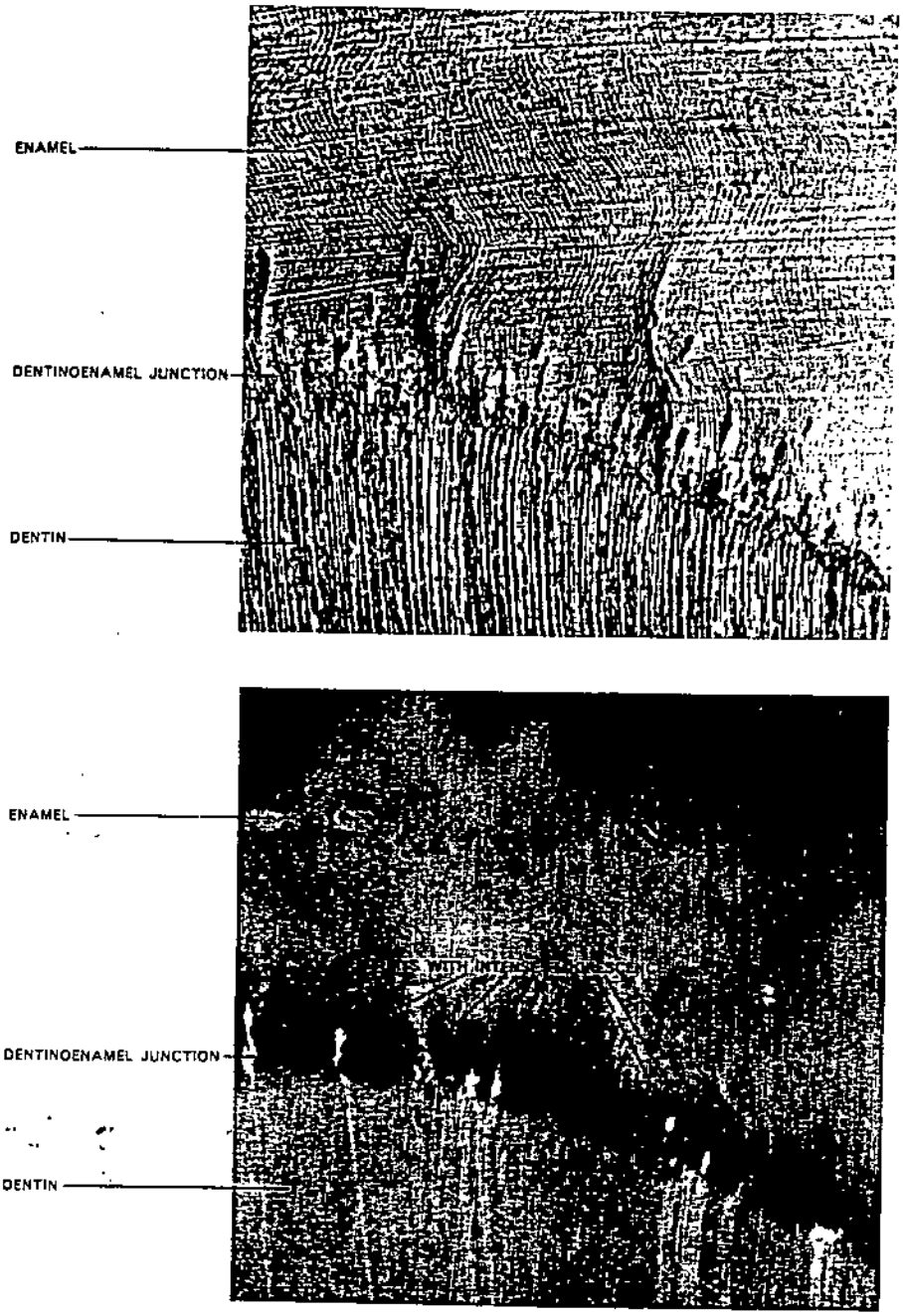

Figure 2–4. Enamel Tufts

Brushlike formations which occasionally extend from the dentinoenamel junction into the enamel. They are hypocalcified or uncalcified inner ends of some enamel rods. Above. Seen by visible light illumination. Below. Seen by fluorescence excited by ultraviolet illumination. (Used with permission from Dickson, G., and others. Fluorescence of teeth: a means of investigating their structure. JADA 45: 661, December 1952.)

electron microscope, question the existence of organic rod sheaths and, at least in human enamel, of a separate interprismatic substance.

Figures 2–5 through 2–9 illustrate the more modern concept of enamel structure.

Enamel Pits and Fissures

Frequently, during the final phases of enamel formation, the peripheral margins of the cusps fail to unite perfectly resulting in the formation of pits or fissures in the enamel grooves and fossae. Pits may occur on the occlusal surface of the premolars and molars, also on the buccal and lingual surfaces of the molars and on the lingual surface of the upper incisors. Fissures may occur on the occlusal surfaces of the premolars and molars. Pits and fissures present opportunity for lodgment of food debris and bacteria and thus promote the occurrence of decay. (See fig. 8–8, p. 184.) (Black, G. V., Operative dentistry, ed. 8. Woodstock, Ill., Medico-Dental Publishing Co., 1948, vol. 1.)

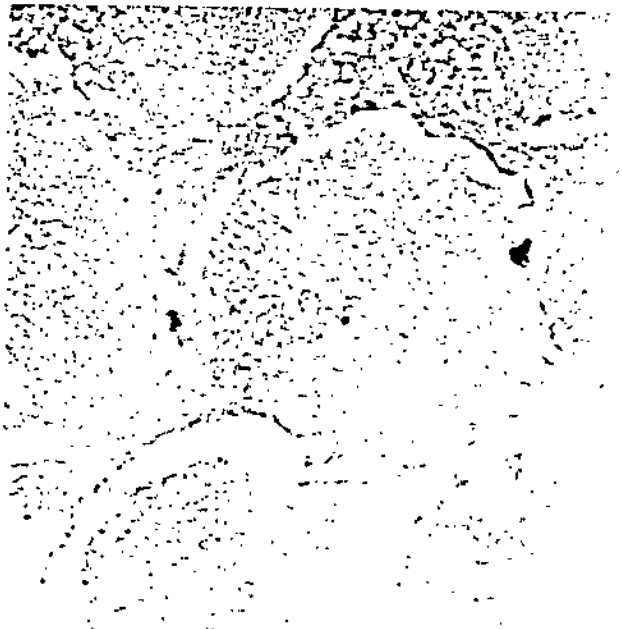

Figure 2–5. Enamel Rods. Cross Section

Human enamel rods have been described by different researchers as having different shapes: round, oval, hexagonal, prismatic, fish-scale shaped, and keyhole shaped. Above—Fish-scale shaped. Electron micrograph of cross section of enamel rods that were first etched with hydrochloric acid. (Courtesy of Clifford H. Miller, D.D.S.) Below.—Keyhole shaped. Electron micrograph of a section cut through an artificial incipient carious lesion in a human permanent incisor and demineralized on the supporting grid. The keyhole outlines of the individual prisms are retained in the organic residue. (With sound enamel the organic material is evenly distributed without indication of prism structure or rod sheaths.) Magnification approximately ×16,000. (Used with permission from Meckel, A. H., Griebstein, W. J., and Neal, R. J. Structure of mature human dental enamel as observed by electron microscopy. Arch Oral Biol 10:775–783, 1965.)

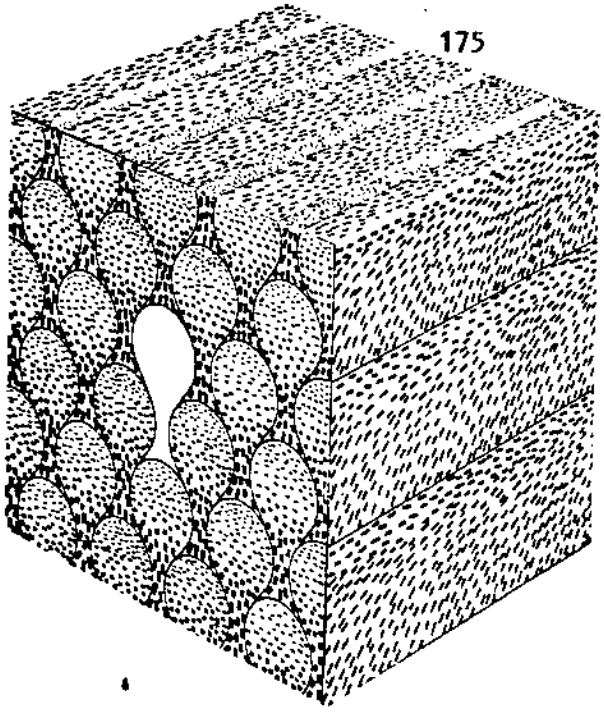

Figure 2–6. Schematic Illustration of Enamel Structure

Box model showing the arrangement of the crystallites when human enamel is sectioned in the three ideal planes, parallel to, or 90° to, the direction of the enamel prisms. Compare corresponding electron micrographs figure 2–7, top surface, and figure 2–8, front surface. (From Meckel, A. H., Griebstein, W. J., and Neal, R. J. Ultrastructure of fully calcified human dental enamel. In Stack, M. V., and Fearnhead, R. W., eds. Tooth enamel. Bristol, John Wright & Sons, 1965.)

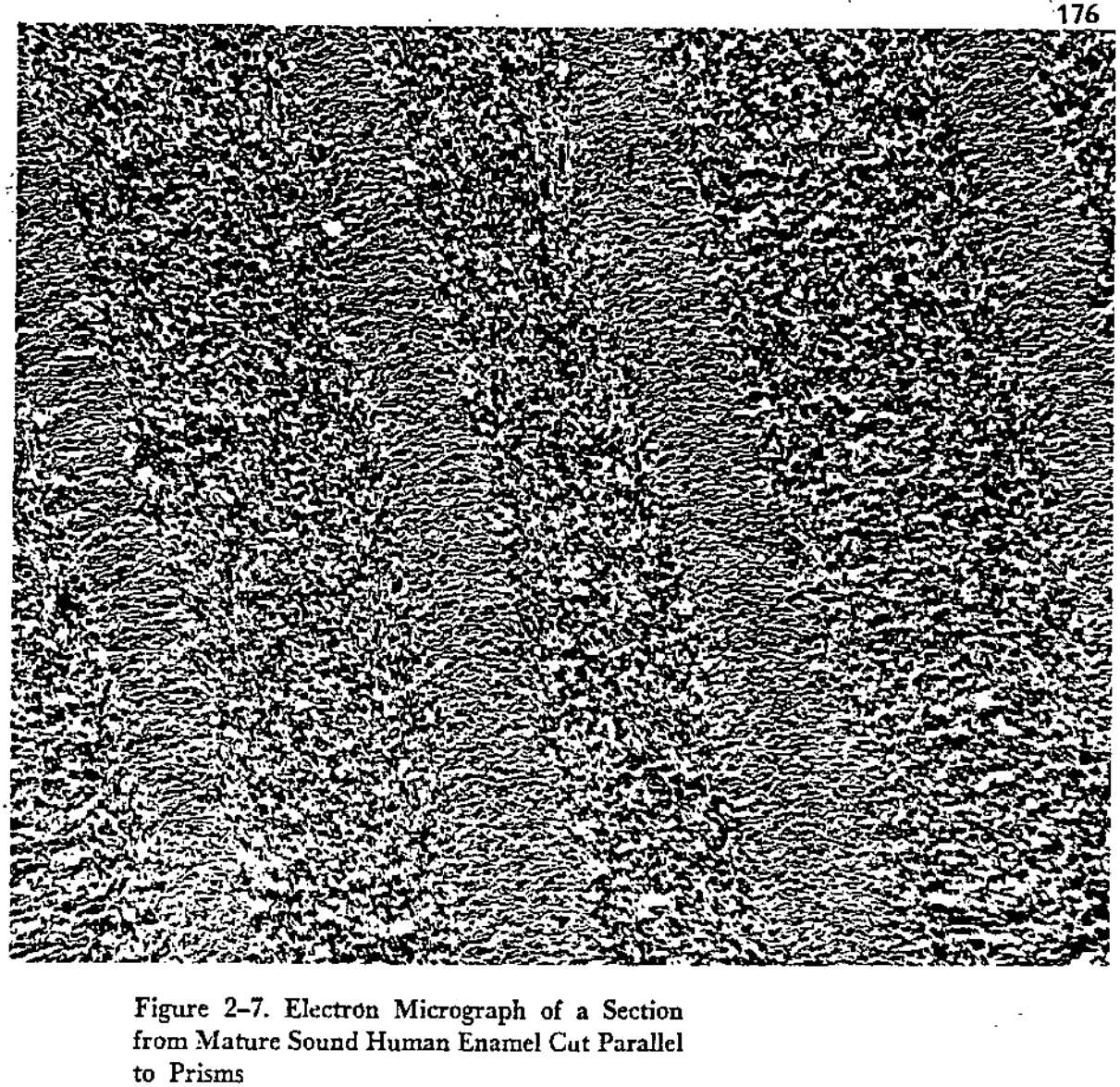

Figure 2–7. Electron Micrograph of a Section from Mature Sound Human Enamel Cut Parallel to Prisms

The wide bands represent the "heads" of the prisms and the individual crystallites are cut almost lengthwise. The narrower bands are the "tails" of the prisms and the crystallites are nearly cross sectioned. The density is uniform throughout the whole section, and in this sound, mature enamel no indications of organic rod sheaths can be found. The border line between prisms is formed by an abrupt change in crystal orientation. Magnification approximately ×6,500. (From Meckel, A. H. Griebstein, W. J., and Neal, R. J. Structure of mature human dental enamel as observed by electron microscopy. Arch Oral Biol 10: 775–783, 1965).

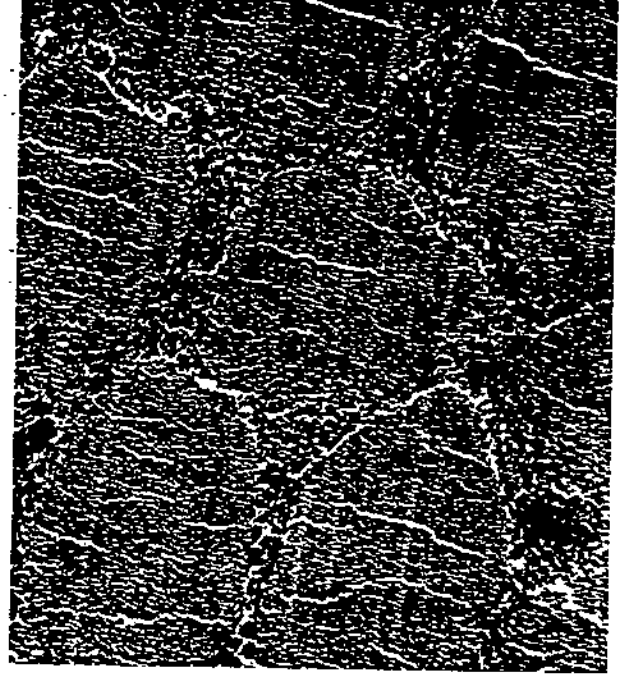

Figure 2–8. Electron Photomicrograph of a Section of Healthy Enamel from a Deciduous Molar Tooth

The section was cut approximately 90° to the direction of the prisms. The keyhole-shaped outline of the prisms is visible, the "heads" being what were previously considered as the individual prisms and the "tails" being what were previously described as the interprismatic material. The different appearance of the "tails" is due only to the fact that the tilting crystallites are cut at a different angle than those in the "head" portion of the prisms. Magnification approximately ×6,000. (Used with permission from Meckel, A. H., Griebstein, W. J., and Neal, R. J. Structure of mature human dental enamel as observed by electron microscopy. Arch Oral Biol 70: 775–783, 1965.)

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Figure 2–9. Electron Micrographs of a Mottled Section of Fluorosed Enamel

In contrast to sound enamel where no spaces between prisms can be recognized, relatively wide spaces can be found in hypomineralized enamel, in this instance in fluorosed enamel. Spaces like these have been described by some authors to be the portions of the prism sheath. Above—Magnification ×8,000. Below—Magnification ×16,000. (Courtesy of Procter & Gamble Co.)

DENTIN

DENTIN is bonelike tissue that forms the bulk or body of the tooth. It is less hard than enamel, being composed by weight of about 70 percent inorganic material and about 30 percent organic material. Dentin as a living tissue consists of cells, odontoblasts, and a mineralized intercellular substance. The odontoblasts consist of a columnar body that contains the nucleus and a long protoplasmic process. The cell body lies at the pulpal surface of the dentin, whereas the process is contained in minute tubules which, in an S-shaped course, extend from the pulpal wall to the dentinoenamel junction and the dentinocemental junction where they divide into a number of branches (fig. 2–10).

Incremental Lines of von Ebner

Dentinogenesis begins at individual growth centers along the dentinoenamel junction and proceeds toward what will become the pulp chamber of the tooth. Adjacent dentin-forming cells begin their formation in successively graded intervals. Each incremental layer of dentin has the form of a cone. Successive incremental cones of dentin deposited within the other proceed toward the pulp and continually form new dental matrix. These growth lines, termed the incremental lines of von Ebner and Owen, result in a pattern of calcification that follows in appearance the incremental lines of Retzius found in enamel. In the deciduous teeth and in the first permanent molars, where the dentin is formed partly before and partly after birth, the prenatal and postnatal dentin are separated by an accentuated contour line, the so-called neonatal line. This line is the result of incomplete calcification, caused by metabolic disturbances at the time of adjustment of the newborn to the abrupt changes in environment and nutrition. (Schour, I., ed. Noyes' oral histology and embryology, ed. 8. Philadelphia, Lea & Febiger, 1960.)

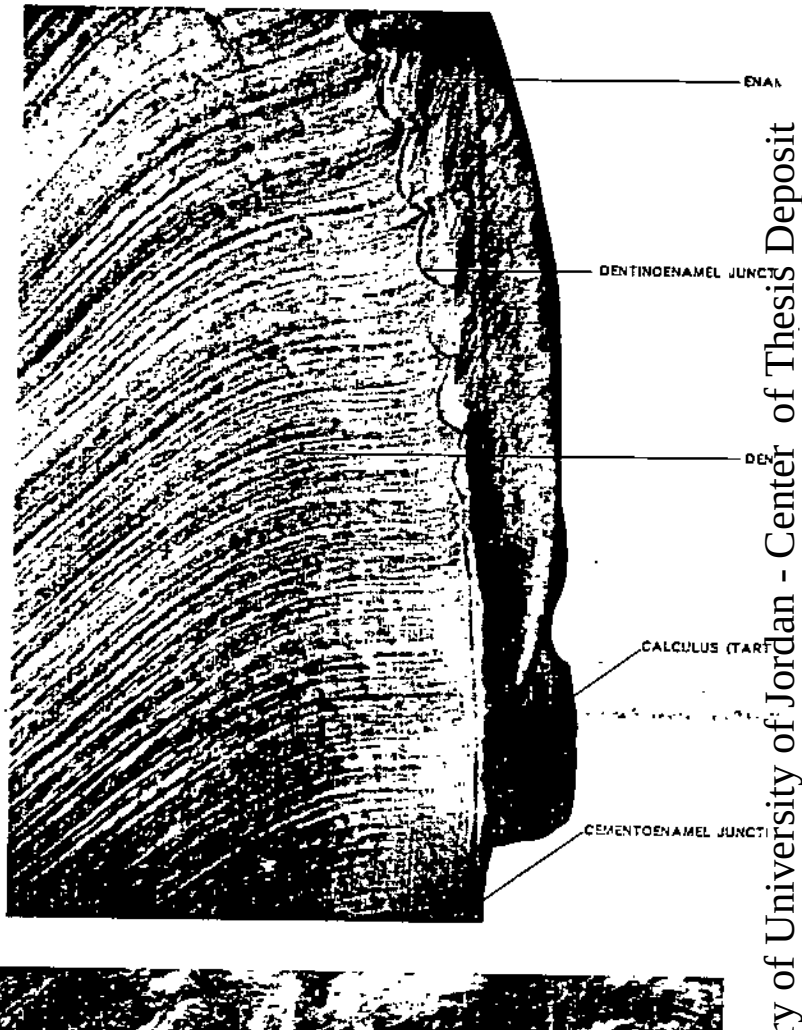

Figure 2–10. Longitudinal Ground Section of a Human Tooth

Note the relation of enamel to the dentinoenamel junction, dentin, and cementoenamel junction. A fragment of calculus is also shown. (Courtesy of John J. Hefferren, Ph. D.)

Figure 2–11. Electron Photomicrograph of Human Dentin

The collagen fibrils in dentin are well mineralized. The 640 Angstrom-unit cross-striations characteristic of collagen are barely visible in the fibrils in the upper left corner. (Magnification approximately ×40,000.)

Figure 2–12. Dentin

Above.—Section of dentin illuminated by visible light. Below.—Section illuminated by ultraviolet radiation. Magnification approximately ×1,000. (Used with permission from Dickson, G., and others. Fluorescence of teeth: a means of investigating their structure. JADA 45: 661, December 1952.)

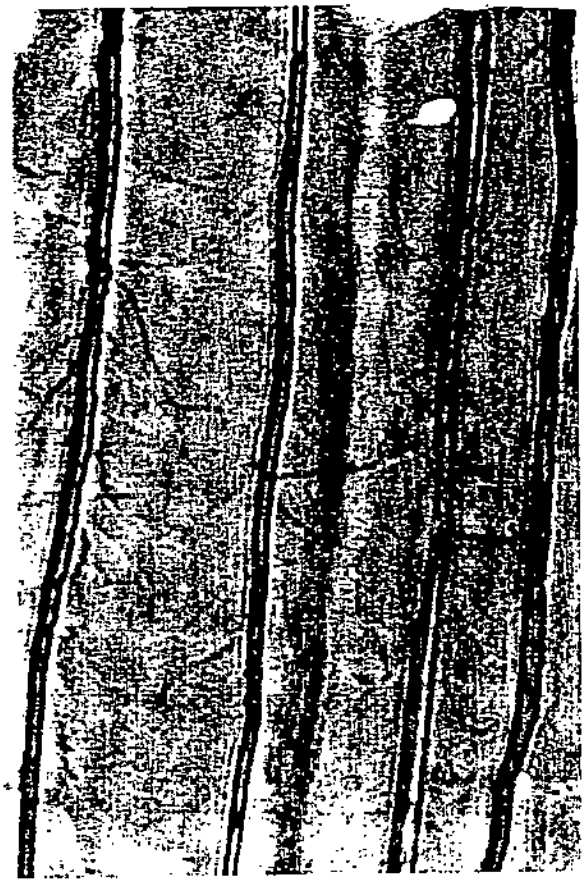

Figure 2–13. Dentinal Tubules

At their pulpal end the tubules are about 3 microns in diameter. Along their length the tubules are connected with each other by minute branches. (Used with permission from Dickson, G., and others. Fluorescence of teeth: a means of investigating their structure. JADA 45: 661, December 1952.)

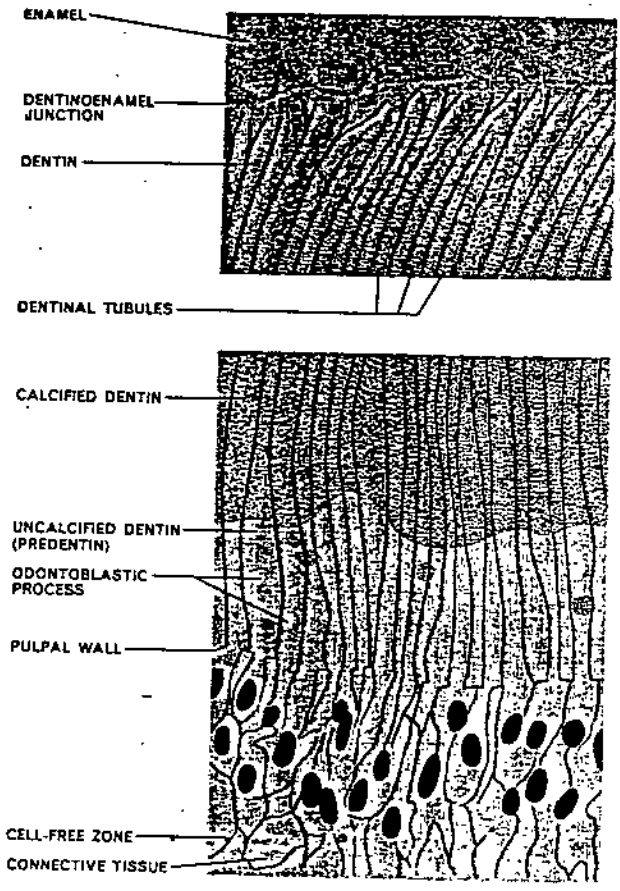

Figure 2–14. Odontoblasts

Dentin is formed by cells called odontoblasts. The bodies of the odontoblasts remain along the pulpal wall of the dentin. Cytoplasmic processes of the odontoblasts extend through the tubules to the dentinoenamel and the dentinocemental junctions. Some think that the odontoblasts in some way transmit stimuli to the nerve endings in the pulp, others report finding nerve fibers in the tubules.

Figure 2–15. Secondary or Reparative Dentin

In response to certain stimuli such as attrition, erosion, caries, and operative procedures, the odontoblasts deposit additional (secondary or reparative) dentin over the pulpal wall to protect the pulp from irritation. (Used with permission from Philippas, G. G., and Applebaum, E. Age changes in the permanent upper lateral incisor. J Dent Res 46(5) : 1002, September–October 1967.)

CEMENTUM

CEMENTUM is bonelike tissue that covers the tooth root. It is composed of about 50 percent inorganic material and 50 percent organic material. The cementum is thinnest at the cementoenamel junction (20 to 50 microns) whereas it is relatively thick (150 to 200 microns) in the apical portion. (See figs. 2–1 and 2–16.)

Cementum sometimes contains, in an irregular arrangement, certain cells (cementocytes) which, during the formation of the cementum, were converted from certain cells in the periodontal ligament (cementoblasts). Clusters of cementocytes may be connected to one another by channels in the cementum. They are most numerous at the apex of the tooth. The periodontal ligament is attached firmly to the tooth by means of Sharpey's fibers which become embedded in the cementum as it is being formed. The functions of the cementum are to assist in anchoring the tooth in its bony socket; to compensate, by its growth, for the loss of tooth substance caused by occlusal wear; and to contribute, by its growth, to the continuous eruption of teeth.

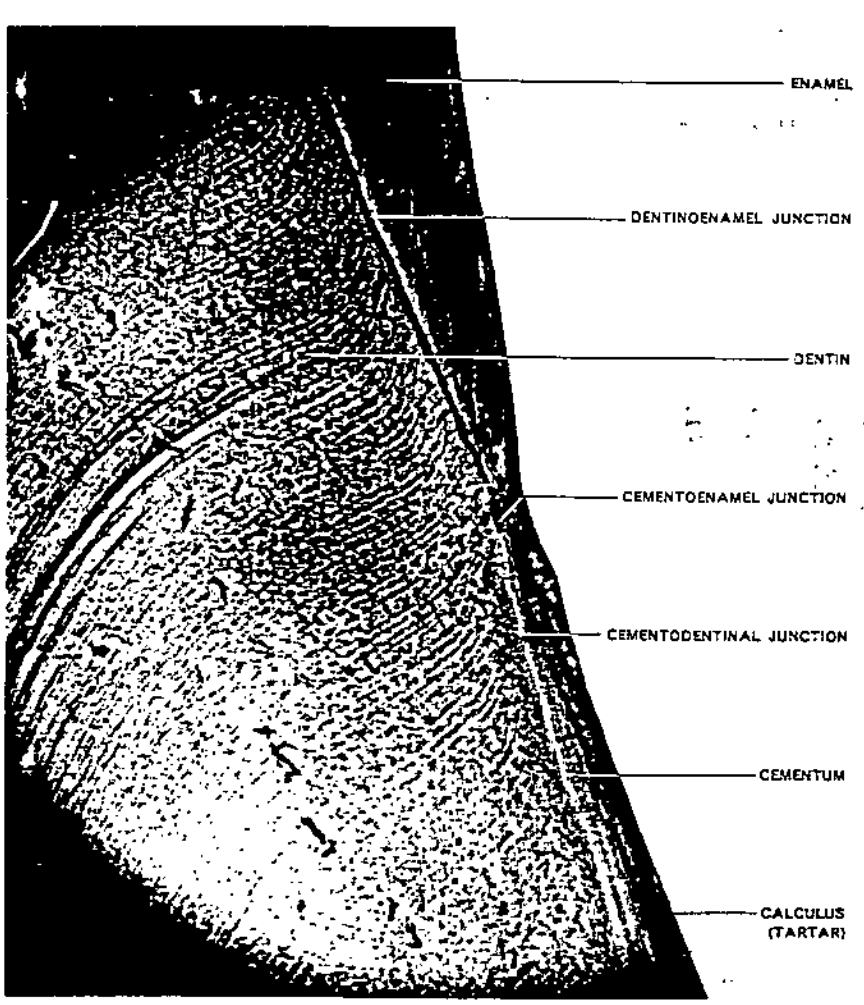

Figure 2–16. Cementum

Longitudinal ground section of tooth showing the cementum of a tooth in relation to the enamel, dentinoenamel junction, dentin, cementoenamel junction, and cementodentinal junction. (Courtesy of John J. Hefferren, Ph. D.)

DENTAL PULP

THE DENTAL PULP occupies the pulp chamber and root canal or canals of the tooth. It is a soft tissue composed of cells and intercellular substance. The intercellular substance is amorphous or jellylike, and different types of cells and a meshwork of minute fibrils are suspended in it. The bodies of the odontoblasts line the walls of the pulp chamber and extend cytoplasmic processes into the dentinal tubules. Other cells include fibroblasts, histiocytes, and undifferentiated mesenchymal cells.

The pulp contains nerves, blood vessels (arteries and veins), and lymphatic vessels, which enter and leave the tooth by way of the apical foramen. Occasionally calcified structures called denticles or pulp stones are found in the tooth pulp. The pulp has several functions: (1) Formative, it produces the dentin; (2) sensory, it responds to external stimuli; (3) nutritive, it receives nutrients and removes wastes by means of the blood vessels and lymphatics; and (4) defensive, it develops, when necessary, sclerotic and secondary dentin as protection against external irritation. (See fig. 2–17.)

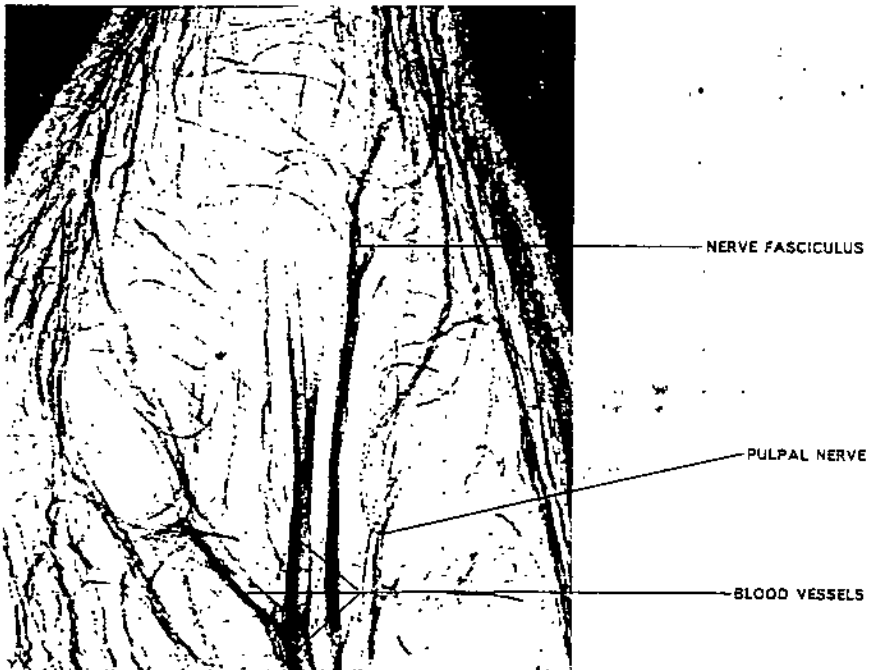

Figure 2–17. Dental Pulp

The coronal portion of a premolar pulp of a teenager. Note the rich subodontoblastic network. Verhoeff's iron hematoxylin stain. Magnification ×50. (Used with permission from Bernick, S. Effect of aging on the nerve supply to human teeth. J Dent Res 46:697, July–August 1967.)

PERIODONTAL LIGAMENT

THE PERIODONTAL LIGAMENT is a layer of connective tissue which surrounds the tooth root and fixes the tooth in its bony socket. It ranges in thickness from 0.12 to 0.35 mm. It contains numerous bundles of fibers some of which attach on one side to the cementum of the tooth and on the other side to the bony wall of the tooth socket. These large bundles of fibers, called the principal fibers of the periodontal ligament, are arranged in six groups depending on their location and their relation to the long axis of the tooth root: free gingival, transseptal, alveolar crest, horizontal, oblique, and apical (fig. 2–18).

The ends of the principal fibers that are fixed in the cementum and the alveolar bone are termed Sharpey's fibers. Other principal constituents of the periodontal ligament are blood vessels, lymph vessels, nerves, and specialized cells such as cementoblasts, cementoclasts, osteoblasts, and osteoclasts—cells which function in the formation of bone and cementum and those which function in the resorption of those tissues.

The functions of the periodontal ligament are: (1) Supportive, it supports the tooth in its socket; (2) formative, it produces both cementum and bone; (3) resorptive, by means of its osteoclast and cementoclast cells it resorbs bone and cementum when necessary; (4) sensory, by means of certain of its nerve endings (tactors) it provides the tactile sensitivity which enables a person to estimate occlusal pressure; and (5) nutritive, by means of its blood vessels it helps provide nourishment to the periodontium.

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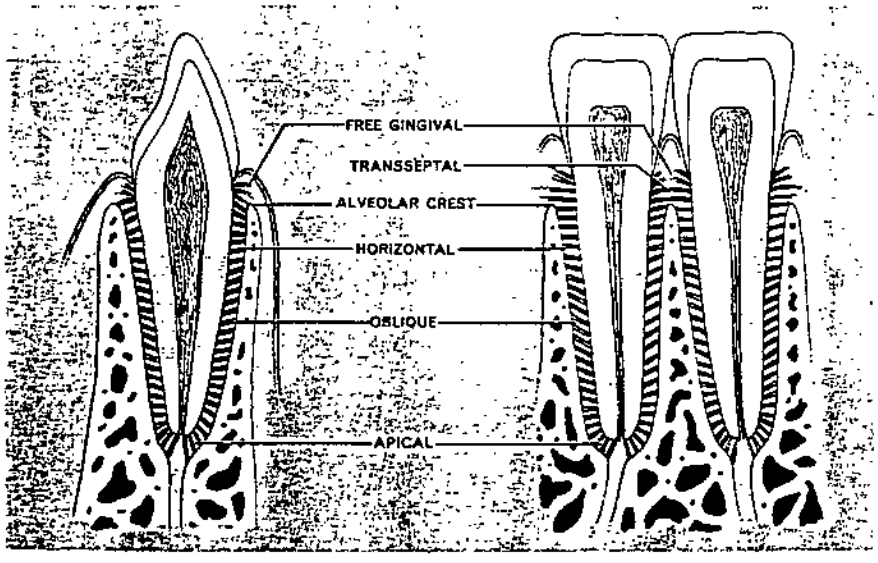

Figure 2–18. Fiber Groups of the Periodontal Ligament

Schematic illustration of the six principal fiber groups of the periodontal ligament. (After Schour, I. ed. Noyes' oral histology and embryology, ed. 8. Philadelphia, Lea & Febiger, 1960.)

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13 Aesthetic Crowns

13.1. Introduction

An anterior tooth may be restored with a veneer crown of a tooth-coloured material where a considerable amount of the clinical crown has been destroyed by caries or trauma, or where the appearance is unsatisfactory. The most widely used crown is made from dental porcelain and is known as a porcelain jacket crown. 53

When such a crown is well made, it gives a durable and pleasing result; however, in addition to all the usual attention that has to be given to the fit, contour and occlusion of a crown in metal, the appearance is dependent on the way the variously pigmented powders are blended during construction. For this reason it presents a great challenge to the operator and too often the results fall below expectations, especially in inexperienced hands.

The indications for jacket crowns have declined since the introduction of composite resin and the acid-etch technique, but the porcelain jacket crown is the restoration of choice for restoring a very heavily filled or unsightly vital anterior tooth because it gives a superior aesthetic result to the only satisfactory alternative, the metal–ceramic crown. Porcelain possesses good colour stability but its weakness is its brittleness. This has been overcome to some extent with the use of alumina-based ceramics which were introduced in the late 1960s. However, fracture of jacket crowns is still a common cause of failure, particularly where there are errors in the shape and sharpness of the tooth preparation, as well as errors in the occlusal contacts of the restoration.

The porcelain jacket crown is less suitable for young patients whose teeth still have large pulps, so these restorations are not commonly provided for teenagers. Usually the labial margin is placed in the gingival sulcus to give a good aesthetic result. However, in a young patient, normal gingival recession can cause the margin to become visible within a year or two; this is often unsightly and yet another reason for not making this type of restoration in young patients. Short clinical crowns provide inadequate retention of the restoration on the preparation, and thin teeth particularly with a deepened overbite may have insufficient room on the palatal surface for the necessary thickness of porcelain. Small upper teeth and most lower incisors rarely provide sufficient room for these crowns. Porce-

lain jacket crowns are not usually used on posterior teeth because they are too brittle. The restorations should also be avoided in patients who grind their teeth or have lost their posterior teeth. In these cases metal–ceramic crowns would be used because they have greater strength, although their colour match is likely to be less good.

13.2. Preparation

Before treatment is commenced it is necessary to have established that the pulp is alive and that there is no radiographic evidence of disease affecting the tooth. The operator should have study models from impressions taken at a previous appointment so that the occlusion can be assessed and to provide a guide to the shape of the tooth during construction of the crown. Where it is intended to crown a number of teeth or to reshape teeth extensively, a trial wax-up with beeswax should be carried out on a duplicate model. Reference can be made to this during construction of the crowns to ensure they are of the correct proportions and their incisal edges are situated in the right place. A special tray should be made.

The preparation of a tooth for a porcelain jacket crown follows the same principles as those for a cast gold restoration. Opposing walls of the preparation should have a 6° taper. The porcelain crown must be thicker than a gold crown so the preparation is relatively more severe and the margin of the preparation is finished as a shoulder instead of a chamfer. Preparation may be considered in the following steps:

(1) Incisal reduction
(2) Labial reduction
(3) Approximal reduction
(4) Palatal reduction
(5) Finishing

Incisal reduction

Three grooves are made in the incisal edge with a long-tapered diamond bur (555) in the turbine handpiece to a depth one-quarter the length of the labial surface of the tooth (Fig. 13.1). The intervening spikes of tooth substance are then reduced with the same bur taking care to avoid the adjacent teeth. This shortening of the preparation enables the bur, which will be used to prepare the labial surface, to reach the gingival margin.

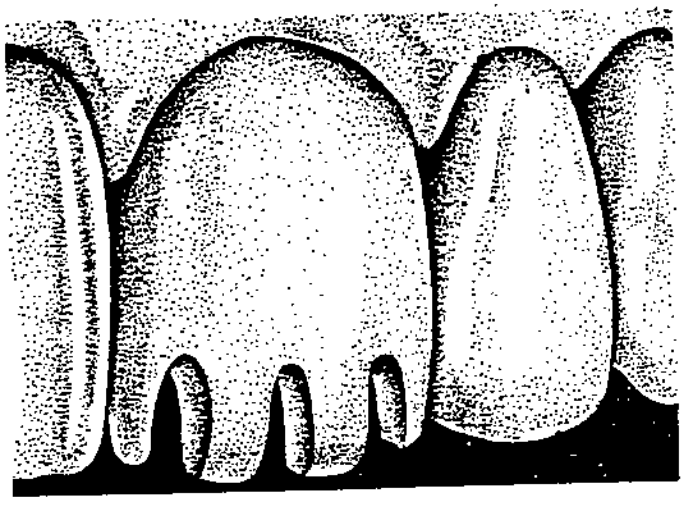

Fig. 13.1. Depth grooves are placed in the incisal edge to control the amount of tooth removed.

Labial reduction

Three grooves are placed in the labial surface to the full depth of the bur such that the depth of each groove incisally is 1.3 mm tapering to 0.8 mm at the gingival level (Fig. 13.2). These grooves ensure that sufficent tooth will be removed to give an adequate thickness of porcelain for strength and colour. If the original surface were convex incisо-gingivally, so should be the base of the grooves by

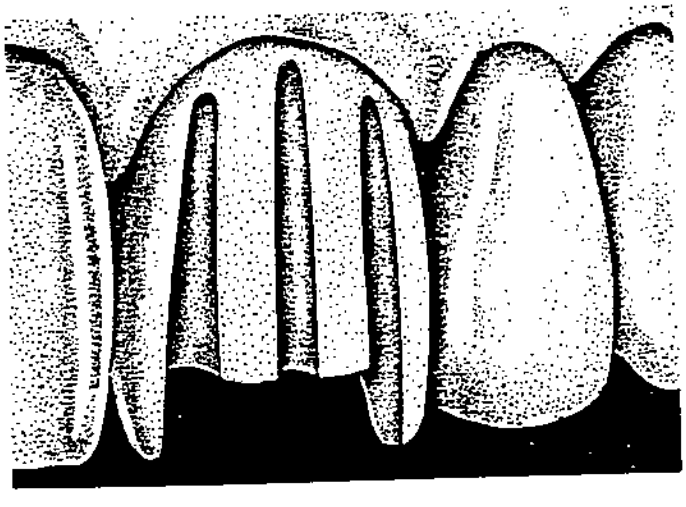

Fig. 13.2. Depth grooves are placed in the labial surface of the tooth to ensure sufficient tooth substance is removed.

altering the angle of the handpiece. If these grooves are not placed prior to reduction of the labial surface it is very difficult to assess how much tooth substance has been removed; and it is likely to cause a crown of incorrect colour to be made because the porcelain may be too thin. The intervening tooth substance between the grooves is then removed to give a tapered reduction of the labial surface (Fig. 13.3); the width of the shoulder is 0.8 mm. The shoulder is then

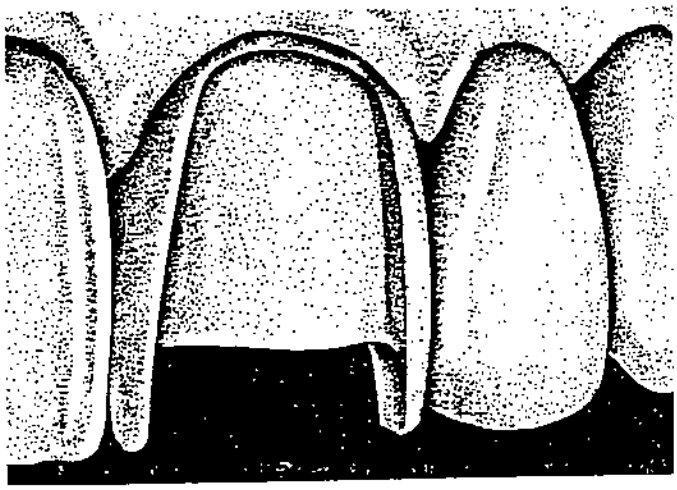

Fig. 13.3. The labial surface has been reduced but the gingival margin of the preparation has not yet been taken into the gingival sulcus.

further extended until it is 0.5 mm into the gingival sulcus but it is not widened in the process. The operator will find it particularly helpful in preparing the shoulder to retract the free gingiva with a flat plastic instrument. As well as improving the visibility of the preparation of the shoulder the gingiva is protected from damage by the bur.

Approximal reduction

The approximal surface is reduced by burring away from the labial side and in doing so the bur is lifted incisally so that a number of strokes are necessary to achieve the preparation; this ensures that adequate coolant reaches the bur. Care must be taken to avoid the adjacent tooth and a matrix band placed around it provides some degree of protection. The width of the shoulder on the approximal surface should not be more than 0.8 mm (Fig. 13.4). The mesial and distal walls of the preparation should possess a 6° taper. With these walls as near parallel as possible retention is significantly improved. The gingival margin of the preparation should be continuous and follow the gingival contour, and this invariably

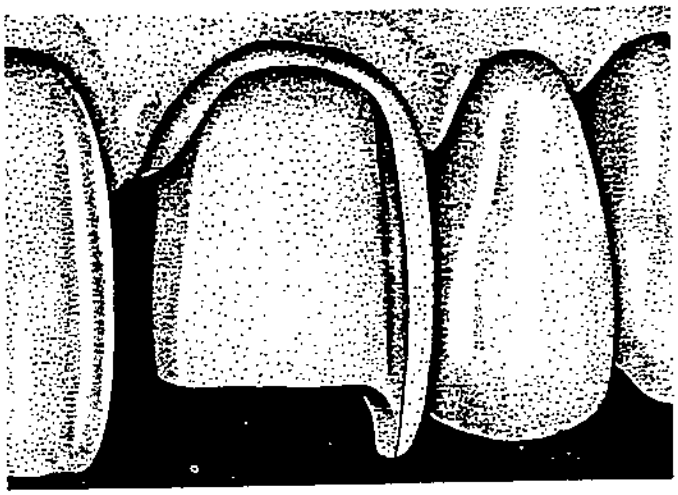

Fig. 13.4. The mesial approximal surface has been reduced and a shoulder finish formed gingivally.

means that the approximal shoulder rises incisally. The only exception is when there is an existing restoration with a subgingival margin. Indeed the preparation should not be deepened to achieve a shoulder at the same level all the way around—though this may give a stronger crown. the gingival papilla will respond with chronic inflammation because of plaque accumulation.

Palatal reduction

A depth groove is placed in the midline of the palatal surface to a depth of 0.8–1.0 mm with the tip of the tapered diamond bur. The shoulder is then formed on the palatal side and merged into the approximal shoulders (Fig. 13.5). The palatal shoulder is usually placed supragingivally, unless the preparation is particularly short. The prepared tooth should be examined for slight taper, and any undercut if present should be eliminated with particular attention being paid to avoiding undercut from corner to corner, e.g. mesio-labial to disto-palatal. The remaining part of the palatal surface is then reduced to the depth governed by the groove. Because this surface of the preparation should be concave it is better done with a small round diamond point in the turbine handpiece or a larger one in the low-speed handpiece. Clearance in intercuspal occlusion should be examined and it must be not less than 1.0 mm. This amount of clearance is also required in lateral and protrusive movements of the mandible and these movements must be checked even if there is more than adequate clearance in intercuspal occlusion.

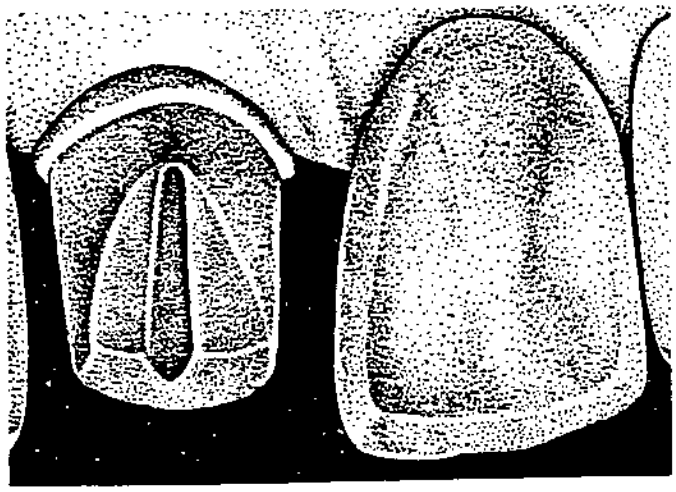

Fig. 13.5. Part of the palatal reduction has been carried out. A palatal shoulder has been created, merging into the approximal shoulders. A depth groove has been placed in the small amount of remaining original palatal enamel.

Finishing

The preparation should next be smoothed with a sintered diamond bur or other finishing bur, and sharp line angles rounded to reduce stress in the subsequent restoration. The incisal edge of the preparation should be bevelled towards the

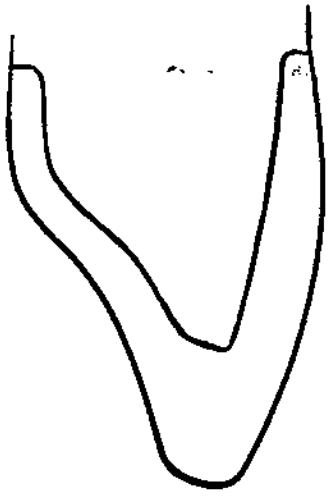

Fig. 13.6. A cross-sectional diagram to show the form of the preparation in relation to the shape of the completed crown which should reproduce the original shape of the tooth.

palatal side and in doing so the height of the preparation may be reduced slightly so that the final length of the preparation is two-thirds to three-quarters the original length of the labial surface (Fig. 13.6). Further reduction should be avoided as the crown is less well supported and the pulp is jeopardized.

The enamel margins should be planed with a 1 mm wide straight chisel or a binangle chisel where access dictates; this procedure removes spicules of enamel and creates a smooth margin to the shoulder on the preparation.

The finished preparation (Fig. 13.7) should be examined from several aspects for shortcomings and any rectified. Frequently, inexperienced operators become

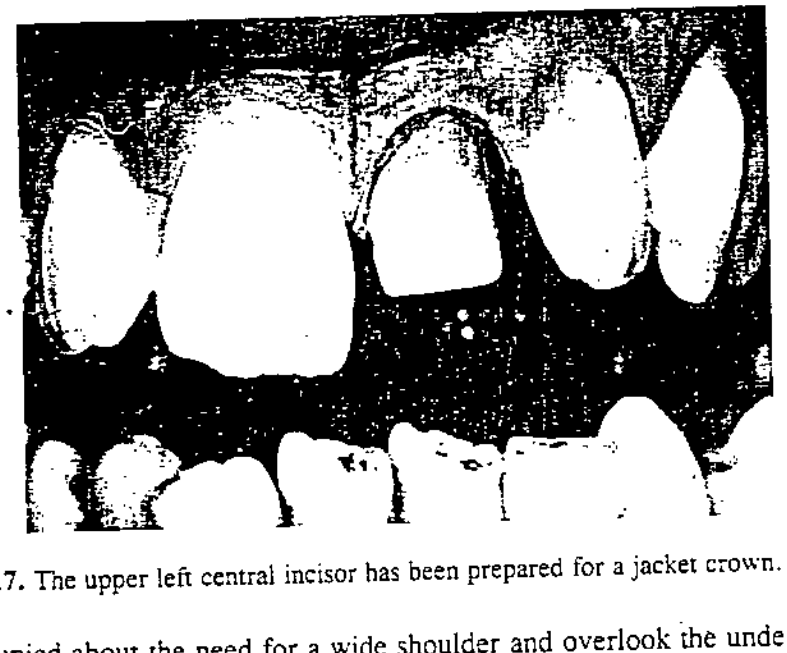

Fig. 13.7. The upper left central incisor has been prepared for a jacket crown.

preoccupied about the need for a wide shoulder and overlook the undercut that they have introduced in creating the shoulder; there is no need to have a shoulder wider than 0.8 mm. Conversely, too much taper is undesirable.

Where the teeth are imbricated it is important to ensure that the preparation is not undercut by an adjacent tooth or it could be impossible to fit the completed restoration.

When the preparation has been completed, an elastic impression is taken, of which details have already been covered in Chapter 12 (page 202).

The shade of adjacent teeth must be recorded so that the restoration will be of similar appearance. It is advisable to assess the shade in good daylight but not in direct sunlight as it is too bright. Most operators use the Vita shade guide[1] (Fig. 13.8) which has four basic colours, Brown, Yellow, Grey and Red, corresponding to A, B, C, D, with the lower numbers being light and the higher

[1]Vita Zahnfabrik, Bad Saeckingen, West Germany.

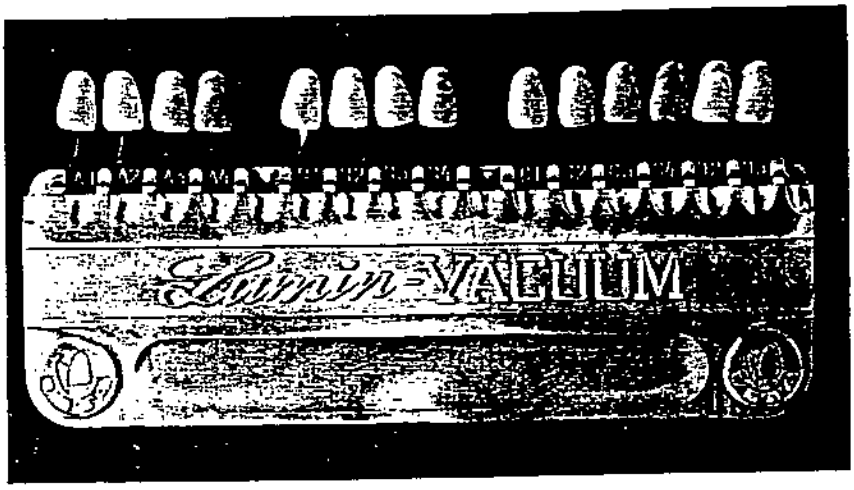

Fig. 13.8. The Vita porcelain shade guide has four basic shades lettered A to D; the higher numbers are darker.

numbers dark. The operator should concentrate on the centre of the teeth avoiding the cervical and incisal edge regions to decide the basic colour of the tooth before determining the brightness. As general rules, teeth darken with age and the majority of teeth have a brown or yellow hue, so it is a good policy to assess the A and B shades for colour match before trying C and D shades. The enamel porcelains do not vary greatly between shades and it is normal practice to use the enamel powder which is suggested for the particular dentine. The tooth should be assessed for transparency of the incisal tip, whether it is as opaque as the shade guide or more transparent. Whilst the skilled ceramist and experienced operator may note subtleties of shade at this stage, the inexperienced operator/technician will find it hard enough to get the basic colour of the crown similar to the shade guide tooth, and specific characterization can be done after the crown has been tried in, using surface stains. When the crown is being made by an experienced technician it is very valuable if he can participate in taking the shade, or if he cannot see the patient, he should be given full written details.

A temporary crown should be constructed and luted into place with a temporary luting cement. Particular attention should be paid to avoid any gingival excess of crown material or luting cement which might cause gingival irritation or recession.

13.3. Laboratory procedures

A model is cast in die-stone as has been described in Chapter 12; the die of the tooth is removed carefully and excess stone trimmed to reveal the shoulder of the

preparation. A sheet of platinum foil is swaged onto the die; particular care must be taken not to damage the model during this procedure. On the foil matrix a high alumina porcelain core is built up and fired. During firing the porcelain shrinks and may lift the foil from the shoulder, therefore the foil should be readapted to the model before further firing to ensure good marginal fit of the restoration. The build-up of the main enamel and dentine porcelain powders is critical to the colour of the final crown, and is particularly difficult to achieve without a great deal of experience (Fig. 13.9). After firing, the crown is ground with diamond wheels to adjust the contour.

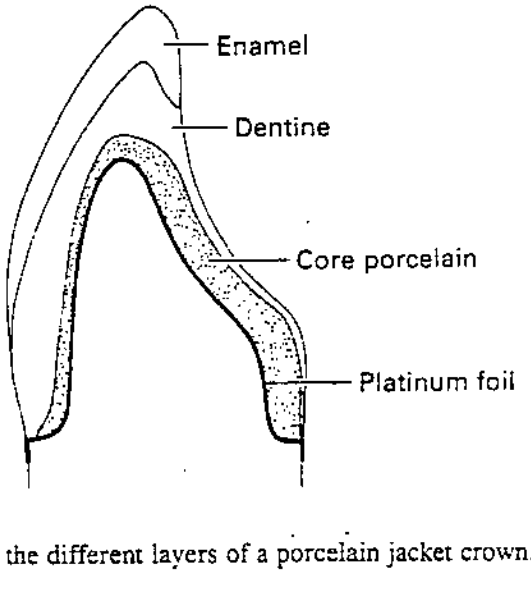

Fig. 13.9. Diagram of the different layers of a porcelain jacket crown.

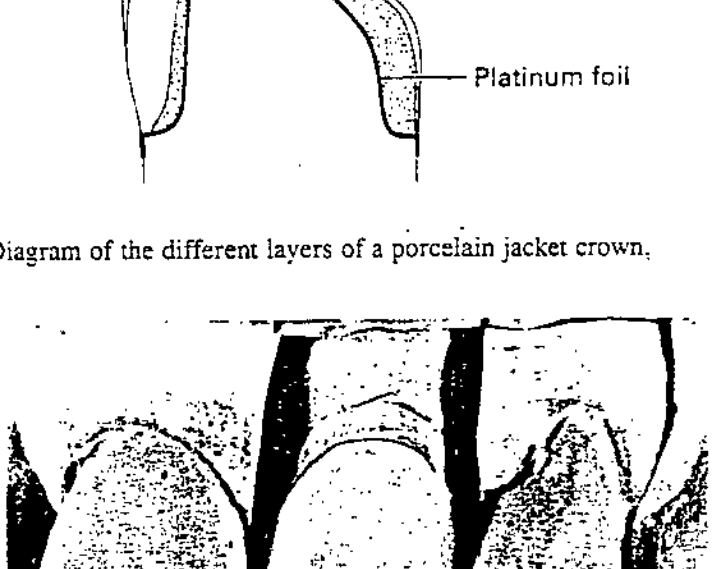

Fig. 13.10. The unglazed porcelain crown, still on its platinum foil matrix, on the model for checking prior to arrival of the patient.

When the crown is returned from the laboratory, with the platinum foil still in position apart from the gingival skirt which has been removed, the operator should assess the restoration prior to the arrival of the patient (Fig. 13.10). The following should be examined: marginal fit and overextension, approximal contacts, shape, occlusion and colour. Any errors should be corrected before the patient arrives for trial insertion of the crown.

13.4. Trial insertion

The temporary crown is removed carefully from the prepared tooth and traces of luting cement must be cleared from the preparation before the crown is tried on the tooth. If all the laboratory stages have been carried out correctly, the crown should seat home fully; however, if the approximal contacts have been overbuilt, it will fail to seat. A trace must then be shaved off the affected contact with a diamond wheel in a straight handpiece with the crown held on the die for support; a diamond wheel is far more efficient than the previously used silent stone. The crown is retried and the procedure repeated until the crown seats home fully. The margins should be examined carefully with an excavator for full vertical extension, extending the full width of the shoulder but the absence of overextension. Deficiencies in fit are difficult to correct and unless they are of a very minor nature require the crown to be remade. Overextension, however, should be corrected by trimming back excess with a diamond wheel: for this procedure the crown should be held on the die. This trimming may have to be repeated several times before the overextension is completely eliminated.

The occlusion should be checked using articulating paper first in intercuspal occlusion and then in lateral and protrusive movements. Any prematurities should be eliminated using a diamond wheel with the crown seated on the die.

The incisal length should be assessed with the patient being examined in the sitting position. For this, reference to the original study model, or trial wax-up model, may be particularly valuable. Then the labial contour is assessed and adjusted as required. If the crown is undercontoured or an incisal angle is too rounded, the crown can be returned to the laboratory for the addition of more porcelain.

Finally the colour is assessed. If the wrong shade has been chosen it is necessary to remake the crown. However, if the colour is very close when the tooth is examined wet, surface stains may be added to reduce the brightness by a light general application, and to alter the colour more significantly by heavier application in particular areas such as the neck. Stains may also be used to simulate restorations, cracks and hypoplasia.

The crown is returned to the laboratory and stained as appropriate and glazed.

After glazing, the platinum foil is removed and any sharp margins smoothed with a rubber wheel. The crown is luted with a glass ionomer luting cement. The procedure is similar to that for a gold casting (see page 200). The finished crown is shown in Fig. 13.11.

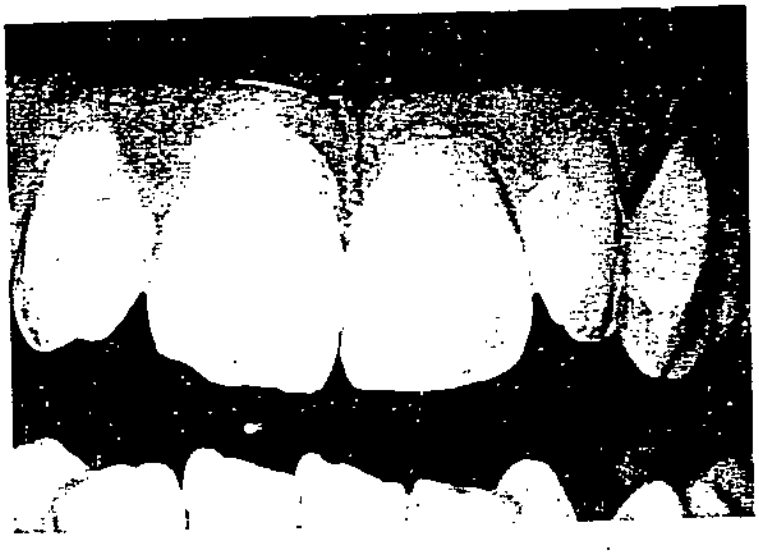

Fig. 13.11. The finished crown fitted on the upper left central incisor.

13.5. Metal–ceramic crown

This type of crown is considerably stronger than the porcelain jacket crown and it is therefore the restoration of choice for posterior teeth where a crown is indicated and the patient would not like a metal crown to show, and secondly for anterior teeth where there is inadequate palatal clearance for a porcelain jacket crown; it is also frequently used as a bridge retainer.

Very often on a posterior tooth such as an upper premolar, the buccal cusp is restored in ceramic with the palatal cusp being in metal. The preparation of the tooth is a hybrid of that for a veneer crown and that for a jacket crown. with the palatal margin being finished as a chamfer while the buccal margin is finished as a shoulder. The gentle transition from shoulder to chamfer occurs on the approximal surface toward the palatal, so that no metal shows from the buccal aspect. The gingival margin should be continuous and not change levels or shape abruptly. The reduction of the buccal surface should be a little greater than that for a porcelain jacket crown. The long-tapered diamond bur should groove the surface 0.2 mm deeper than the bur; at the occlusal of the buccal surface the depth of the preparation should be 1.5 mm tapering to 1.0 mm at the gingival. This greater thickness compared with a porcelain jacket crown is to create sufficient

room to accommodate a 0.5 mm thick metal veneer over which there is enough ceramic to achieve a satisfactory colour match of the restoration. Some authorities have stated the need for a shoulder 1.5 mm wide, and while this may give an improved colour at the neck, it is unnecessary to remove so much dentine and in teeth where the pulp is vital it may be potentially harmful. As these crowns are often placed on heavily restored teeth, the amalgam core must be well retained, usually by pins, since there will be little remaining buccal tooth substance to assist in retention.

On the occlusal surface at least 1.5 mm should be removed from the buccal cusp slope whereas only 1 mm need be removed from the palatal cusp, checking sufficient clearance in lateral excursions of the mandible as well as in intercuspal occlusion.

The resistance form of the restoration is improved by placing a seating groove on the palatal wall, which usually has sufficient dentine to accommodate it whereas the other walls are closer to the pulp. However, if the tooth has a large amalgam core the groove may be placed on an approximal wall.

Where a metal–ceramic crown is being made for an anterior tooth, the palatal clearance in intercuspal, lateral and protrusive occlusions should be at least 0.8 mm and the palatal margin is finished as a chamfer. If retention would be poor, particularly on a tooth which has suffered attrition, it may be improved by placing grooves on each approximal wall in line with the labial wall (Fig. 13.12) provided

Fig. 13.12. Diagrams of a preparation for a metal–ceramic crown where extra retention is required from grooves on the approximal surfaces. *Left:* view from the approximal surface showing the groove at a 6° taper to the labial wall. *Right:* view from the incisal edge.

that care is taken to avoid unnecessary encroachment on the pulp; this is usually not a hazard in teeth suffering from attrition or erosion.

On an upper premolar it is usual for the metal part of the crown to restore the

full contour of the palatal cusp but only to provide a veneer approximately 0.5 mm thick over the reduced buccal cusp (Fig. 13.13). By the addition of approximately 1 mm of ceramic to the metal the contour of the buccal cusp should be correctly

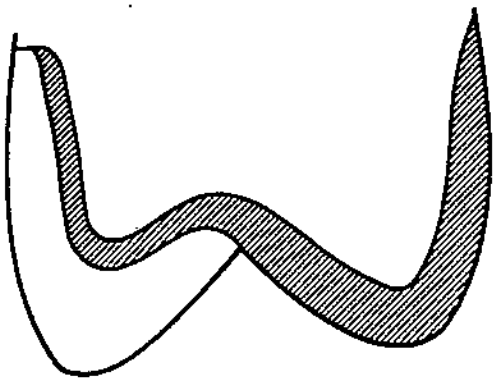

Fig. 13.13. Diagram of a longitudinal bucco-palatal cross-section of a metal–ceramic crown for an upper premolar. The palatal cusp is restored entirely in metal while the buccal cusp is restored with a 1 mm veneer of ceramic over a 0.5 mm layer of metal. The buccal margin has a shoulder finish while the palatal margin has a chamfer finish.

formed. The successful bonding of the ceramic to the metal requires a large surface area and the avoidance of sharp internal angles on the ceramic veneer. On the occlusal surface the ceramic should finish at a butt joint with the metal. The

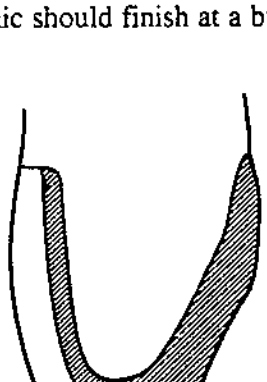

Fig. 13.14. Diagram of a longitudinal labio-palatal cross-section of a metal–ceramic crown for an upper incisor. The metal is kept short of the incisal edge to allow translucency of the tip. The labial margin is formed as a ceramic to tooth butt joint to give good appearance.

metal which abuts the ceramic should be thick so that it cannot flex and cause fracture of the ceramic. With all posterior teeth, it is important that cusps built up in ceramic are supported underneath by metal to resist fracture of the ceramic veneer. With anterior teeth, the metal should be short of the incisal edge to allow translucency of the tip of the crown and the metal should be of sufficient thickness where it abuts the ceramic to resist flexion (Fig. 13.14).

The labial gingival margin of the restoration looks unsightly if it is made of metal; however, it is possible to avoid metal showing by arranging for a ceramic to tooth butt joint. The casting is initially made the full width of the shoulder at the gingival margin but the metal is trimmed back 0.5 mm from the margin of the shoulder prior to the application of ceramic (Fig. 13.14).

After the crown has been made it is returned from the laboratory for trial insertion and the procedure is similar to that already described for a porcelain jacket crown. The exposed metal surfaces should be polished after glazing.

13.6. Removal of porcelain restorations

To remove a porcelain jacket crown, a groove should be placed in the middle of the labial surface using a diamond bur in the turbine handpiece with copious waterspray to prevent overheating. A straight chisel (2 mm wide) should be placed sideways in the groove and rotated (Fig. 13.15). This will crack the porcelain on the palatal side of the restoration and break the cement lute: the pieces of porcelain will normally lift off.

Fig. 13.15. A straight chisel inserted in a groove cut in a porcelain jacket crown prior to rotating the chisel.

To remove a metal–ceramic restoration, a groove should be placed in the middle of the labial surface of the ceramic with a diamond bur until the metal substructure is reached. A fine cross-cut tungsten carbide bur should then be used to cut through the metal taking care not to cut into the underlying dentine. A chisel is used to flex the metal and break the cement lute in a similar way to removal of an all metal crown.

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Principles of Minor Oral Surgery

David A. McGowan

The GDP who performs extractions and is ready and able to deal with possible complications will also have the skills and experience to perform preplanned minor oral surgery. In this article Professor McGowan provides a guide for all those who wish to improve their knowledge of this branch of the surgeon's art.

THE ABILITY to extract teeth is still a necessary skill for the dentist, and, as in any form of surgery, complications will arise from time to time. The dentist who extracts teeth must be prepared to meet these complications. The skills, experience and practice organization required for this can also usefully be employed in preplanned dento-alveolar surgery.

Minor oral surgery comprises those surgical operations that can comfortably be completed by a practised nonspecialist dentist in not more than 30 minutes under local anaesthesia.

In any surgical operation there are four stages:

- Diagnosis and treatment planning.
- Pre-operative preparation.
- The operation.
- Post-operative care.

This article will review the general principles of each of these stages in relation to minor oral surgery.

DIAGNOSIS AND TREATMENT PLANNING

All surgery produces tissue damage and patient morbidity, so every operation must be justified by the benefits. There is no 'routine' operation. The purpose must be one of the following:

- Elimination of disease
- Prevention of future disease or disadvantage
- Removal of damaged or redundant tissue
- Improvement of function or aesthetics.

As an example, the removal of a retained root fragment inflicts certain surgical damage and is not justified by the hypothetical risk of future infection. However, when there is a defect in the overlying mucosa, the balance is completely altered and removal is advised.

Effective clinical decision-making depends on the gathering and objective analysis of relevant information, and then on judgement based on experience, instinct, and possibly even prejudice. The clinician can never allow him or herself the certainty which patients demand, and a minor oral surgical operation is only one item in a patient's continuing dental care.

Treatment planning must be responsive to the practical day-to-day realities of economic and social factors, and successful patient management depends on achieving the right balance.

Apart from the few purely soft tissue procedures, minor oral surgery diagnosis depends heavily on radiographs. Acceptance of a low standard of radiography is frankly negligent.

Pre-operative assessment of difficulty cannot be exact, and the margin of error must always lie on the safe side. Overestimation of difficulty leads to relief and gratitude, while underestimation leads to embarrassment. The general dentist who refers a difficult case to a specialist will earn the respect of both patient and colleague.

Fitness for Minor Oral Surgery

The dangers of minor oral surgery have been grossly exaggerated. Excluding general anaesthesia, minor oral surgery under local anaesthesia, with or without sedation, is a remarkably safe undertaking.

It was formerly considered sufficient to believe that if a patient was fit enough to come to the surgery, they were fit to receive treatment— and the cautious sited their premises at the top of a flight of stairs! However, it is now considered negligent to fail to obtain a current medical history and to appreciate its significance, and from student days onwards, considerable efforts are made to educate dentists to a high level of knowledge and understanding of medicine.

In case of concern, it is prudent to discuss potential problems with the patient's physician. It must, however, be remembered that advice once sought must be taken, and will always tend to err on the side of caution. Minor oral surgery does not include the treatment of patients who are obviously acutely ill; nor does it include the chronically sick, unless they are ambulant and able to live a relatively normal life. Well-controlled and stable chronic disease is unlikely to raise problems, but the often complex medication itself can raise the possibility of unfavourable drug interactions. However, 2–4 ml of one of the commonly used local anaesthetic solutions containing 2% lignocaine with 1/80,000 adrenaline will not be harmful.

It is far more important to treat the patient with kindness and consideration, and to avoid stress, than to complicate the issue by using allegedly safer preparations of less certain efficacy.

For a detailed discussion of the subject some recommended texts are listed in the Further Reading.

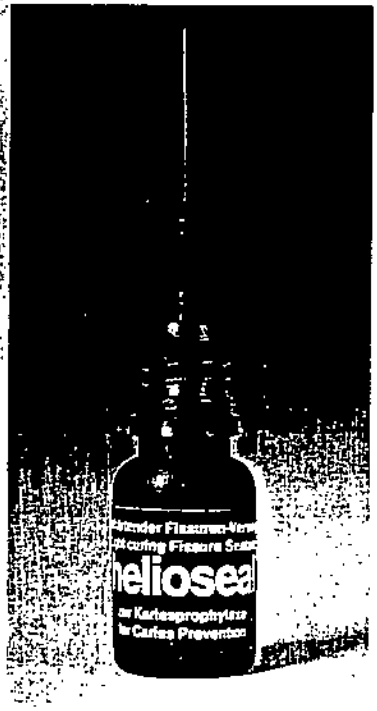
PRE-OPERATIVE PREPARATION

Thorough preparation is the key to successful surgery (Figure 1). Efficiency wins, and maintains, patients' confidence and co-operation. Difficulties arise more often from lack of planning or forethought than from any lack of manual skill.

This article is based on Part I of *An Atlas of Minor Oral Surgery: Principles and Practice* by David A. McGowan, published by Martin Dunitz Ltd, London, 1989, and is reproduced by kind permission of the publisher.

David A. McGowan, MDS, PhD, FDS RCS(Eng), FFD RCS(Ire), FDS RCPS(Glas), *Professor of Oral Surgery, University of Glasgow.*

GOING FROM STRENGTH TO STRENGTH



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1 TRUMMLER, A & H: "Clinical Study of Fissure Sealing with Helioseal over 96 months."; St Gallen School Dental Clinic. Swiss Journal of Dental Medicine. January 1990.

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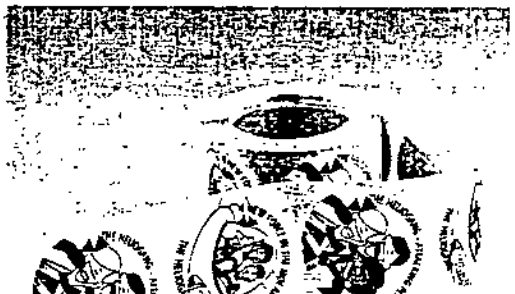

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The Patient

No one looks forward with pleasure to surgery, however minor. Patients will be apprehensive to a variable extent and deserve sympathetic reassurance. Most fears will be alleviated by discussion, but the fear may impede communication. A patient must consent, at least verbally, to the planned treatment. He or she must receive an explanation of the operation, its purpose and procedure, and of the consequences, including possible harmful effects. Radiographs are a great aid to explanation. An appraisal of the degree of sedation required needs to be made in advance, and the social consequences of both the operation and sedation discussed. If possible, the patient should be accompanied home afterwards by a responsible adult.

Case records should be checked and placed where they can readily be consulted during the operation without handling. Radiographs must be illuminated properly and checked.

The Equipment

The instrument kit required will vary with the demands of the procedure and the operator's preference. A suitable surgical kit is listed in Figure 2. Instruments should be prepared and sterilized in kits, and will remain sterile if stored dry in a closed pack.

Two fundamental requirements, which cannot be overemphasized, are effective lighting and suction. Suction for surgical purposes should be of the high-vacuum/low-volume type to ensure the efficient removal of blood. High-volume apparatus produces drying of the wound and also carries the risk of the loss of small fragments of tooth or soft tissue, which should be retained for examination.

Cutting equipment should be tested, and any dressings or medicaments required made ready in advance.

The Assistant

Minor oral surgery is a 'four-handed' procedure, and skilled assistance is crucial. It is obviously vital to explain the operation plan to the assistant in advance.

The Operator

The operator needs to be clear as to how he or she intends to proceed. Most problems can be anticipated. As the operation proceeds the options become clearer and a change of plan may be needed.

The patient should be positioned so as to give the operator a clear view and a comfortable working position.

THE OPERATION

All minor oral surgery operations follow a similar sequence of stages (Figure 3). Adherence to a logical overall plan is a great help when difficulties arise. The operative sequence follows the anatomical tissue planes—first inwards until the objective is achieved, and then outwards until the wound is repaired.

To illustrate the normal operative sequence, Figures 4–11 show the stages of an operation to remove an impacted lower third molar that was causing pericoronitis.

Figure 1. *Pre-operative check list.*

Patient
- Comfortable—physically and mentally relaxed
- Informed consent
- Information
  - case records
  - radiographs
- Anaesthetized ± sedated
  - verbal
  - oral
  - intravenous
  - inhalational

Equipment
- Light
- Suction
- Instruments
- Dressings/medicaments

Assistant
- Trained/informed

Operator
- Pre-operative assessment
- Operation plan
- Contingency plans

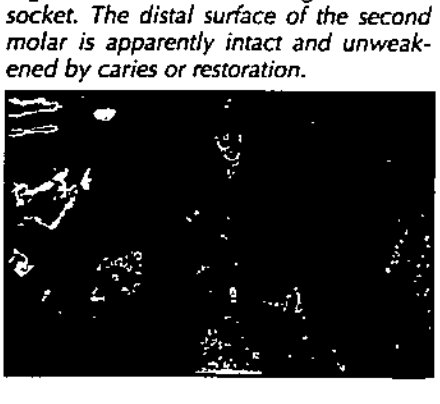
Figure 2. *A basic selection of instruments for minor oral surgery.*

- Metal aspirating syringe
- Disposable needle
- Cartridges of 2% lignocaine with 1/80,000 adrenaline
- Mirror
- Probe
- Tweezers
- Gauze swabs (10 cm x 10 cm)
- Aspirator tip and matching stilette
- Kilner cheek retractor
- Scalpel handle with disposable blade
- 2 Howarth's periosteal elevators (Howarth's nasal raspatory)
- Mitchell's trimmer (Cumine scaler is similar)
- Straight handpiece
- No. 6 rose-head bur (steel or tungsten carbide)
- No. 6 tapered fissure bur (tungsten carbide)
- Cloth sleeve
- 2 plastic gallipots
- Warwick-James' elevators (right and left)
- 2 Coupland's chisels (medium and small)
- 2 Cryer's elevators (right and left)
- Upper universal extraction forceps
- Rongeurs
- Disposable plastic irrigating syringe
- Small mosquito artery forceps
- Large straight artery forceps
- Gillies' needleholder
- Mayo needleholder
- Gillies' tissue forceps
- Disposable suture, 3/0 silk on 3/8 cutting needle

Figure 3. *Stages of the operation sequence.*

- Retraction
- Incision
- Reflection
- Bone removal
  - access
  - point of elevation
  - removal of obstruction
- Tooth section
- Delivery
- Clean-up
- Sew-up
- Check-up
- Follow-up
- Write-up

Figure 4. *Retraction and the operation site: the tooth is partially erupted, with the disto-buccal cusp visible. The distal gingival margin can easily be bisected by an incision from the distal groove, and the buccal gingival roll is thick and will form a good corner for advancing across the socket. The distal surface of the second molar is apparently intact and unweakened by caries or restoration.*



Retraction (Figure 4)

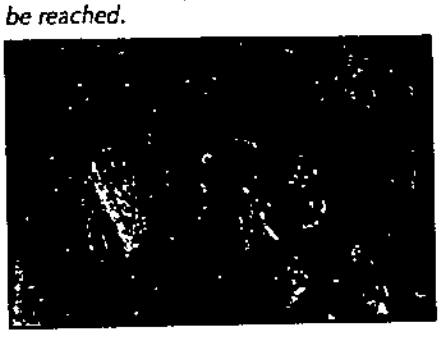
The first procedure is the placement of a suitable retractor so as to display the operation site and hold the lips, cheeks and tongue out of the way. The Kilner cheek retractor will control both lips and cheek. The tongue is best controlled by ignoring it—conscious efforts by the patient are seldom helpful. When the retractor is in place, a final check should be made on the relative positions of the patient, the operator, the assistant, and the light.

Incision (Figure 5)

The shape of the incision has to be planned with the needs of both exposure and closure in mind. A long incision heals as easily as a short one, and so exposure should be generous. While the mental nerve is the only significant structure at risk, thoughtful placement of incisions can reduce haemorrhage by avoiding unnecessary section of muscles or small constant vessels. Most incisions can be made onto the underlying bone, to ensure separation of both mucosal and periosteal layers in the one cut. The hand should be steadied, if possible, by using a suitable rest for the fingers. Incisions may sometimes be conveniently extended with tissue scissors.

Figure 5. *Incision: this is made as planned. Note the angle at which the incision crosses the attached gingiva.*

Figure 6. *Reflection: a generous exposure has been achieved, and the point of a curved Warwick-James' elevator inserted to confirm that a point of application can be reached.*



Reflection (Figure 6)

The mucoperiosteal flap is reflected with a periosteal elevator, such as a Howarth's. Two elevators can be used to advantage at this stage—one working and the other aiding retraction in the subperiosteal plane. Adequate undermining of the wound margins is required in order to mobilize the flap. Generous reflection is the key to adequate vision, and wide exposure reduces traction trauma to the wound edges.

Figure 7. *Bone removal:* **(a)** *A gutter has been created on the buccal and distal side by cutting to a depth of about half the root length, using the root itself as a cutting guide. Elevation is tried and is partly successful, but the crown is held by the disto-lingual bone.* **(b)** *The crucial disto-lingual corner is now cut through to the lingually placed Howarth's periosteal elevator, which acts as a guard and prevents damage to the lingual tissues, including especially the lingual nerve.*

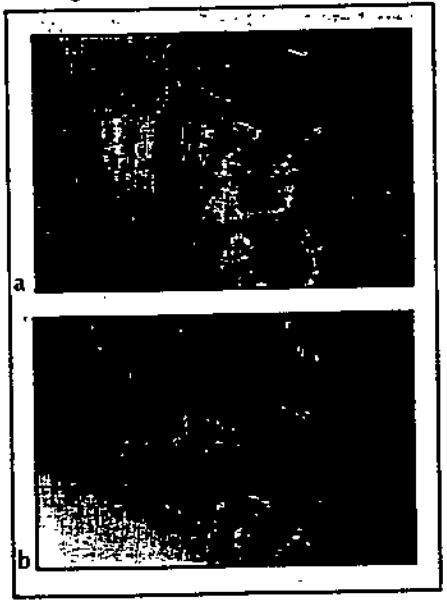
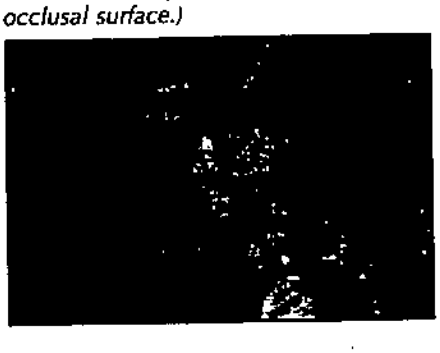


Figure 8. *Elevation: the tooth can now be uprighted and is free for delivery. (Caries and calculus deposits can be seen on the occlusal surface.)*



Bone Removal (Figures 7 and 8)

Removal of bone is usually required and, in the interest of vision and to reduce trauma from excessive elevating force, should be generous. This is most conveniently achieved by using a bur in a slow-to-moderate-speed handpiece. Handheld chisels are useful in 'peeling off' thin layers of bone, and rongeurs are ideal when the blades can be placed either side of the piece of bone to be removed. Bone files are seldom required since sharp edges can be 'nibbled' off. Excessive smoothing is unnecessary.

Although generous in extent, bone removal must never be blindly destructive. The main objectives should be the achievement of access, the establishment of a point of application for an elevator (or forceps), and the removal of the obstruction to movement of the tooth or root. Slots or gutters around teeth or roots should be deep and narrow so as to preserve a fulcrum for leverage. Additionally, the shape of the tooth must be borne in mind, both when clearing the cardinal points of the crown and in allowing for curvature and angulation of the roots.

Tooth Section

Division of a tooth may resolve the conflicts of the paths of withdrawal, or relieve impaction. This is best achieved by piercing the surface with a round bur, which is then sunk to the estimated width of the tooth, and the round 'shaft' converted into a slot with a fissure bur. Tungsten carbide tipped burs are essential for efficient cutting. All cuts should be judged so as to remain within tooth substance, and to avoid damage to the neighbouring structures. Final separation is achieved by levering within the slot with a flat elevator until the tooth cracks apart. In order to avoid propagating the crack through the bone, it is safer to gain even limited movement of the tooth within the socket before section.

Delivery (Figure 9)

When all necessary bone removal and tooth section is complete, the tooth or root is delivered, usually by leverage with an elevator. When the root form is complicated, and there is marked curvature in more than one plane, withdrawal with forceps may be easier, if they can be applied. The successful delivery of the tooth is a cause of some satisfaction, and

is usually greeted with relief by the patient, but this does not represent the end of the operation! The stages which follow are just as important as those already completed.

Pathological specimens are welcomed by the oral pathology departments of most dental schools. They will provide suitable containers (including fluids), advise on postal service rules on packing and despatch, and report on specimens—usually without charge.

Clean-Up (Figure 10)

The socket, or other bony defect, should be examined for the presence of debris. Soft tissue tags can be removed with discretion, although there is no evidence that they cause any harm. Excessive irrigation washes away adherent clotted blood, which is the best dressing material available. Bleeding points may need to be clipped but, fortunately, significant haemorrhage is very rare, and ligation, which is often extremely difficult, is seldom required. Persistent oozing will respond to packing with a damp swab, and to patience. When bleeding is controlled, and the wound is clean it is then ready for closure.

Sew-Up (Figure 11)

Most wounds are sutured so as to replace the flap in the optimum position for healing. The object is not to pull the edges together to form a tight seal, but rather to support them in position and prevent displacement in the early phase of healing. Reducing the gape of the defect also serves to decrease the chance of ingress of food debris. Gentle traction on the tissues will hold them firmly to the bone surface and stop them bleeding. Insertion of too many sutures tears the tissue unnecessarily, and the resulting tangle of suture thread tends to accumulate plaque and promote inflammation. Suture ends should not be cut too short, but rather left tied in an accessible position for later removal.

Check-Up

On completion of suturing, the tension of retraction should be released and the wound re-examined for any gaping. A short period of pressure, applied by biting gently on a damp swab, will ensure the final cessation of haemorrhage. During this time, the patient's post-operative instructions may be discussed. It is prudent to use a set of brief, printed

Figure 9. *Delivery: the follicular soft tissue tag is grasped with a haemostat and used to lift out the tooth. A loosened tooth will always come away with the follicle, but the reverse is not reliably true.*

Figure 10. *Clean-up: the socket is clean but must be checked for calculus or other debris lying in the blind spot distal to the second molar.*

instructions (Figure 12), since memory can be fallible under such circumstances. Patients must understand how to keep the wound clean, with frequent saline mouth baths, and know how to get help if they suffer haemorrhage, severe pain or excessive swelling. Proscription of mouth-cleaning or rinsing, or of taking fluids by mouth, or taking alcohol in moderation, or indeed of smoking, is unnecessary, as there is no evidence that any of these practices have the slightest effect on initial wound healing. Nevertheless, excess should be avoided. Suitable analgesics should be given or prescribed, and sensible restriction of activity and rest at home overnight advised.

Figure 11. *Sew-up: closure is simply achieved with a single suture.*

Follow-Up

A return appointment must be made before the patient is discharged. Seven days is usually the most convenient interval, but postponement for a few extra days is of no consequence. Earlier review, except in response to problems, should be avoided, as healing to the point of reasonable comfort usually needs this 7-day interval.

Figure 12. *Sample post-operative advice.*

ADVICE TO HELP YOU RECOVER QUICKLY

The operation wound in your mouth requires just as much care as it would anywhere else in your body. It needs to be left alone as far as possible for the first 24 hours so that the initial healing is undisturbed. From that time on, the aim is to keep it clean so as to try to avoid infection.

Pain: should be relieved by simple painkillers like aspirin, paracetomol or ibuprofen.

Swelling: mild swelling is a natural effect of surgery and will go down in a few days.

Stiffness: is caused by a protective spasm of the jaw muscles and will also take a few days to disappear.

Bleeding: should not occur after your return home.

General activity: be sensible and have an early night for once!

Cleaning: clean wounds heal best. Regular tooth brushing (as best you can) and rinsing with with warm salty water will speed your recovery.

IF YOU HAVE A PROBLEM OR ARE WORRIED ABOUT YOUR PROGRESS, PLEASE DO NOT HESITATE TO TELEPHONE ME FOR ADVICE.

Write-Up

Brief, but accurate, operation notes must be made at the time to record the procedure used, and to note any variation from the usual technique. Involvement of significant vessels or nerves, and account of broken apices and the number of sutures inserted, are all particularly important. A dramatic description is unnecessary and it is best rather to concentrate on those factors most likely to be significant in the long-term follow-up. All such notes must, of course, be dated and clearly signed, since they constitute the legal as well as the clinical record of the operation.

POST-OPERATIVE CARE

A wise oral surgeon once remarked "The operation is finished when the patient stops complaining". For most patients, the follow-up is short and untroubled, but for a few the consequences can be lifelong.

Suture Removal

At the time of suture removal, patients need to be assured that their progress is normal and that the residual discomfort, swelling or trismus are as expected.

The appearance of the sutures is in itself a valuable indicator of the success of the patient's wound care. By no means do all minor oral surgical wounds heal by first intention and, in most cases, there will be granulating areas and often small defects where food fragments can lodge. Swabbing with damp cotton wool and flushing with saline or chlorhexidine solution will clean up the area and leave it much fresher.

Premature removal of sutures is difficult due to swelling, and perhaps trismus, although it can be a relief to the patient if there is gross oedema and the sutures have been tied tightly. Comfortable suture removal requires the same conditions as the original surgery—retraction, light, suitable instruments and skilled assistance. Many patients fear the procedure and they can really be reassured only by painless removal of the first suture. Scissors must be sharp right up to the points, and non-toothed tissue forceps are best for holding and withdrawing the cut threads. Even if sutures have not been inserted, it is essential that the progress of healing is reviewed at about one week post-operation. Large defects or dry socket may be packed with iodoform ribbon gauze, which will stay fresh in the oral wound for some weeks. Smaller defects may benefit from regular flushing with a suitable syringe, and the patient may require instruction in this.

Infection

Most post-operative pain and swelling are due simply to surgical trauma, although bacterial contamination is inevitable at operation and thereafter. Antibiotics should only be prescribed in the following cases:

- Where infection was present pre-operatively.
- Where healing capacity is impaired.
- Where protection from bacteraemia is essential.
- When surgical trauma is particularly severe.

Haemorrhage

Post-operative haemorrhage is unusual, especially if care is taken to ensure complete haemostasis before discharging the patient after the operation. In the unlikely event of a post-operative haemorrhage occurring, the surgeon must be available to give advice and help. In most cases, gentle pressure on the wound, achieved by biting on a damp cloth pack for 10–15 minutes, will cope with the problem; sitting quietly and bed rest will also help. In more persistent or severe cases, the patient must return to the surgery for re-examination of the wound. It is important to reassure the patient, and their families, that the bleeding, while a nuisance, is not dangerous to their life or health.

The administration of local anaesthetic solution into the bleeding area is often dramatically effective in arresting the bleeding by vasoconstriction. It allows proper examination of the wound and further suturing, or packing, to proceed without pain.

Persistent oozing may respond to packing with oxidized cellulose gauze. This material forms a matrix for promotion of blood clotting and has no mechanical effect. Very rarely, a vascular bleeding point may be identified and clipped with a haemostat. Direct ligation of small vessels is very difficult to achieve, and a light binding suture around the tissue containing the vessel will usually be more feasible, and hence more effective.

Restricted Mouth-Opening

Restricted mouth-opening for one or two weeks after third molar removal is so common that all patients should be warned to expect it. Slow healing and prolonged inflammation will resolve when the underlying inflammatory stimulus is removed. In some cases, trismus persists for months, although it is never permanent. Some of these cases are examples of the rare problems that arise after inferior dental block injections, due either to haemorrhage or infection of the needle track. There is no effective treatment, and much patience is therefore required of the sufferer, supported by the surgeon. Relief, when it comes, tends to be rapid, and this lends weight to the suggestion that the mechanism is reflex inhibition of movement provoked by a painful stimulus.

Alteration of Sensation

Alteration of sensation in the area supplied by the mental or lingual nerve can follow surgery in the mandible. Pre-operative radiography may give a prior warning of this danger. Flaps raised in the region of the mental foramen should be reflected far enough to identify the position of the nerve, rather than risk damaging it. If, despite these precautions, damage does occur, then careful assessment of the post-operative symptoms is essential. The extent and degree of alteration in sensation must be carefully recorded so that recovery can be monitored accurately. Generally speaking, those cases where some recovery is apparent in a few days will probably return to normal in a few months, but when there is more delayed recovery, or indeed no improvement by the end of 9 to 12 months, then no further progress can be expected. It follows, therefore, that patients must consent to the operation knowing the possibility of altered sensation, which occurs in up to 5% of cases of third molar removal. Fortunately, only one in ten of these cases suffer from permanently altered sensation.

Sympathetic and thoughtful post-operative care not only benefits the patient, but also enables the surgeon to appraise critically the results of his work. This personal audit is the duty of every ethical clinician.

Further Reading

Medical Background

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