ANAESTHESIA FOR MICROLARYNGOSURGERY

THESIS

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C O N T E N T S

ANAESTHESIA FOR MICROLARYNGOSURGERY

CHAPTER I

INTRODUCTION

P R E F A C E

Microlaryngosurgery - which is considered a new technique in laryngosurgery - has now completed few decades. This technique has allowed precise removal of vocal cord lesions with minimal morbidity and mortality as contrasted to a few short years ago.(1)

Indirect laryngoscopy was introduced first by Czermak in 1858, and the earliest record of direct visualization of the larynx was by Kirsten in 1894. Sophistication of direct laryngoscopy progressed rapidly as Bunning and Yankauer have introduced magnification and binocular visualization in 1910 . However, patient respiration led to lens fogging. The larger laryngoscopes necessary for binocular vision were also uncomfortable to a patient who was anaesthetised with only topical application .

Further innovations during these earlier years included the killian suspension laryngoscope and the lynch modification. Unfortunately, these also increased the discomfort of the patient when the procedure was performed under local anaesthesia. Many of the subsequent improvements which are now accepted as routine in microlaryngosurgery were destined to await improved anaesthetic techniques.(2)

Utilization of general anaesthesia through small endotracheal tube and its benefits in laryngosurgery has flourished by 1962. Since that time improvements and modifications of anaesthetic techniques in laryngoscopy and laryngosurgery has progressed rapidly.(3)

Anatomical and physiological considerations

The larynx, which is the organ of the voice as well as an air passage, extends from the root of the tongue to the trachea. In the adult male it is situated opposite the third, fourth, fifth and sixth cervical vertebrae, but it occupies a somewhat higher position in the child and in the adult female .

The skeletal framework of the larynx is formed of cartilages, which are connected by ligaments and membranes and are moved by a number of muscles. It is lined with mucous membrane continuous above and behind with that of the larynx and below with that of the trachea.(4)

The inlet of the larynx is bounded anteriorly by the epiglottis, posteriorly by a sheath of mucous membrane stretched between the two arytenoid cartilages, and on each side by the free edge of a fold of mucous membrane - the aryepiglottic fold - which joins the arytenoid cartilage to the side of the epiglottis .

The vocal cords are two pearly-white folds of membrane stretching from the angle of the thyroid cartilage to the

vocal processes of the arytenoid cartilages. In the adult, the narrowest part of the laryngeal cavity is the area between the vocal cords, whereas in children is at the cricoid ring.(5)

Nerve supply of the larynx :

Sensory :

The mucous membrane of the larynx receives its nerve supply from both the superior and recurrent laryngeal nerves.

The superior laryngeal nerve arises from the inferior ganglion of the vagus but receives a small branch from the superior cervical sympathetic ganglion. This nerve descends in the lateral wall of the pharynx and at the level of the greater horn of the hyoid divides into an internal and external branch.(6)

The internal laryngeal branch, descends to the thryrohyoid membrane, pierces it above the superior laryngeal artery and then divides again into two branches. The upper branch supplies the mucous membrane of the lower part of the pharynx, epiglottis, vallecula and vestibule of the larynx. The lower branch passes medial to the pyriform fossa beneath the mucous membrane and

supplies the aryepiglottic fold and the posterior part of the rima glottidis.(6)

The recurrent laryngeal nerve accompanies the laryngeal branch of the inferior thyroid artery and travels upwards deep to the lower border of the inferior constrictor muscle of the pharynx immediately behind the cricothyroid joint . It supplies the mucous membrane of the larynx below the vocal cords .

Motor :

The recurrent laryngeal nerve innervates all the muscles of the larynx except the cricothyroid which is supplied by the external laryngeal nerve and small part of the arytenoid which is supplied by the internal laryngeal nerve.(5)

Problems of Anaesthesia for Microlaryngosurgery

Patients who are exposed to laryngosurgery constitute usually a risky group of patients. Most of them have malignancy, upper respiratory obstruction, resistant chest infection, bad general condition, anaemia and cachexia. Also, as most patients are of the older age group, the incidence of hypertension, coronary artery disease and atherosclerosis is higher.(1)

During surgery sharing of the airway between the anaesthetist and the surgeon complicates other problems.(1) The anaesthetist may be faced during induction of anaesthesia with difficult intubation of such patient from the pathological lesion in the larynx and any accompanying oedema. Also intubation in some lesions may cause severe bleeding.(7,8)

The anaesthetist must control and maintain a patent airway throughout surgery .

The prevention of aspiration of blood, pus or other material into the lung with the protection of the airway during anaesthesia is essential. The restoration of post-

operative protective reflexes should be in the forefront of an anesthetists mind.(7 & 8)

The provision of good operating conditions with full paralysis of the laryngeal muscles and relaxation of the jaw is mandatory in microlaryngosurgery. Also there must be no restriction of the operating time, so that any surgery must be completed without hurry.(1)

For the surgeon, the presence of an endotracheal tube whatever its size, makes the surgical field obstructed especially in lesions of the posterior part of the larynx .

Ventilation :

It is one the great problems in laryngosurgery. The margin of safety for patients undergoing microlaryngosurgery under general anaesthesia has been greatly enhanced by recent advances in the anaesthetic techniques.(9) Multiple techniques have been employed in the search for a simple, yet safe technique for ventilation for patients undergoing operative laryngoscopy which will allow optimal surgical exposure and yet permit the anaesthetist to retain control of the airway.(10)

The apnoeic technique :

In this technique the patient is deeply anaesthetized and paralysed while the laryngoscopist and anaesthetist exchange control of the airway.[10 & 11] This technique has several names "apnea", "diffusion respiration" , "apnoeic oxygenation" and "insufflation".[12]

Insufflation of oxygen in the trachea is an apparently satisfactory method of maintaining oxygenation in patients who have been anaesthetized and paralysed for diagnostic laryngoscopy.[13 & 14]

It is generally believed that carbon dioxide elimination under these circumstances is poor or absent. The mean rate of rise of arterial $PaCO_2$ in apnoeic anaesthetised man is 3.8 mmHg./minute .

The method of high-flow endotracheal insufflation is expected to reduce the rate of rise to 3.3 mmHg/min.[13]

There is evidence available to show that the heart beats give rise to a small amount of alveolar ventilation.[15]

During apnoeia, oxygen delivered into the trachea, without respiratory effort, reaches the alveoli and diffuses across the alveolar capillary membrane in sufficient quantities to maintain adequate oxygenation of the blood .

The limiting factor in this technique is the rise of the CO_2 causing respiratory acidosis, hypertension, and increase in intracranial tension.(12)

Also awareness during general anaesthesia is particularly manifest during the use of apnoeic oxygenation technique for endoscopic procedures on the respiratory passages .

So although this method is quiet adequate for brief examinations, it is clumsy and does allow safe use of a suspension laryngoscope, safe microlaryngeal surgery or prolonged operations.(16 & 17)

So the apnoeic technique for microlaryngosurgery is a valuable tool and has its safety. It is preferred in almost all the endoscopic procedures of less than 10 minutes duration. Relaxation is present, also the bulk and frequent trauma of endotracheal tube is absent .

The venturi injector principle :

Injector techniques to achieve artificial ventilation were first used in bronchoscopy and were subsequently adapted for laryngoscopy .

The injector principle is derived from the Bernoulli theorem (1738) which states that the pressure of a fluid in motion through a tube of varying cross-sectional area is least at the narrowest portion where the speed is greatest. Some 60 years later G.B. Venturi (1797) showed that in order for a stream of fluid to regain a pressure much higher than that at the constriction, it was necessary for the tube immediately distal to the constriction to open out gradually. Gases behave like fluids but, because they are compressible, deviate somewhat from the principle .

From these principles evolved the various types of injector with an entrainment duct. The entrainment is the result not only of the subatmospheric pressure, but also of its propulsive effect on the resting gas surrounding the jet .

So Intermittent jets of oxygen, using blowgun attachment at a pressure of 414 kpa (60 lbf in^2), will entrain sufficient

air to provide adequate pulmonary ventilation. With lungs of average compliance, this is true even if the glottis tends to close reflexly or to become partially obstructed during inspiration. If the glottis is open, additional air will be entrained and a given tidal volume will be achieved more quickly.(18)

This jet of oxygen may be introduced through a ventilating laryngoscope(19), or through nasotracheal or orotracheal polyethylene catheter,(20) or transtracheally through the cricothyroid membrane or just below the cricoid cartilage.(21)

The essential requirements for the injector technique are:

- A source of oxygen at high pressure .
- A means of interrupting the gas flow intermittently. This may be manual or a valve of the blowgun type or automatic using the Bird mark 2 ventilator.(18)
- Appropriate tubing and connectors .

If there is some degree of glottic obstruction, a longer expiratory phase will be required. Failure to allow adequate deflation of the lungs increases the risk of pneumothorax .

Using ventilating laryngoscope airway control and ventilation are dependent upon the surgeon, not the anaesthetist, air is entrained, resulting in an unpredictability of inspired oxygen concentration .

Small endotracheal tubes :

Oral endotracheal tubes up to 6 mm may be used, but because of resistance to gas flow, it is not suitable for spontaneous respiration in adults but used with circuits where low gas flows are possible, such as the Bain or circle system with absorber, satisfactory artificial ventilation can be achieved.(22)

Cuirass respirator may also be used to augment ventilation during laryngoscopic procedures, but this technique is cumbersome and inefficient.(23)

High frequency flow (H.F.F.) or high frequency positive pressure ventilation :

This technique can provide automatic ventilation during laryngoscopy under general anaesthesia. This technique utilizes an insufflation frequency of 60/min. and a relative insufflation time of 22% ventilator through a nasotracheal catheter.

Laryngoscopic H.F.P.P.V. permits laryngeal surgery with a virtually unobstructed surgical field under complete muscular relaxation. The alveolar ventilation of the patient may be controlled by adjustment of the pressure of the anaesthetic gas mixture and there is no air entrainment through the larynx during insufflation .

This makes possible use of oxygen/Nitrous oxide and the oxygenation of the patient may be controlled by adjustments of the oxygen concentration of the anaesthetic gas mixture .

As there is a continuous upward gas flow through the larynx, blood or pieces of loose tissue are not sucked down into the trachea.

Effect of intubation on cardiovascular system :

There are many reports which stated that laryngoscopy and microlaryngosurgery under general anaesthesia using endotracheal intubation was associated with a very low incidence of disturbances of cardiac rhythm.(24)

Elevation of blood pressure during direct laryngoscopy for tracheal intubation become manifest after 15 seconds and

reached a peak if laryngoscopy is continued for 30 to 45 seconds. Heart rate also increased during tracheal intubation.

So when a rapid laryngoscopy cannot be assured or when a high risk patient is involved as in coronary artery disease, arterial hypertension and intracranial aneurism it would seem prudent to attenuate these effects by the use of topical oropharyngeal lidocaine spray (0.75 mg/kg.).(27)

Also in high risky patients, it may be possible to administer atropine sulphate I mg and practolol (0.2 mg.kg/B.w) I.V. prior to anaesthesia this will diminish the excessive increase in arterial blood pressure and heart rate which occurs during laryngoscopy and endotracheal intubation.(28)

Technique of anaesthesia for microlaryngosurgery :

The first choice in anesthesia for microlaryngosurgery is between local and general technique .

General anaesthesia for microlaryngosurgery is presented as a solution to one of the most difficult problems, which frequently confronts the anaestheologist in a varied surgical practice. Traditionally, laryngosurgery in the past was performed with the patient under topical anaesthesia .

This however, has some drawbacks which limit its usefulness. First, topical anaesthesia has a small but definite and probably irreducible toxicity of its own. Secondly, laryngosurgery performed in this manner is uncomfortable and even terrifying to a significant number of patients. Thirdly, the inability of these patients to compose themselves and to relax sufficiently often makes the operative manoeuvres of the laryngoscopist difficult and occasionally even dangerous. Fourthly, this obvious torment and fright of the patient may make the operator nervous, tense, and hurried in the performance of a task which requires a calm, relaxed, and methodical artisan.(29)

Technique of local anaesthesia :

Recurrent laryngeal nerve block: block of both recurrent laryngeal nerves was performed to get a non-irritable larynx with immobile vocal cords. The nerve was reached by blind injection alongside the first tracheal ring until the vertebral column is reached, then withdrawing the point of the needle 1-1.5 cm.(30)

Five ml. of 1% carbocaine were injected on each side. The block success is realized by the onset of aphonia. Glossopharyngeal nerve block causes temporary abolition of the gag reflex and loss of tactile sensation over the posterior third of the tongue and the lateral and posterior wall of the oropharynx and hypopharynx. Superior laryngeal nerve block results in loss of tactile sensation over the posterior surface of the epiglottis and the mucosa of the larynx and upper trachea. This may be performed by topical transmucosal block of its internal branch by placing anaesthetic soaked packs in the pyriform sinuses .
For block of superior laryngeal nerve the index finger is placed between the hyoid bone and the easily palpable posterior superior border of the thyroid cartilage .
A.22-gauge needle penetrates the skin just above the finger tip and is advanced medially in a slightly posterio-inferior direction on a plane almost parallel with the clavicle , through the thyrohyoid membrane and into the larynx. The same procedure is repeated on the opposite side.(31)

Complications of Microlaryngosurgery :

Many complications are met with before, during and after

microlaryngosurgery. The chief complication is laryngospasm which may be due to blood, mucus , aspiration or light anaesthesia. Complete spasm, leading to increasing hypoxia and cyanosis, is a dangerous situation. Signs of laryngospasm are cyanosis, inspiratory stridor, suprasternal notch and intercostal muscles retraction, tachycardia, hypertension tachypnea and hypercarbia .

Laryngeal spasm may resolve spontaneously or a few breaths of pure oxygen may be necessary to restore arterial oxygen tension. Spasm due to peripheral stimulation suggests the need for a deeper plane of anaesthesia. Also temporary cessation of surgical stimuli may occasionally be necessary.

The condition may call for active treatment if it persists more. Intravenous corticosteroids and antihistaminics may be tried to relieve spasm . If the spasm is resistant and the patient's condition deteriorates with increasing hypoxia and hypercarbia, a short-acting relaxant suxamethonium may be given I.V. provided a mean of artificial ventilation is available. A small dose of non-depolarising relaxant is often sufficient to abolish partial laryngeal spasm, and may even result in increased tidal exchange. A small

endotracheal tube is introduced between the cords until the general condition of the patient improves and drug effects are taking place .

If patient is in extremes with impossible intubation , a large needle can be inserted into the larynx through the cricothyroid membrane and air can be injected from a 20 ml. syringe repeatedly, or half a litre of oxygen per minute can be insufflated. Tracheostomy is needed only on the rarest occasions.(32 & 33) . Other complications include respiratory obstruction, difficult intubation, trauma, stenosis of trachea and laryngotracheitis, ulceration of vocal cords and laryngeal cartilages. Among the most important complications are the cardiac arrhythmia, extrasystoles and cardiac atrioventricular conduction affection due to prolonged or vigorous intubation.(34&35

Indications of microlaryngoscopy :

Microlaryngoscopy is indicated if despite all efforts, one is unable to visualize the larynx adequately through indirect laryngoscopy, if any thickened epithelium in the larynx raises even the slightest suspecion of a carcinoma or precancerous lesion. Also it is indicated if a lesion

remains unclear diagnostically or when diagnosis and surgery can be carried out in the same session .

Microlaryngosurgery is used in cases of decortication of vocal cords or the removal of heavily bleeding or stenosing lesions. Some operations on the arytenoid cartilages and possibility of recognising and grading pre-malignancy of the larynx .

Contra-indications to the procedure arise either for anatomical reasons or because of more general disabilities of the patient. Direct laryngoscopy should not be carried out on any patient in whom hyperextension of the cervical spine is impossible or dangerous, such as patients who have extensive spondylarthroses or patients who have had T.B. or surgery of the cervical spine. Moreover, when the glottis is so small, because of a tumour that makes intubation impossible .

A history of more generalised disease as recent coronary infarction, embolism, cardiac arrhythmia, severe hypertension or liver disease of course makes the use of general anaesthesia dangerous, thus constituting a contra-indication to microlaryngosurgery and microlaryngoscopy. (36 & 37)

AIM OF THE WORK

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The aim of this work is to evaluate a technique of general anaesthesia using a small cuffed oral endotracheal tube (5 mm.). A study of haemodynamic parameters, respiratory parameters and complications of this technique is also performed .

CHAPTER II

MATERIAL AND METHODS

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MATERIAL :

Twenty five patients were admitted to Alexandria University Hospital for microlaryngosurgery .
All patients in this study were adults with age ranging from 16 to 70 years with a mean of 47.16 years. Thirteen patients were males and twelve were females .

All patients were free of cardio-vascular and respiratory diseases or any disease affecting the measured parameters .

METHODS :

All patients received general anaesthesia through small oral cuffed endotracheal tube .

Pre-anaesthetic examination was done for all patients.

Pre-medication :

One mg. atropine sulphate was given intramuscularly half an hour before operation .

Induction :

Pre-oxygenation was done for 3 minutes. A sleeping dose of thiopentone sodium followed by succinyl choline 1 mg/kg. BW. were given intravenously .

This was followed by intermittent positive pressure ventilation with oxygen using Boyle's apparatus's face mask.

Intubation :

It was done using No. 5 oral cuffed endotracheal tube using macintosh laryngoscope .

Maintenance of anaesthesia :

This was done using nitrous oxide/oxygen 5L/5L technique supplemented with fluothane 1% and an apnoeic dose of flaxedil after spontaneous respiration was regained. Controlled ventilation was maintained all over surgery . At the end of the operation, decurarising dose of prostigmine methyl-sulphate and atropine sulphate diluted in 10 c.c. saline was given intravenously slowly after stoppage of anaesthesia (if flaxedil was used) .

Good oropharyngeal suction was done and 100% oxygen through face mask was administered after extubation .

Patients were put post-operatively in the semiprone position (Tonsillectomy position) and strictly observed till complete conciousness was regained .

Measurements :

1- Pulse rate : counted in one minute from the radial artery. It was counted before giving premedication, during microlaryngosurgery (every 15 minutes) and after operation by five minutes (during recovery) .

2- Arterial blood pressure : Arterial blood pressure, systolic and diastolic was measured indirectly using sphygmomanometer. It was measured before giving premedication, during microlaryngosurgery (every 15 minutes) and after the operation by five minutes .

3- Mean arterial blood pressure : Mean arterial blood pressure was calculated for each reading of arterial blood pressure using the following formula :

Mean A.B.P. = diastolic pressure + 1/3 pulse pressure

4- Blood gases : PaO_2 , $PaCO_2$ and pH estimations were done for ten patients. Puncture of radial artery and instillation of an intra-arterial catheter was done. Samples were

withdrawn pre-operative, operative and post-operative.

5- Colour : Cyanosis (if occurred) was observed as manifested through mucous membrane of lips and skin of the periphery before, during and after surgery .

6- Surgical field and relaxation: The degree of comfort during surgery was observed as regards motility of the cords, good space for the insertion of the operating laryngoscope by the laryngologist (in the presence of small cuffed oral endotracheal tube), between the vocal cords, also suppression of reflexes and relaxation was observed .

7- Recovery : Time elapsed till return of conciousness, i.e. until the patient can respond to orders was also recorded .

8- Complications : Complications encountered during and after microlaryngosurgery as laryngospasm, cyanosis and vomiting were recorded .

RESULTS

R E S U L T S

Twenty five patients were admitted in Alexandria Main University Hospital for microlaryngosurgery. Patients were adults with age ranging from 16 to 70 years with a mean of 47.16 years old . Thirteen patients were males and twelve were females .

The distribution of patients admitted for microlaryngosurgery according to diagnosis are listed in table (1) . 64% of patients were diagnosed as cancer larynx, 20% with vocal polyps, while 12% with primary scleroma and 4% with laryngeal trauma .

1- Pulse rate :

Before operation :

Pulse rate ranged from 70 to 110 beat per minute with a mean of 82.24 ± 8.72 .

During operation : (Every 15 minutes)

Pulse rate ranged from 76 to 120 beat/minute with a mean of 91.04 ± 9.83 with a mean difference from the

pre-operative values of 8.8 ± 2.3 which is statistically significant ($P < 0.05$) .

Post-operatively :

The pulse rate ranged from 84 to 130 beat/minute with a mean of 100.92 ± 10.23 with a mean difference from pre-operative values of 18.68 ± 3.79 which is statistically significant ($P < 0.05$) (Table 2 and Fig. 1) .

2- Pulse rhythm :

Extrasystoles (less than five/minute) were observed in 12.5% of patients with cancer larynx during operation. After the operation, the extrasystoles disappeared completely and the pulse became regular again without any treatment (Table 5) .

3- Mean arterial blood pressure :

Before operation :

The mean arterial blood pressure ranged from 83.3 mmHg to 110 mmHg. with a mean of 94.09 ± 9.67 .

During operation: (Every 15 minutes)

The mean arterial blood pressure ranged from 83.3 mmHg

to 110 mmHg with a mean of 96.62 ± 9.12 with a mean difference from the pre-operative values of 2.53 ± 5.46 which is statistically significant ($P < 0.05$) .

Post-operatively :

The mean arterial blood pressure ranged from 83.3 mmHg to 110 mmHg with a mean of 96.09 ± 9.40 with a mean difference from pre-operative values of 2.92 ± 5.63 which is statistically significant ($P < 0.05$) (Table 3 and Fig. III) .

4- Blood gases :

Before operation :

PaO_2 ranged from 90 to 96 mmHg with a mean of 91.7 ± 2.4 . $PaCO_2$ ranged from 36 to 42 mmHg with a mean of 39.4 ± 1.8. pH ranged from 7.39 to 7.40 with a mean of 7.4 ± 0.01 .

During operation :

PaO_2 ranged from 185 to 240 mmHg with a mean of 202.5 ± 19.89 with a mean difference from the pre-operative values of 109.8 ± 15.58 which is statistically significant ($P < 0.05$).

$PaCO_2$ ranged from 27 to 35 mmHg with a mean of 30.1 ± 2.37 with a mean difference from pre-operative values of - 9.3 ± 3.88 which is statistically significant ($P < 0.05$). pH ranged from 7.41 to 7.46 with a mean of 7.42 ± 0.01 with a mean difference from pre-operative values of 0.23 ± 0.14 which is statistically significant ($P < 0.05$) .

Post-operatively :

PaO_2 ranged from 95 to 100 mmHg with a mean of 97.1 ± 1.79 with a mean difference from pre-operative values of 5.4 ± 1.42 which is statistically significant ($P < 0.05$) . $PaCO_2$ ranged from 30 to 40 mmHg with a mean of 37.8 ± 3.6 with a mean difference from pre-operative values of - 1.6 ± 3.7 which is statistically insignificant ($P > 0.05$). pH ranged from 7.40 to 7.46 with a mean of 7.42 ± 0.02 with a mean difference from pre-operative values of 0.19 ± 0.15 which is statistically significant ($P < 0.05$) (Figs. III, IV, V).

5- Post-operative complications :

Table (5) shows that post-operative complications were encountered in patients with cancer larynx. It was found

that 25% had laryngospasm, 25% had post-operative cyanosis and 25% with delayed recovery .

The recovery time ranged from 3 to 8 minutes with a mean recovery time of 5.14 .

T A B L E 1

Distribution of patients according to diagnosis

Diagnosis	Number	Percent
Cancer larynx	16	64
Vocal cord polyps	5	20
Primary scleroma	3	12
Trauma	1	4

T A B L E 2

Distribution of patients according to pulse rate/min.

Pre-operative, operative and post-operative

Case No.	Before	During (every 15 minutes)	After
1	80	88	100
2	80	90	100
3	80	84	90
4	82	84	90
5	70	76	84
6	70	76	84
7	80	90	100
8	70	76	90
9	80	90	100
10	82	90	100
11	80	90	100
12	78	88	100
13	70	78	90
14	90	100	110
15	90	100	115

T A B L E 2 (Cont.)

Case No.	Before	During (every 15 minutes)	After
16	90	100	110
17	86	96	100
18	80	90	100
19	78	90	100
20	90	100	110
21	90	100	110
22	80	90	100
23	80	90	100
24	110	120	130
25	90	100	110
$\bar{X}$	82.24	91.04	100.92
S.D. $\pm$	8.72	9.83	10.23

	Difference between intra- and pre-operative values	Difference between post- and pre-operative values
Mean	8.8	18.68
S.D. $\pm$	2.3	3.79
t	19.1	24.90

T A B L E 3

Distribution of patients according to mean arterial blood pressure/mmHg in the pre-operative, operative and post-operative periods

Case No.	Before	During (every 15 minutes)	After
1	103.3	103.3	103.3
2	93.3	103.3	103.3
3	93.3	93.3	93.3
4	103.3	103.3	103.3
5	93.3	93.3	103.3
6	86.6	86.6	86.6
7	96.6	96.6	96.6
8	83.3	83.3	83.3
9	83.3	93.3	83.3
10	83.3	93.3	93.3
11	93.3	93.3	93.3
12	83.3	86.6	83.3
13	83.3	83.3	83.3
14	106.6	106.6	106.6
15	90	93.3	93.3

T A B L E 3 (Cont.)

Case No.	Before	During (every 15 minutes)	After
16	103.3	103.3	106.6
17	106.6	106.6	106.6
18	83.3	83.3	83.3
19	103.3	103.3	103.3
20	83.3	83.3	93.3
21	83.3	106.6	83.3
22	90	90	93.3
23	106.6	106.6	106.6
24	110	110	110
25	106.6	110	106.6
$\bar{X}$	94.096	96.62	96.09
S.D.$\pm$	9.67	9.128	9.407

	Difference between intra and pre-operative values	Difference between post- and pre-operative values
Mean	2.53	2.92
S.D.$\pm$	5.46	5.63
t	2.32	2.59

T A B L E 4

Distribution of patients according to PaO_2, $PaCO_2$ and pH changes in the pre-operative, operative and post-operative periods

No.	PaO_2			$PaCO_2$			pH		
	Pre-oper.	Intra-oper.	Post-oper.	Pre-oper.	Intra-oper.	Post-oper.	Pre-oper.	Intra-oper.	Post-oper.
1	90	185	95	36	35	35	7.39	7.41	7.41
2	90	190	96	40	30	40	7.41	7.42	7.40
3	90	190	96	40	30	40	7.41	7.42	7.40
4	96	230	100	41	28	41	7.39	7.44	7.40
5	95	240	98	42	27	30	7.42	7.46	7.[illegible]
6	90	190	96	40	30	40	7.41	7.42	7.44
7	94	220	100	38	33	38	7.39	7.42	7.42
8	92	200	96	37	28	34	7.40	7.41	7.44
9	90	190	96	40	30	40	7.42	7.45	7.44
10	90	190	98	40	30	40	7.40	7.42	7.42
Mean	91.7	202.5	97.1	39.4	30.1	37.8	7.40	7.42	7.42
S.D.	2.4	19.89	1.79	1.8	2.37	3.6	0.01	0.01	0.02

	Difference between intra- and pre-operative values			Difference between post-pre-operative values		
	PaO_2	$PaCO_2$	pH	PaO_2	$PaCO_2$	pH
Mean	109.8	-9.3	0.23	5.4	-1.6	0.19
S.D.±	15.58	3.88	0.14	1.42	3.70	0.15
t	22.3	7.8	5.75	12.27	1.36	4.75

T A B L E 5

Distribution of patients with cancer larynx according to post-operative complications

Type of complication	No. of patients	Percent
Free	2	12.5
Arrhythmia	2	12.5
Laryngospasm	4	25
Delayed recovery	4	25
Cyanosis	4	25
Total	16	100

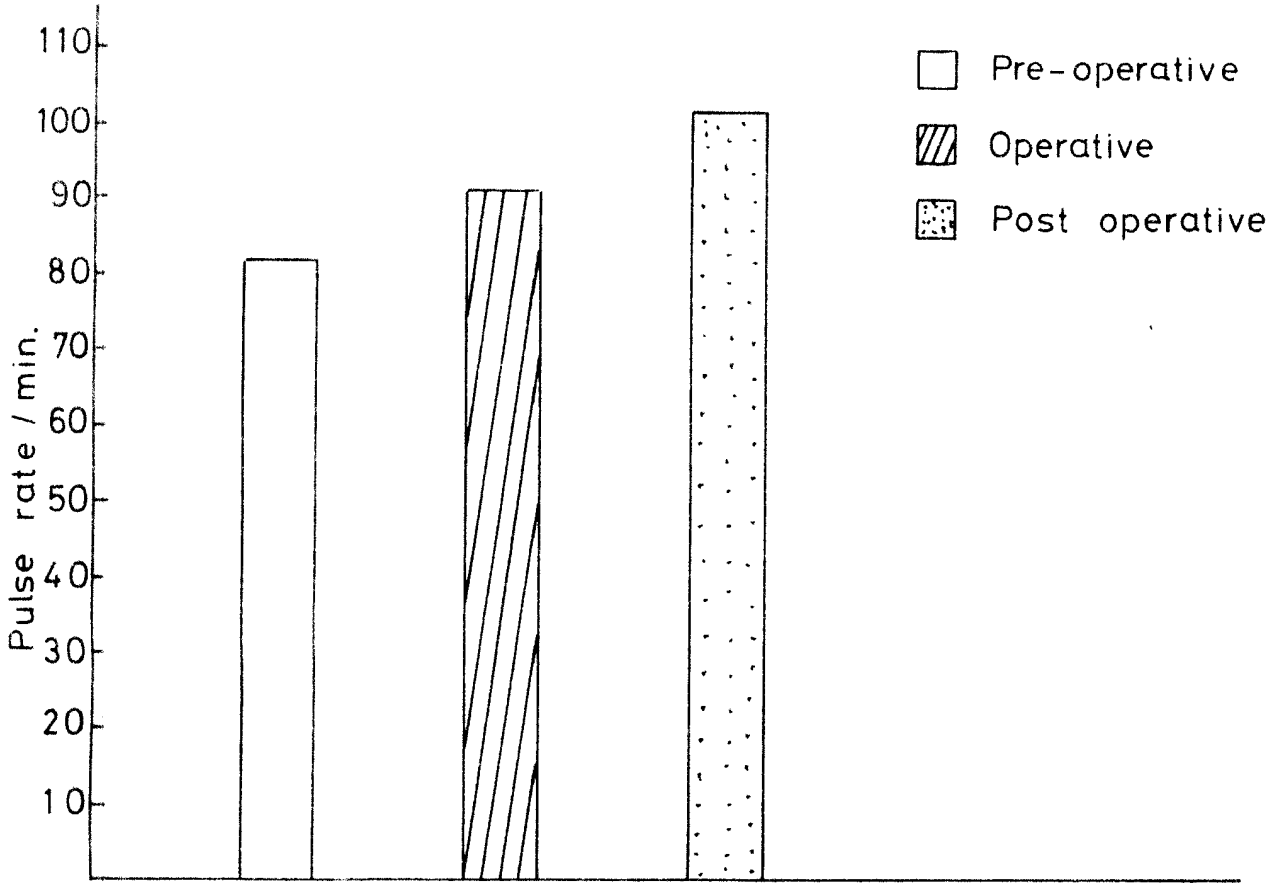

Fig (I) Shows the changes in pulse rate /min. in the pre-operative , operative and post-operative periods .

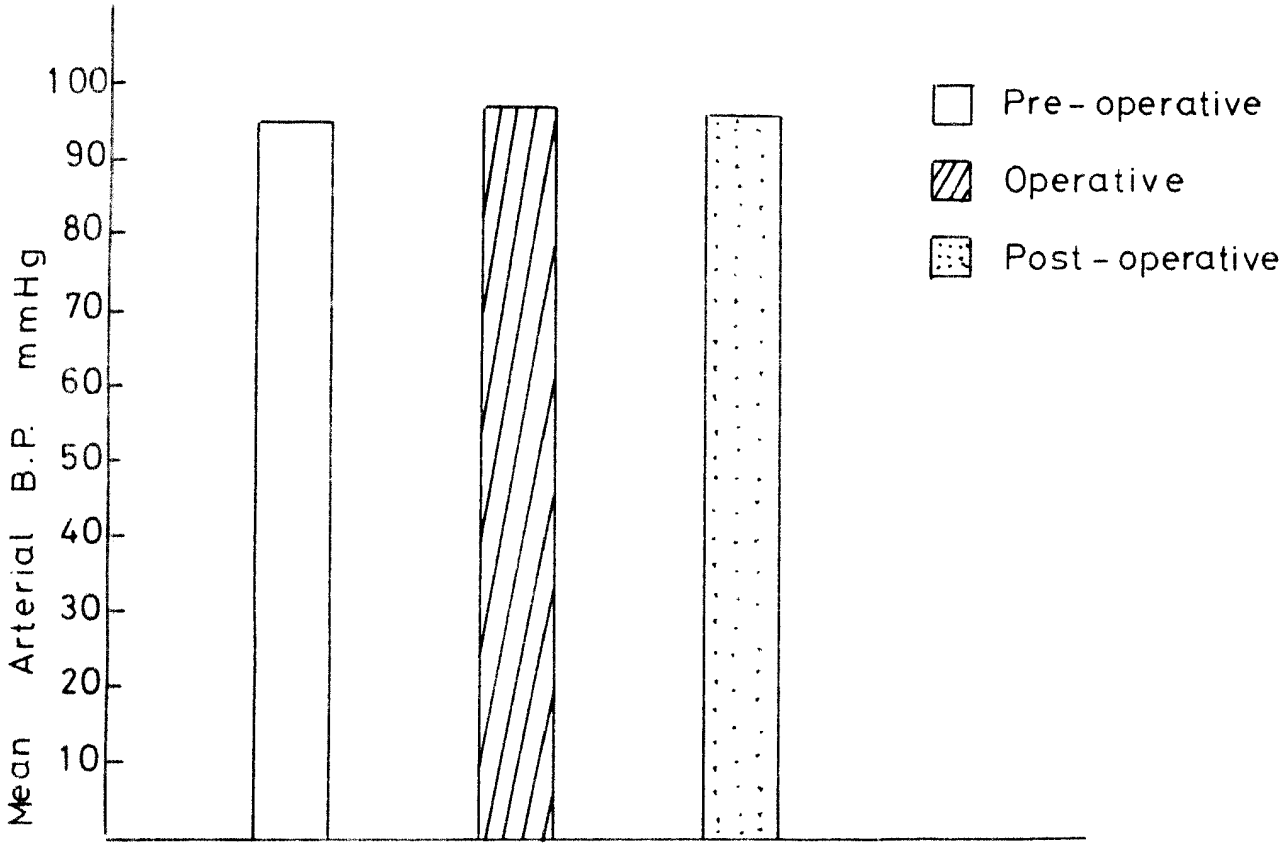

Fig (II) Shows the changes in Arterial blood pressure (mean) mmHg in the pre-operative, operative and post-operative periods.

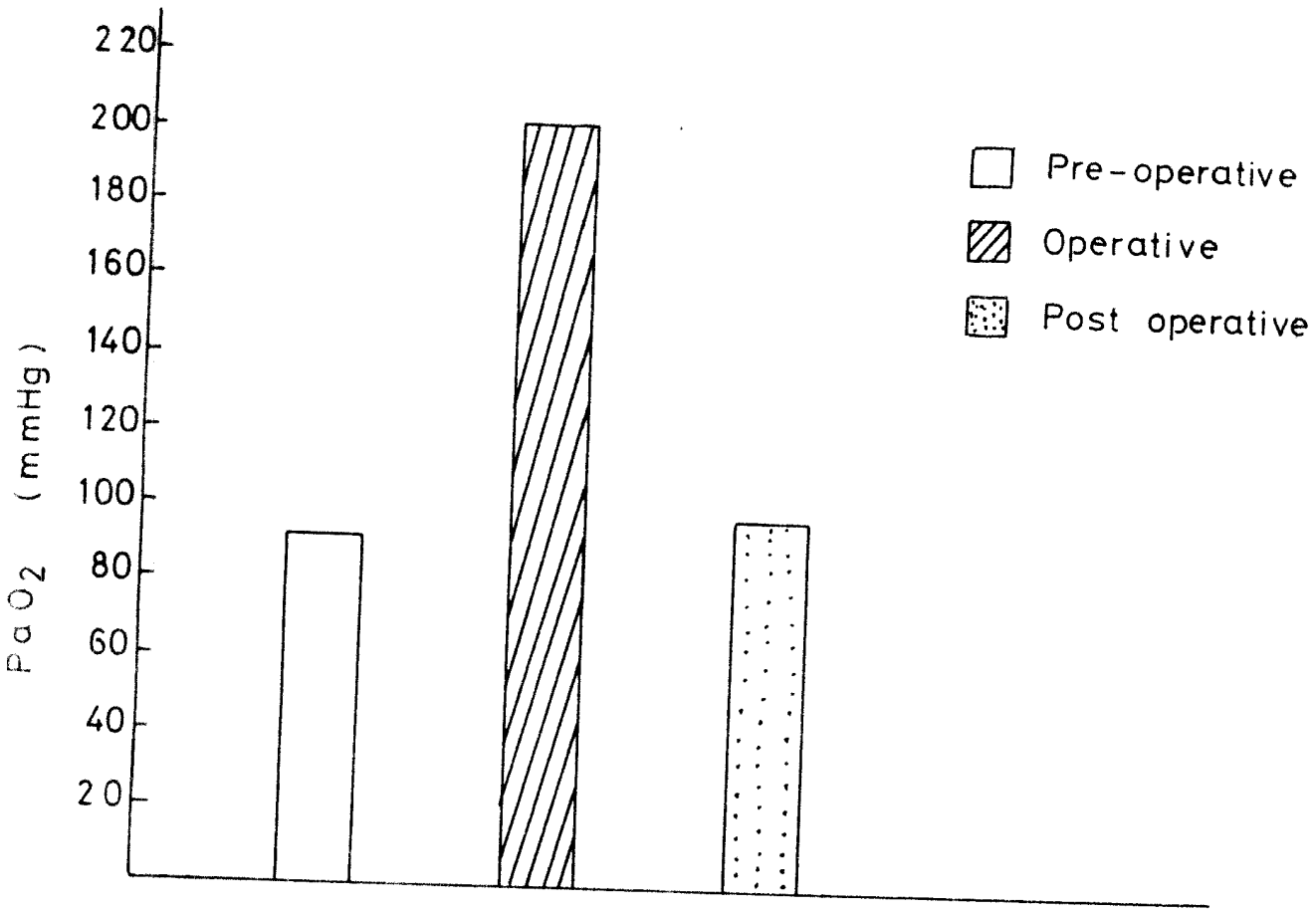

Fig (III) Shows the changes in PaO_2 / mmHg in the pre-operative, operative and post-operative periods.

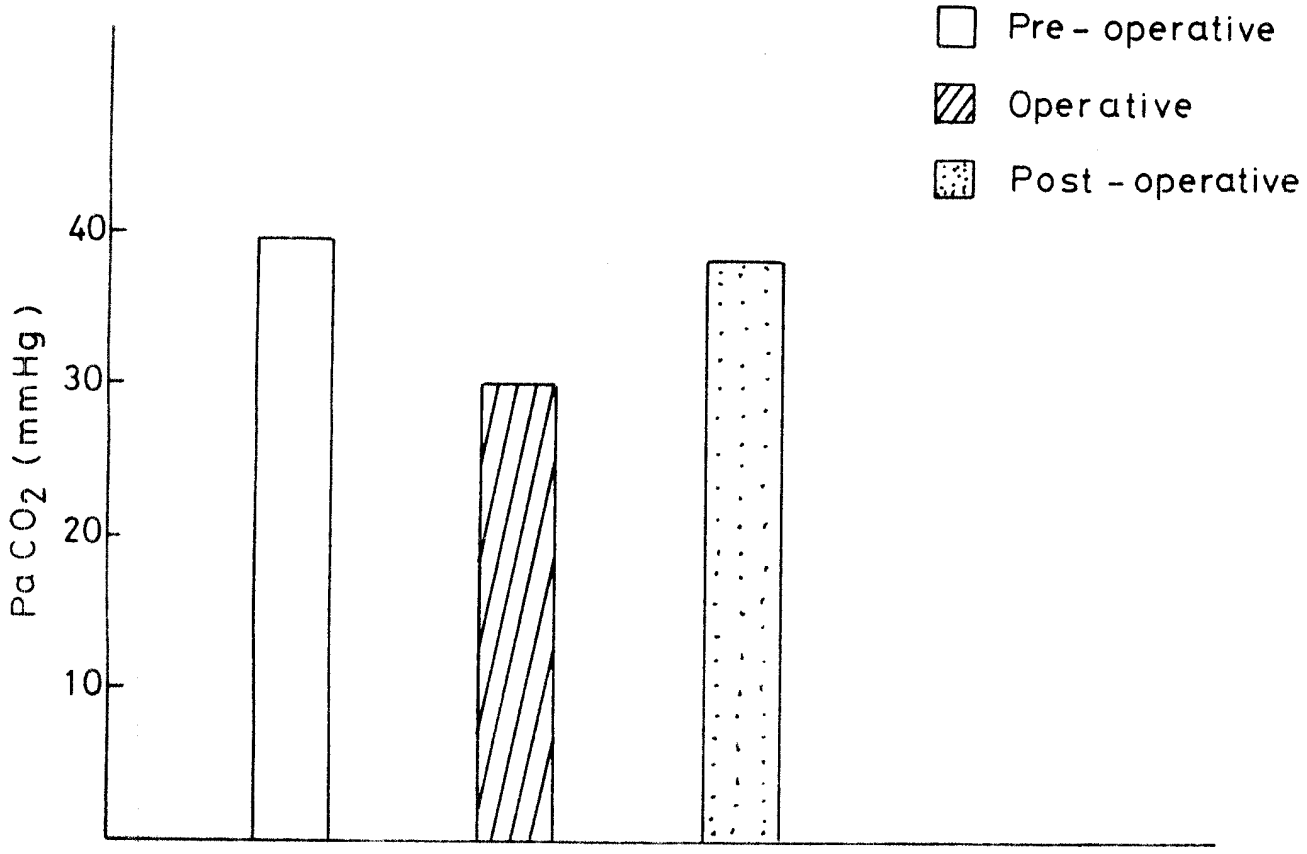

Fig (IV) Shows the changes in $PaCO_2$ /mmHg in the pre-operative, operative and post-operative periods.

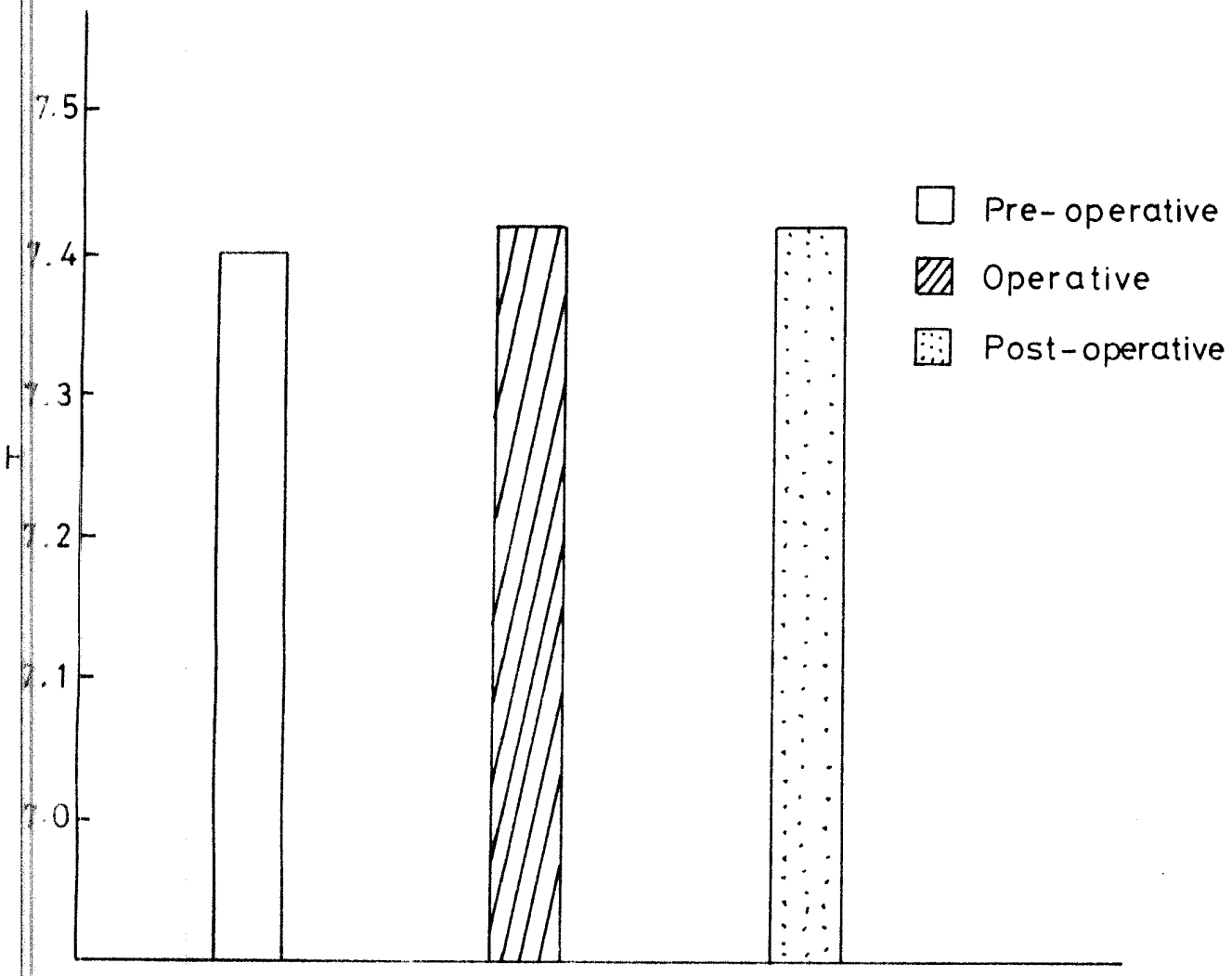

Fig (V) Shows the changes in pH in the pre-operative, operative and post-operative periods.

CHAPTER IV

DISCUSSION

D I S C U S S I O N

Patients submitted to microlaryngosurgery constitute a major anaesthetic problem. They are usually risky, suffering from respiratory obstruction and hypoxia. Most of them are aged and in a poor general condition. The anaesthetic technique for such operations should include maximal safety to the patient and minimal discomfort to the surgeon. Therefore rapid induction, relaxation of the jaw together with prompt suppression and immediate return of reflexes and rapid recovery are needed. Prevention of aspiration is a very important item to be fulfilled.(4,8)

The provision of safe general anaesthesia for microlaryngosurgery cures many problems, and good co-operation between the surgeon and the anaesthetist is essential to overcome all the difficulties encountered. The laryngologist asks for a clear view of the larynx with well relaxed immobile vocal cords together with sufficient space within which he can work .

The anaesthetist on the other hand guides his anaesthesia to have a good control on the respiration, to ensure protection of the lower airway from aspiration of blood, mucus or

debris, to give sufficient time for the surgeon to complete his surgery and to assure rapid recovery. Opinions differ as regards the best method of anaesthesia in microlaryngo-surgery. (38)

Some authors used the technique of local anaesthesia for both superior recurrent laryngeal nerves, but it has many disadvantages, such as the patients must be co-operative, because the procedure is too unpleasant to be done on conscious patients and there is no protection of the air-way against aspiration. (39)

Thus, general anaesthesia was found to be much more comfortable to the patient as well as to the operating team. General anaesthesia with intubation gives the advantage that the vocal cords are immobile, the patients are well relaxed and adequately ventilated and thus the time for surgery is not limited. (40)

However, the discussion was always centred on whether intubation was necessary or not. If the trachea is intubated, the tube may obscure the operative field specially if the lesion is situated posteriorly, it may get kinked by the laryngoscope at any stage interfering with the smooth

cause of anaesthesia and it may compromise the flow of anaesthetic gases and oxygen.[38] On these basis, some anaesthetists prefer not to intubate and they used many techniques such as venturi technique, high frequency flow, apnoeic oxygenation and gamma -OH administration.[41,42]

The application of venturi principle for oxygen and gas delivered through a 16 gauge catheter translaryngeally has some drawbacks as the adaptors used were cumbersome and heavy, causing frequent dislodgement, also adequate ventilation was impeded due to the inability of the standard anaesthesia equipments to generate the required pressure and flow rates to overcome the resistance of these relatively narrow tubes.[7,8] The catheter is easily introduced and does not obstruct the view of the cords and their whole length is easily seen.[7,8]

Some anaesthetists use small bore catheter (3.5 mm. I.D.) which is inserted between the vocal cords and connected to a source of oxygen under high pressure. Ventilation was produced by the oxygen plus air entrained (Venturi principle) through the holes at the proximal end of the catheter. This technique has several advantages as it offers control of

the airway through the blackflow of gases during expiration preventing aspiration. This allowed for extended periods of time without interfering with the endoscopist's activity.(43)

There are some disadvantages for this technique as in patients with glottic obstruction e.g. by tumour where expiration is impeded by the presence of the catheter in the larynx. Also because of the considerable reflex of gases through the open end of the laryngoscope, the endoscopists may prefer to employ an eye piece.(43) The catheter may be occluded by laryngeal spasm due to its small calibre. The inflation pressure is not known, and the tube is floating free between the cords and may get in the surgeon's way or can cause damage to tracheal mucosa from the force of the oxygen jet emitted from the end. Because of the small size of the jet, some air entrainment would be expected and in addition, massive tissue emphysema can occur when the jet is not inside the tracheal lumen or when the outflow of gas from the glottis is obstructed (ventilator barotrauma).(21)

The use of high frequency flow (H.F.F.) offers exact control of the inspired O_2 concentration and a reduction in the potential for aspiration, and air moving upwards towards

the vocal cords in both inspiration and expiration blows debris away from the surgical field.[44]

Some authors claimed some advantages to technique of general anaesthesia without intubation.[38, 45] They found that general anaesthesia without intubation provides good field to the surgeon, but this technique provided no protection to the lower airway and therefore no control on ventilation and the surgeon will be in a hurry.[38]

The combination of local analgesia of the operative site with general anaesthesia achieved by the intravenous injection of gamma-OH supplemented by thiopentone and chlorpromazine, provided respiratory exchange which is more than adequate. However, with such a technique, the patient takes much longer time to awake, about 2 hours, and movements of the vocal cords may hinder proper surgery. Moreover, secretions, blood or debris may go lower down in the respiratory tract and the expiratory gases may cause fogging of the objective lens of the microscope.[41,42]

The technique of apnoeic oxygenation[46] provides ideal condition for the surgeon, but in view of the accumulation of CO_2 and the limitation of the time permissible for surgery, such a technqiue becomes hazardous.[46]

The method of apnoeic oxygenation leads to oxygen saturation level which was usually maintained higher than normal, that a pH as low as 6.72 could be tolerated.(2)

The CO_2 increased 3 mmHg/minute and blood pressure became elevated.(13) Reventilation of patients every 3-4 minutes if procedure is prolonged gave desirable goals.(46)

The disadvantages of this technique include the speed with which the operator must accomplish his task, also cardiac arrhythmia frequently happen due to increase in CO_2 tension and arterial blood pressure elevation due to catecholamine release.(12)

In the present study, the patients were given thiopentone sodium, succinylcholine and intubated with a cuffed portex tube 5 mm. whose cuff has been previously inflated in boiling water to attain and adult size cuff. The anaesthesia was maintained by gas, oxygen, fluothane and muscle relaxant. The respirations were controlled manually .

This technique provided excellent viewing to the surgeon's field, and the patients were fully relaxed with suppression

of laryngeal reflexes. Also it provided complete airway protection. It was satisfactory for the microlaryngosurgery and not limited by time and gave an uninterrupted procedure and adequate ventilation. Microlaryngosurgery with small cuffed endotracheal tube has proved to be a good technique.(40)

This technique provides many advantages to surgeon , anaesthetist and the patient. The patients were fully relaxed and with obtunded pharyngeal and laryngeal reflexes. Also this technique has consistently provided excellent viewing and operating conditions with complete airway protection . It was also proved to be a physiological technique and not limited by time and there was no airway complications.(22) Induction and recovery were rapid and smooth.(29) The endotracheal cuff besides blocking the space between the tracheal wall and the tube preventing aspiration and exit of gases that may fog the lens of microscope, anchors the tube and prevents it from floating freely between the cords.(47)

The use of small cuffed endotracheal tube in miorolaryngo-surgery divorced the anaesthetist's equipments from that of the surgeon.(40) Although these tubes occupy 1/5 to 1/4 of the adult's laryngeal inlet and thus reduce the operative

field, the view was rated satisfactory for the microlaryngo-surgery. In addition, the surgeon was able to manipulate the tube in the larynx, examine the trachea and perform bronchoscopy if required without fear of inadequate ventilation due to pressure or kink, because of the firm nature of the tubes and the use of a high pressure gas source to overcome any resistance.[7,8]

Intubation provided an uninterrupted and prolonged microlaryngoscopy. Also, the anaesthetist was able to adjust the patient's ventilation and administration of inhalational anaesthetics. This made the patient comfortable and amnesic to the procedure, and minimized post-operative complications.[7,8] The likelihood of awareness during operation is reduced.[44,48] The use of nasal intubation is recommended over oral intubation in adult patients requiring long time pulmonary support in whom there are no contra-indication to naso-tracheal intubation.[49]

The intubation with a plain small calibre Magill rubber tube and respiration was controlled by the help of a non-depolarising muscle relaxant gave favourable results as

tensions of CO_2 and oxygen in the arterial blood were within normal limits as before surgery.(50)

The difference in resistance between No. 10 and No. 5 Magill tubes with common peak flow of 40L/minute is only 1 cm. H_2O, so the use of small tubes did not give great resistance to the flow of oxygen and anaesthetic gases.(50)

In the present study, pulse rate was significantly increased during and after microlaryngosurgery ($P < 0.05$) which may be due to sympathetic stimulation owing to surgical trauma or due to atropine given before operation, and the mean arterial blood pressure also showed significant increase during and after microlaryngosurgery ($P < 0.05$) .

Haemodynamic effects of anaesthesia using small endotracheal tubes for microlaryngosurgery were investigated by many workers.(40) They found that heart rate and mean arterial blood pressure showed an insignificant increase during and after microlaryngosurgery.(1,40,51)

In another paper, it was agreed that the pulse rate and mean arterial blood pressure were significantly increased.(40)

Also it was found that the maximal increase during anaesthesia in mean arterial blood pressure and heart rate above pre-anaesthetic levels were significant.(26,52)

It was showed that the mean heart rate increased significantly during anaesthesia for microlaryngosurgery and microlaryngoscopy and ranged from 96.7 to 120 beat per minute ($P < 0.001$) .

The mean systolic blood pressure increased during this time from 127.5 mmHg to a maximum of 175.5 mmHg ($P < 0.001$).(53)

In the present study, blood gas analysis was performed on ten patients submitted for microlaryngosurgery. It was found that the PaO_2 ranged from 185 mmHg to 240 mmHg during operation due to high percentage of oxygen administration and efficient ventilation. $PaCO_2$ ranged from 30 mmHg to 35 mmHg during operation due to controlled ventilation and pH ranged from 7.41 to 7.46 indicating no increase in $PaCO_2$ and no accompanying respiratory acidosis.

In another paper using the fine endotracheal tubes, blood gas studies on patients undergoing microlaryngosurgery showed that $PaCO_2$ ranged from 36 mmHg to 25 mmHg, PaO_2 ranged

from 180 mmHg to 240 mmHg and pH ranged from 7.41 to 7.46.[40]

In another paper using the same technique, it was found that it gave high values for PaO_2 and no increase in $PaCO_2$.[7,8,40] The measurements of the arterial oxygen and carbon dioxide tensions during the period of anaesthesia proved without doubt that such a technique is satisfactory. These findings coincide with those of other authors.[1,40,51,54]

The use of a cuffed nasotracheal tube for microlaryngo-surgery with CO_2 absorber resulted in intra and post-operative arterial CO_2 tensions which did not differ significantly from the pre-operative level if the maximum operating time did not exceed 45 minutes,[22] and thus the author recommended its use because it provides safe and excellent operating conditions in adults.[22]

In the present study, cyanosis occured in 25% of patients with cancer larynx after microlaryngosurgery using this technique due to laryngeal spasm .

Recovery was rapid and smooth with a mean recovery time of 5.4 minutes .

Delayed recovery occured in 25% of patients with cancer larynx mostly due to deep anaesthesia and prolonged operation time. Also laryngeal spasm occurred in 25% of patients with cancer larynx in the post-extubation period most probably due to irritation of the larynx after excessive manipulations in this sensitive area .

CHAPTER V

SUMMARY AND CONCLUSION

SUMMARY AND CONCLUSION

The present study includes 25 patients undergoing microlaryngosurgery by using 5 mm. diameter cuffed endotracheal tube and controlled ventilation, most of them diagnosed as cancer larynx (64%). Microlaryngosurgery was done at maximal comfort and ease by using this technique .

There were statistically significant increase in pulse rate and mean arterial blood pressure during and after microlaryngosurgery. Blood gas analysis gave statistically significant increase in PaO_2 during and after microlaryngosurgery, $PaCO_2$ showed statistically significant decrease during operative interference and insignificant decrease after operation. pH showed significant increase during and after microlaryngosurgery .

In a group of patients with cancer larynx, it was found that 25% of patients suffered from laryngeal spasm, 25% cyanosis, 25% delayed recovery and 12.5% of patients encountered with extrasystole which disappeared after operation spontaneously without any treatment, while the other groups of patients were free. The mean recovery time was 5.14 minutes.

CONCLUSION :

General anaesthesia using small cuffed endotracheal tube whose cuff has been previously inflated in boiling water to attain an adult size cuff, is suitable for microlaryngosurgery specially for irritable and non cooperative patients .

It provides good working conditions for the surgeon, maximal safety to the patient and excellent control on the anaesthesia with minimal derangement of the physiological body balance .

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بسم الله الرحمن الرحيم

ملخص البحث والاستنتاج
تخدير الجراحه الميكروسكوبيه للحنجره

تشكل حالات الفحص والجراحه الميكروسكوبيه للحنجره صعوبه وخطوره بالغه بالنسبه لتخديرها لان هؤلاء المرضى يعانون دائما من انسداد في الجهاز التنفسى ونقص الاكسوجين ويشكون من الهزال والتهابات الجهاز التنفسى ومعظمهم مسنين ومصابين باورام سرطانيه بالحنجره .

الدراسه الحاليه تشمل خمسه وعشرون مريضا اجروا فحص وجراحه ميكروسكوبيه للحنجره عن طريق التخدير الكلى باستخدام انبوبه حنجره صغيره قطرها ٥ مم بحنفاخ ٦٤ ٪ منهم مرضى باورام سرطانيه في الحنجره ٢٠ ٪ باورام حميده في الاحبال الصوتيه بينما ١٢ ٪ بسكليروما اوليه في الحنجره ٤ ٪ بتشخيصات مختلفه وقد اجريت الجراحه لهؤلاء المرضى بسهوله وامان .

وقد وجد ان تلك الطريقه في التخدير قد احدثت بعض الزياده في معدل النبض ومتوسط ضغط الدم اثناء وبعد اجراء الجراحه بينما لم يحدث تغير ملحوظ في معدل ضغط الاكسوجين في الدم ، ولكن حدث نقص ملحوظ في معدل ضغط ثاني اكسيد الكربون في الدم اثناء الجراحه فقط . هذا وقد حدثت بعض المضاعفات بالنسبه للمرضى المصابين باورام سرطانيه في الحنجره فقط مثل تقلص حنجرى لـ ٢٥ ٪ من المرضى وكذلك زرقه لـ ٢٥ ٪ وتاخر زمن الافاقه بالنسبه لـ ٢٥ ٪ (ومتوسط زمن الافاقه هو ١٤ر٥ دقيقه) .

وايضا حدث اضطراب في ضربات القلب في ٥ر١٢ ٪ من المرضى اثناء الجراحه وقد عادت الى المعدل الطبيعى بعد اجراء الجراحه بدون علاج .

الاستنتاج :-

التخدير الكلى باستخدام انبوبه حنجره صغيره (٥مم) بحنفاخ ، طريقه مناسبه وفسيولوجيه حيث انها توفر الامان للمريض والراحه والسهوله للجراح وتؤدى الى تحكم ممتاز في التخدير باقل معدل تغير في موازين الجسم الفسيولوجيه .