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Matthew A. Sandretti
Virginia Commonwealth University

Bhavna Shroff
Virginia Commonwealth University

Steven J. Lindauer
Virginia Commonwealth University

Al M. Best
Virginia Commonwealth University

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RESTORING LATERAL INCISORS AND ORTHODONTIC TREATMENT: PERCEPTIONS
AMONG GENERAL DENTISTS AND ORTHODONTISTS

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science
in Dentistry at Virginia Commonwealth University.

By

Matthew August Sandretti
B.S. Chemistry, University of California Los Angeles, June 2009
D.D.S. University of California Los Angeles University School of Dentistry, June 2013

Director: Dr. Bhavna Shroff
Virginia Commonwealth University Department of Orthodontics Program Director

Virginia Commonwealth University
School of Dentistry
Richmond, Virginia
April 2015

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ABSTRACT

RESTORING LATERAL INCISORS AND ORTHODONTIC TREATMENT: PERCEPTIONS AMONG GENERAL DENTISTS AND ORTHODONTISTS

By Matthew A. Sandretti, D.D.S.

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Dentistry at Virginia Commonwealth University.

Virginia Commonwealth University, 2015

Thesis Director: Bhavna Shroff, D.M.D., M.Dent.Sc.
Program Director, Department of Orthodontics

The purpose of this study was to identify and compare preferences and perceptions of orthodontists and general dentists when restoring peg-shaped lateral incisors. The investigation sought to summarize these preferences with regard to treatment planning, tooth preparation and interdisciplinary communication. A pair of mailed and electronic surveys was distributed to 1,500 general dentists and orthodontists, respectively. The results indicated that general dentists perceived that general dentists held the primary decision-making responsibility, while orthodontists disagreed ($P<0.0001$). Orthodontists prioritized the treatment goals of Class I canine relationship and overbite/overjet more significantly than general dentists, whom valued tooth proportions more highly ($P<0.0001$). General dentists reported receiving significantly less

input than orthodontists report seeking ($P < 0.0001$). The consensus of both groups showed that the tooth should be positioned centered mesiodistally and guided by the gingival margins incisogingivally. Both groups agree that orthodontists must improve communication to improve treatment results.

INTRODUCTION

The goals of orthodontic treatment encompass both functional and esthetic concerns. These objectives vary with patient presentation, therapeutic philosophy and chief complaint; however optimum anterior esthetics is, almost invariably, a strong consideration.

The appearance of peg-shaped lateral incisors occurs in a small, yet distinguishable portion of the overall population. Meskin and Gorlin¹ found in a population of white patients an incidence of 0.88% for peg-shaped lateral incisors. Montagu² reported that as much as 2.5% of incisors displayed some significantly recognizable reduction in size. The incidence increases dramatically for cleft lip and palate patients, with Wu et al reporting incidence of 10% in cleft palate only patients and 45-58% for patients with cleft lip extending into the alveolus.³ In a meta-analysis completed by Hua et al⁴ the overall prevalence of peg lateral incisors was found to be 1.8%, with a higher prevalence in orthodontic patients (2.7%). Though peg-shaped lateral incisors have an overall low incidence in patient populations without craniofacial anomalies, treatment strategies must be in place to address the poor esthetic appearance and the negative impact on the patient's occlusion.

Patients with severely undersized, malformed or peg-shaped lateral incisors present compromised anterior esthetics and significant treatment challenges to restore a pleasing smile. The optimization of smile esthetics with peg laterals involves the restoration of proper physical and perceived tooth dimensions. The concept of relative incisor width has often been referred to as the "Golden Proportion" which states that the ideal ratio is 1.6-1.0-0.6 for the central incisor,

lateral incisor and canine in the frontal smiling view.⁵ This corresponds to a perceived lateral incisor width that is approximately 62% of the width of the central incisor. Wolfart et al determined that laypeople deemed esthetically pleasing a lateral incisor width of 50-74% the width of the central incisor from the frontal view, confirming the impact of the lateral incisor width on acceptable smile esthetics.⁶ Kokich reported that when an ideally-shaped lateral incisor was decreased 3 mm bilaterally it was deemed unattractive by orthodontists and general dentists. Lay persons found the difference unacceptable at 4 mm of bilateral reduction.⁷ In a follow-up study, all groups determined the smile esthetics to be unacceptable when the lateral incisor reduced by 2 mm unilaterally.^{7,8} Decreased mesio-distal width of a lateral incisor also may present concurrently with a significant midline deviation. Beyer and Lindauer additionally showed in their investigation of midline deviations that the mean acceptable threshold for midline deviation was 2.2 mm.⁹ Peg-shaped lateral incisors commonly present malocclusions beyond these limits of acceptability and thus compromise the perception of smile esthetics.¹⁰ These studies highlight that peg lateral incisors drastically impact the balanced proportions essential to an esthetically pleasing smile to both dentists and the layperson.¹¹

Peg-shaped lateral incisors also create significant functional and occlusal challenges due to the introduction of a relative tooth size discrepancy. As Bolton discussed, a smaller ratio of anterior tooth size in the maxillary arch may result in shift in classification toward angle Class II canine and/or molar, decreased overbite/overjet, or the presence of maxillary spacing.¹² A tooth size discrepancy may also lead to significant shift in the midline position.¹³ These outcomes are all viewed as generally undesirable and are not goals of excellent orthodontic management.

Freeman et al demonstrated that the presence of a significant Bolton tooth-size discrepancy may occur in as much as 30.6% of the orthodontic population and thus is an essential factor in routine

treatment planning.¹⁴ The complete correction of occlusal challenges is frequently not possible without correction of the underlying tooth-size discrepancy. Therefore, treatment may require buildup of severely undersized maxillary laterals and/or enamel reduction of mandibular anterior teeth to correct the occlusal disharmony.¹⁵

The most common treatment options for peg-shaped lateral incisors include orthodontic alignment, direct/indirect composite bonding, bonded porcelain veneers, full-coverage crowns, periodontal recontouring or no treatment.¹⁶ Frequently, the selected treatment plan utilizes more than one of these treatment options and the involvement of a multidisciplinary dental team to properly sequence the therapy.¹⁷ In such team settings, proper communication and planning is imperative in the successful management of the dental treatment and attainment of optimal outcomes. While much of the literature focuses on the treatment planning of orthodontics in conjunction with restorative treatment,^{10,18} there is a lack of data regarding the communication practices and treatment implementation between restoring dentists and orthodontic specialists.

The purpose of this study will was to identify and compare preferences and attitudes of general dentists and orthodontists regarding (1) treatment planning and timing, (2) tooth positioning, and (3) interdisciplinary communication in the comprehensive treatment of peg-shaped lateral incisors. It also established areas of consensus and discrepancy amongst the two groups of practitioners. Thus, the null hypothesis was that there was no difference in the communication and clinical preferences of orthodontists and general dentists in the interdisciplinary management of peg-shaped lateral incisors.

MATERIALS AND METHODS

Approval to conduct this study was granted by the Institutional Review Board (IRB) at Virginia Commonwealth University (VCU) in March 2014.

A parallel pair of original surveys was created to examine the treatment preferences when restoring peg lateral incisors and coordinating orthodontic treatment. The surveys asked comparable questions that were reworded appropriately to pertain to the role of each practitioner. As an example, the question “How often do you ask for input during the finishing stage?” in the orthodontist survey would be worded “How often does the orthodontist ask you for input during the finishing stage?” in the general practitioner survey. Each survey consisted of 20 questions relating to the roles of each practitioner, the delivery of care and preferred interdisciplinary communication. It also included questions on technical aspects of treatment such as tooth positioning and materials selection for restoration. A section for comments was included and respondents were encouraged to provide additional input.

1,500 randomly selected AAO members were surveyed electronically, using the database of the American Association of Orthodontists Partners in Research program. Following a four week response period, a follow-up email was sent to remind selected members to participate. Those that had already completed the survey were thanked and asked to refrain from participating again.

Paper surveys were mailed to 1,500 general dentists using the VCU mailing service. General dentists were selected by randomly drawing a letter and state from a generated listing and obtaining the contact information from the ADA database. This process was repeated until a

list of 5,000 general dentists was created. Using a random number generator, 1500 entries were selected from the list of 5,000. Each survey was randomly given an identification number to track participants, but was not linked to the entered results. Four weeks after the initial mailing, a follow-up mailing was sent to the general practitioners that did not initially participate.

Study data were collected and managed using REDCap (Research Electronic Data Capture) tools program. This program is a secure web-based application designed to support data capture for research studies, data verification and export procedures to statistical packages. (REDCap Consortium hosted at Virginia Commonwealth University; Richmond VA). The responses were summarized as counts and percentages or means and standard deviations, as appropriate. Chi-square or logistic regression analysis were used for all comparisons of nominal outcomes. ANOVA was used for comparison of mean data values. All calculations were done with SAS software (JMP pro version 10, SAS version 9.3, SAS Institute Inc., Cary NC).

RESULTS

Survey Demographics

A total of 154 responses were recorded for orthodontists, (Response rate of 10.3%). The general dentist mailing returned 145 responses out of 1433 confirmed deliveries, (Response rate of 10.1%). The years in practice of the respondents are summarized in Table 1. The general dentists responding to the survey on average had more years of experience than the orthodontists, a difference that was statistically significant ($P < 0.0001$). 60% of the general dentists had been practicing 26+ years, while only 32% of the orthodontists had been practicing for over 25 years.

Table 1. Survey Demographics

	How long have you been practicing Orthodontics/Dentistry?										Mean	SD	P Value
	Less than 5 years		6-15 years		16-25 years		26+ years		(n)				
	%	(n)	%	(n)	%	(n)	%	(n)	(n)				
General Dentists	6	(9)	18	(25)	16	(23)	60	(85)	(142)	23.58	9.44	<.0001*	
Orthodontists	15	(23)	24	(37)	29	(44)	32	(48)	(152)	18.50	10.08		
Total	11	(32)	21	(62)	23	(67)	45	(133)	(294)				

Practitioner Confidence and Satisfaction

Table 2 displays the perceived confidence and satisfaction in treating combined orthodontic-restorative cases. Orthodontists felt significantly more confident with a mean rating of 9.6 out of 10 when treating these cases compared to general dentists (Mean rating 8.4; $P < 0.0001$). There was also a significantly larger standard deviation in the general dentist group, indicating a much wider distribution of perceptions ($P < 0.0001$). Orthodontists were also significantly less satisfied

with the final result (reported a 7.69 out of 10) than general dentists (8.53; $P < 0.0001$). Figure 1 shows the relationship between satisfaction and confidence separately for the two groups of practitioners. Circle size is proportional to the number of practitioners. Within the general dentist group there was a significant positive correlation between confidence and satisfaction ($r = 0.25$, $P = 0.0024$) and this correlation was similar yet marginally higher ($P = 0.0796$) than the correlation within orthodontists ($r = 0.23$; $P = 0.0042$). In both cases, more confidence was indicative of increased satisfaction with the final result. There was no correlation between practitioner experience and confidence level ($r = 0.00058$; $P = 0.99$).

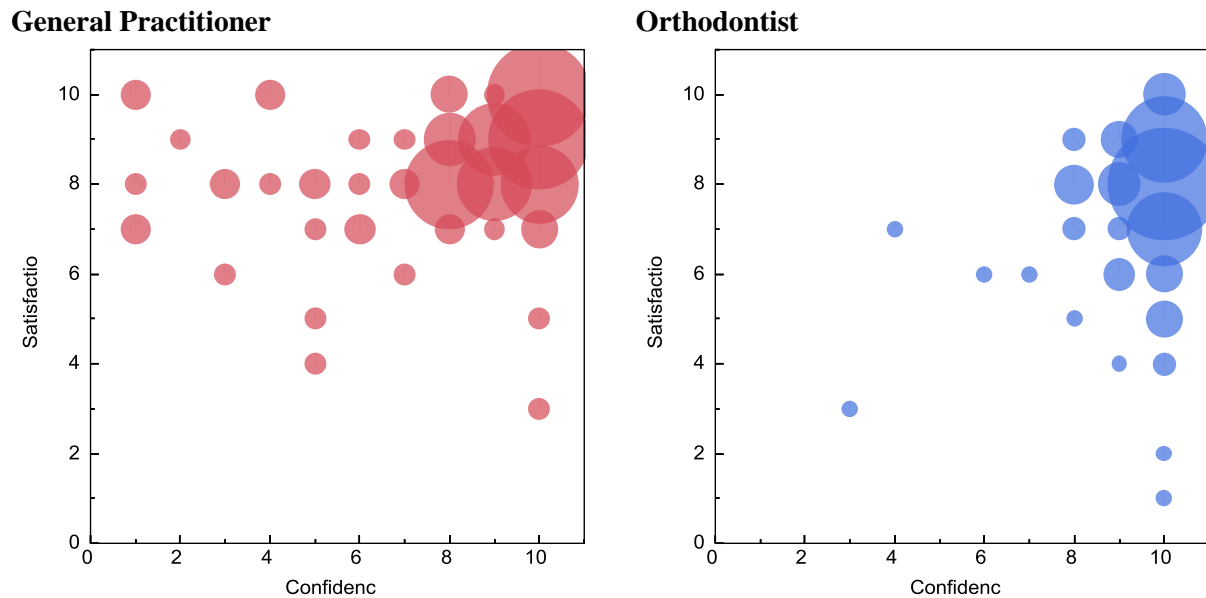


Figure 1. Relationship between satisfaction and confidence by practitioner group

Table 2. Practitioner Confidence and Satisfaction

In general, how confident do you feel in treatment planning and treating this case?

Group	n	Mean*	SD**
General Dentists	142	8.40	2.27
Orthodontists	154	9.60	0.99

*Means ($P < .0001$) and **SD significantly different ($P < .0001$)

Overall, how satisfied are you with the final result in the completion cases involving restorations of peg laterals and orthodontic treatment?

Group	n	Mean*	SD
General Dentists	145	8.53	1.21
Orthodontists	152	7.69	1.48

* $P < .0001$

Treatment Planning and Sequencing

Both orthodontists and general dentists agreed that the final treatment plan was usually established prior to the start of any treatment ($P=0.863$). Likewise, orthodontists and general dentists also reported that they generally preferred to have the final treatment plan decided prior to initiating orthodontic treatment. This was collectively 57% of the responses, which showed no difference amongst orthodontists and general dentists (55% and 60%; $P=0.151$). This data is summarized in Table 3.

Table 3. Treatment Planning

When is the final treatment plan, including restorative plans, usually decided between you and the other dentist?

Group	Before orthodontic treatment begins		Early in orthodontic treatment		Toward the end of orthodontic treatment		After orthodontic treatment		(n)	P Value
	%	(n)	%	(n)	%	(n)	%	(n)		
General Dentists	60	(85)	14	(20)	22	(31)	4	(6)	(142)	0.151
Orthodontists	55	(84)	13	(20)	31	(48)	1	(2)	(154)	
Total	57	(169)	14	(40)	27	(79)	3	(8)	(296)	

When would the determination of the final treatment plan, including restorative plans, be PREFERRED to be completed?

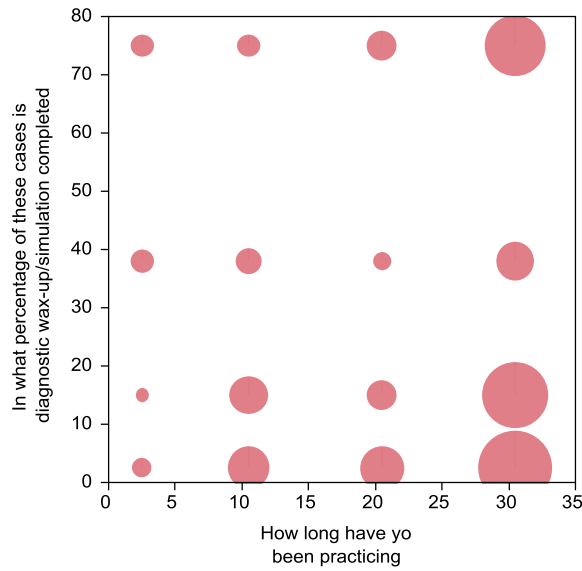
Group	Before orthodontic treatment		Early in orthodontic treatment		Towards the end of orthodontic treatment		After orthodontic treatment		Doesn't matter		(n)	P Value
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)		
General Dentists	53	(76)	15	(21)	21	(30)	8	(11)	4	(6)	(144)	0.863
Orthodontists	57	(87)	11	(17)	22	(33)	6	(9)	4	(6)	(152)	
Total	55	(163)	13	(38)	21	(63)	7	(20)	4	(12)	(296)	

When completing the treatment planning process, practitioners were asked if diagnostic wax-ups/simulations were integrated in their treatment planning protocol. Table 4 shows that most orthodontists (77%) rarely complete a diagnostic wax-up or simulation. Among general dentists there was significantly more variation, as 38% of dentists rarely used wax-ups, 26% used them occasionally and 24% reported completing them routinely. The relationship between years in practice and the percentage of cases where a diagnostic wax-up or simulation is completed were compared. The mid-points of the ranges of the answers for each question were plotted and depicted in Figure 2. Circle size was proportional to the number of practitioners. The correlation between years in practice and use of wax-ups/simulations was significant ($r = 0.16$; $P = 0.0075$). Generally, practitioners with more years of experience were more likely to complete diagnostic wax-ups.

Table 4. Diagnostic Wax-Up

	In what percentage of these cases is a diagnostic wax-up/simulation completed?									P Value
	Less than 5%		5-25%		26-50%		51%+		Total	
	%	(n)	%	(n)	%	(n)	%	(n)		
General Dentists	38	(54)	26	(38)	13	(18)	24	(34)	(144)	<.0001
Orthodontists	77	(118)	16	(25)	4	(6)	3	(5)	(154)	

General Practitioner



Orthodontist

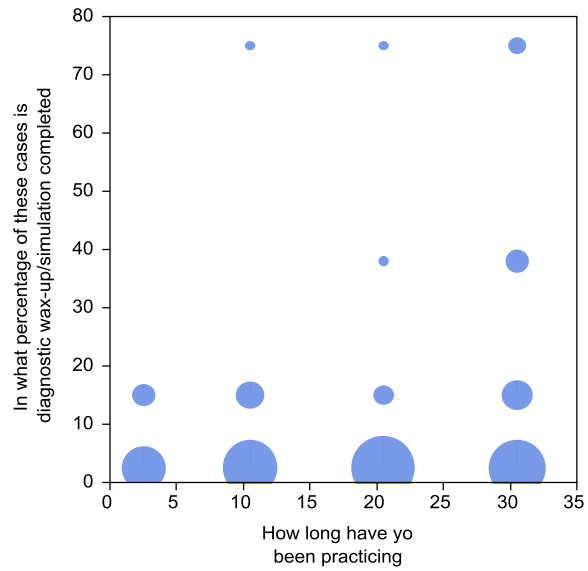


Figure 2. Relationship between use of diagnostic wax-up and practitioner experience

The responses were also analyzed regarding which practitioner was most responsible in making the decision if restorations were the best choice. Table 5 summarizes that orthodontists most commonly responded that they were primarily responsible (47%), while general dentists rarely thought orthodontists were primarily responsible for making the decision (11%; $P < 0.0001$). Conversely, the vast majority of general dentists perceived that they were the primary decision maker (80%) while much fewer of orthodontists felt general dentists should make the decision (26%, $P < 0.0001$). Figure 3 further depicts this disparity in perception as responses in all three categories were statistically significant.

Table 5. Primary Decision-Making Responsibility

Who is primarily responsible for deciding IF restorations are the best choice to enhance the esthetic outcome?

	The restoring dentist		The orthodontist		The patient/patient's parents		Total	P Value
	%	(n)	%	(n)	%	(n)		
General Dentists	80	(105)	11	(14)	10	(13)	(132)	<.0001*
Orthodontists	26	(40)	47	(72)	27	(41)	(153)	

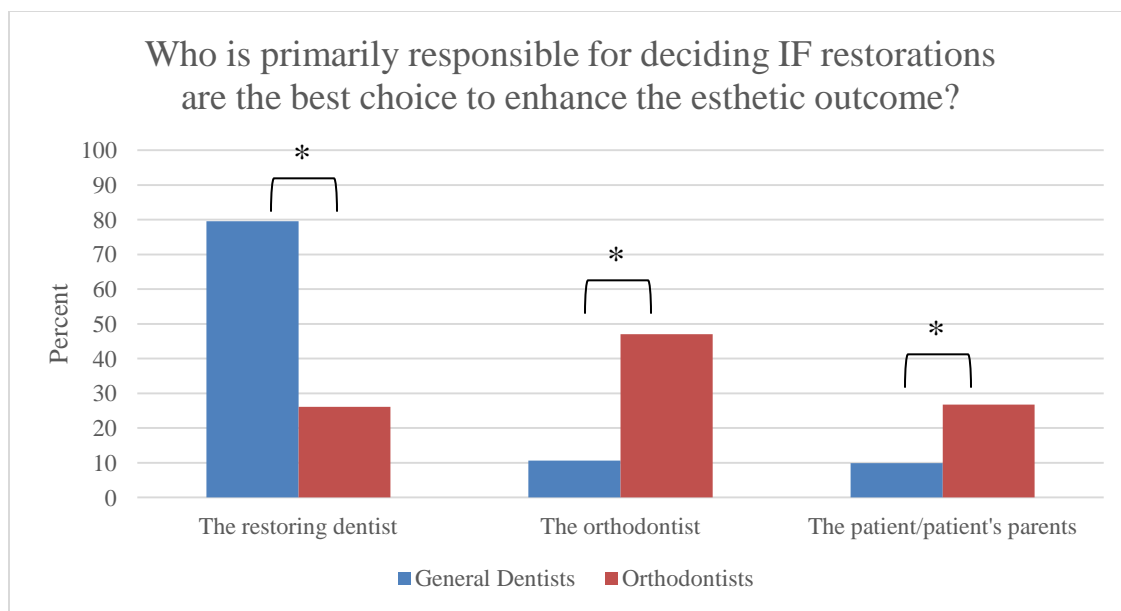


Figure 3. Perceptions of Decision-Making Responsibility

Table 6 shows the treatment planning protocol and preferences for treating peg laterals in adolescent patients and the preferences for the final restoration. In prioritizing treatment goals, orthodontists were more likely to value Class I canine relationship (27%) than general dentists, (15%; $P=0.0042$). Treatment goals of general practitioners primarily focused on restoring the ideal tooth size ratio (51%) compared to orthodontists (30%; $P<0.0001$)

Table 6. Treatment Priorities

Of your treatment priorities for the anterior dentition during adolescence for this patient, which is the most important treatment goal?

	Overbite and Overjet		Tooth size ratio		Eliminating existing spaces		Eliminating tooth-size discrepancy		Class I canine relationship		(n)	P Value
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)		
General Dentists	26	(35)	51	(70)	4	(6)	3	(4)	15	(21)	(136)	0.0042*
Orthodontists	36	(54)	30	(46)	3	(5)	4	(6)	27	(41)	(152)	

Both orthodontists and general dentists agreed that composite restorations were the restoration of choice for adolescent patients, however there was some disagreement regarding the timing of

restoration placement. While restorative treatment immediately after orthodontic treatment was the most common response for both groups, more orthodontists preferred the restoration be placed prior to orthodontic treatment if possible (25%) than general dentists (10%), while general dentists preferred the restoration post-orthodontics (52% vs 34%; $P=0.0024$). For the final or definitive restoration, orthodontists and general dentists equally preferred composite bonding (37%) and porcelain veneers (43%), while full coverage restorations were less commonly preferred (18%). There were no differences between the preferences of general dentists and orthodontists for all responses ($P=0.293$).

Table 7. Materials and Timing of Restoration

	Which is your PREFERRED restorative treatment for the laterals during this phase of treatment (adolescence)?											P Value
	Composite resin bonding		Porcelain veneers		Full coverage crowns		None-close spaces		None-leave spacing		(n)	
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)		
General Dentists	80	(116)	3	(5)	5	(7)	1	(1)	11	(16)	(145)	0.0067*
Orthodontists	90	(138)	1	(2)	0	(0)	0	(0)	9	(14)	(154)	
Total	85	(254)	2	(7)	2	(7)	0	(1)	10	(30)	(299)	

When would you PREFER this initial restoration be placed?

	Early or before orthodontic treatment		During final stages of orthodontic treatment		Immediately after orthodontic treatment		A while after orthodontic treatment		Doesn't matter		(n)	P Value
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)		
	General Dentists	10	(14)	24	(35)	52	(75)	8	(12)	2		
Orthodontists	25	(38)	22	(34)	34	(53)	14	(22)	2	(3)	(154)	
Total	17	(52)	23	(69)	43	(128)	11	(34)	2	(6)	(299)	

Which treatment modality do you PREFER to utilize for the final restoration, assuming all are viable options?

	Composite resin bonding		Porcelain veneers		Full coverage crowns		I prefer not to restore peg laterals		(n)	P Value
	%	(n)	%	(n)	%	(n)	%	(n)		
	General Dentists	41	(57)	39	(54)	20	(28)	1		
Orthodontists	34	(52)	48	(73)	16	(25)	2	(3)	(153)	
Total	37	(109)	43	(127)	18	(53)	1	(4)	(293)	

Final Tooth Positioning

Table 8 displays the responses of all practitioners regarding the perceived input of the restoring dentist. When clinicians were asked how often the orthodontist asks for input during the finishing stage, there was a large disparity between the groups. 67% of orthodontists reported they sought input routinely, or over 75% of the time, while a much smaller proportion of general dentists reported being routinely asked (31%; $P < 0.0001$). General dentists indicated that orthodontists often asked less than 50% of the time (57%) while a minority of orthodontists reported that this was the case (20%; $P < 0.0001$). Figure 4 shows that there was a significant disagreement between groups with orthodontists perceiving that they asked for input far more often than the general dentists report being asked.

Table 8. Input during Tooth Positioning

During the finishing stage, HOW OFTEN does the orthodontist seek input from the restoring dentist regarding tooth positioning?

	Less										P-value	
	than 5%		5-25%		26-50%		51-75%		Over 75%			
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	(n)	
General Dentists	23	(33)	20	(29)	14	(20)	13	(18)	31	(44)	(144)	$< .0001^*$
Orthodontists	7	(11)	4	(6)	9	(14)	12	(19)	67	(103)	(153)	

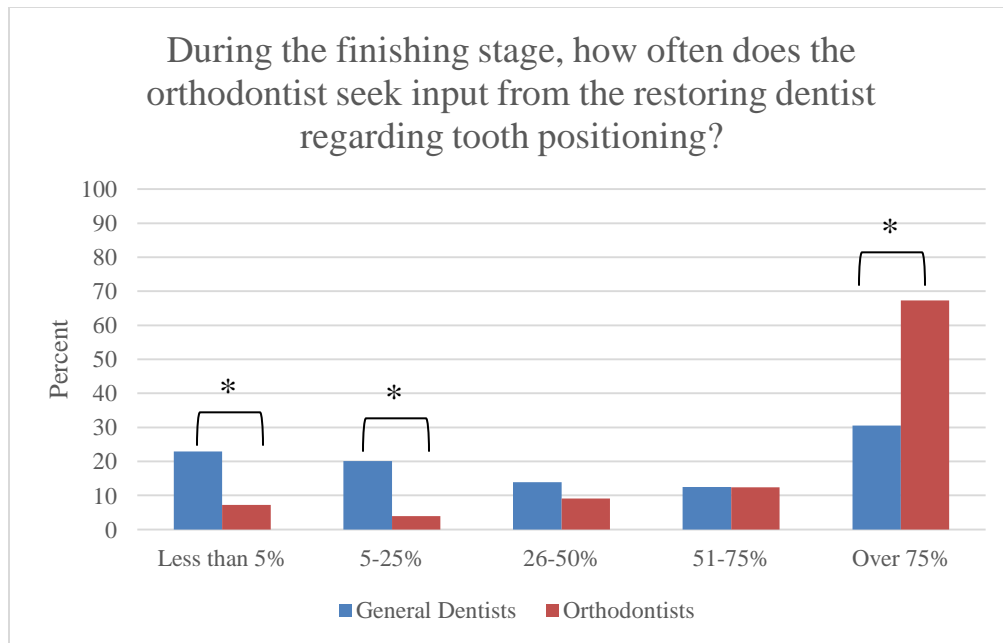


Figure 4. Perceived input in tooth positioning

With regard to tooth positioning, the preferences of clinicians in all three planes of space are summarized in Table 9. In the mesio-distal plane, the most common preference was for the tooth to be centered mesio-distally (45%). The other more common preferences of practitioners were to use the shape of the existing tooth (27%) and the desired emergence profile (23%) as guides in mesio-distal positioning. No differences were found between groups ($P=0.113$). In the facio-lingual plane, general dentists tended to focus on the ideal tooth angulation more than orthodontists (54% vs 31%). Orthodontists more commonly determined the facio-lingual position by the material desired for the restoration (29% vs 8%; $P < 0.0001$). Finally, in the vertical dimension, most practitioners used the gingival margins as the guiding factor (57%). However, 20% of general dentists and 5% of orthodontists used the incisal edges as the determining factor, a difference which was significant ($P < 0.0001$).

Table 9. Final Tooth Positioning in Three Planes of Space

Please select the factor that in general you feel is MOST IMPORTANT in deciding the final tooth positioning in each of three planes of space

Mesiodistally

	Centered mesiodistally		The shape of the existing tooth		The desired emergence profile		The material desired for the restoration		Does not matter			P-value
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	(n)	
General Dentists	52	(76)	23	(34)	21	(30)	1	(2)	3	(4)	(146)	0.113
Orthodontists	39	(60)	30	(46)	25	(39)	4	(6)	1	(2)	(153)	
Total	45	(136)	27	(80)	23	(69)	3	(8)	2	(6)	(299)	

Faciolingually

	Ideal overbite and overjet		Tooth angulation close to ideal		The material desired for the restoration		Does not matter			P-value		
	%	(n)	%	(n)	%	(n)	%	(n)	(n)			
General Dentists			35	(50)	54	(77)	8	(11)	3	(5)	(143)	<.0001*
Orthodontists			39	(60)	31	(48)	29	(44)	1	(1)	(153)	
Total			37	(110)	42	(125)	19	(55)	2	(6)	(296)	

Incisogingivally

	The incisal edges of the adjacent teeth		The gingival margins of the adjacent teeth		The level of the CEJ of the adjacent teeth		The material desired for the final restoration		Does not matter			P-value
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	(n)	
General Dentists	20	(28)	50	(71)	21	(29)	3	(4)	6	(9)	(141)	<.0001*
Orthodontists	5	(8)	63	(97)	24	(37)	6	(10)	1	(2)	(154)	
Total	12	(36)	57	(168)	22	(66)	5	(14)	4	(11)	(295)	

Areas of Improvement

Finally, the clinicians were asked to assess their biggest areas of dissatisfaction and the primary areas of improvement needed for both orthodontists and general dentists. The results are displayed in Table 9. A majority of orthodontists were dissatisfied with the shade and/or morphology of the restoration (51%) compared to a smaller number amount of general dentists that responded similarly (14%; $P<0.0001$). The general dentists, however, tended to be more dissatisfied with the gingival contours (33%) and final tooth positioning (19%) than their orthodontic counterparts (20% and 1% respectively; $P<0.0001$). The distribution of the areas orthodontists should improve upon were nearly identical across the both groups of practitioners ($P=0.806$), with the largest group (40%) indicating that communication with the restoring dentist was the primary area of improvement needed. The responses of the areas of improvement for general dentists were however not consistent between groups of practitioners. Orthodontists perceived that general dentists needed to improve the quality of the restoration far more than often than perceived by general dentists (34% vs 8%; $P<0.0001$). General dentists instead perceived that they most needed to improve their ability to understand the challenges of orthodontic treatment and the establishment of a cohesive treatment plan (31% and 29%, respectively). Both of these perceptions were more commonly reported by general dentists than orthodontists (17% and 14%, respectively; $P<0.0001$).

Table 10. Areas of Improvement

Which area represents your biggest source of dissatisfaction with the final result?

	Quality of restoration		The size of the restoration		The final tooth positioning		The gingival contours		Treatment Time		Communication of practitioners		(n)	P-value
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)		
General														<.0001*
Dentists	14	(20)	13	(18)	19	(27)	33	(46)	14	(19)	7	(10)	(140)	
Orthodontists	51	(78)	8	(12)	1	(1)	20	(30)	10	(15)	11	(17)	(153)	
Total	33	(98)	10	(30)	10	(28)	26	(76)	12	(34)	9	(27)	(293)	

In which area do you think Orthodontists could improve most in the coordination and completion of these cases?

	Positioning tooth/teeth properly		Cohesive interdisciplinary treatment plan		Communication with the restoring dentist		Communication with the patient/family		Understanding the challenges of dentist		(n)	P-value
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)		
General												0.806
Dentists	9	(13)	22	(31)	39	(54)	3	(4)	26	(36)	(138)	
Orthodontists	11	(17)	22	(34)	41	(62)	5	(7)	21	(32)	(152)	
Total	10	(30)	22	(65)	40	(116)	4	(11)	23	(68)	(290)	

In which area do you think the Restorative Dentists could most improve in the coordination and completion of these cases?

	Quality of restoration		Cohesive interdisciplinary treatment plan		Communication with specialists		Communication with the patient/family		Understanding the challenges of orthodontist		(n)	P-value
	%	(n)	%	(n)	%	(n)	%	(n)	%	(n)		
General												<.0001*
Dentists	8	(11)	29	(40)	25	(35)	7	(10)	31	(43)	(139)	
Orthodontists	34	(52)	14	(21)	28	(42)	7	(11)	17	(26)	(152)	
Total	22	(63)	21	(61)	26	(77)	7	(21)	24	(69)	(291)	

DISCUSSION

It is very important for orthodontists when approaching interdisciplinary cases to clearly and effectively communicate with the general dentist and to finish with an outstanding clinical result. According to previous literature, treatment results and good communication were vital factors in determining referral decisions and were consistently ranked as more important than office location, personal relationship or fee schedule in referral recommendations.^{19,20} As various aspects of treatment management are discussed, it is prudent to understand that orthodontists as specialists must take measures to cultivate agreement and synchronicity in managing interdisciplinary treatment. It is vital to maintain an effective communication strategy and to understand that this communication affects the quality of the clinical results as well as professional relationships. The written comments collected in the survey were generally very favorable and most of those commenting reported a positive relationship with other clinicians.

Survey Demographics

The overall response rate for the mailed survey was 10.1% and 10.3% for general dentists and orthodontists, respectively. The response rate compares similarly to other recent studies with response rates of 7.2%-13.7% for large-scale mailed surveys to general dentists and orthodontists.^{19,21} The response rate is hardly a complete census, it appears to be representative of all practitioners and consistent with previous literature. One interesting finding was that responding dentists on average had significantly more experience in practice than orthodontists, with a difference of 5 years in the mean level of experience (23.58 vs 18.50). Part of this

observation could be explained by the 2-3 years of residency training completed by orthodontists, however this does not fully account for the experience level difference. This difference may also be indicative of the media chosen (paper vs electronic), as more experienced practitioners may be more comfortable with paper surveys while younger practitioners favored electronic communication. This bias in practitioner experience with more experienced general dentists was also shown in a similar survey instrument.²¹

Practitioner Confidence and Satisfaction

This study indicated that orthodontists in reported greater confidence than general dentists in treating peg lateral incisors. Previous literature suggests this difference may be explained as a result of the relative differences in patient population encountered by each practitioner. Peck and Peck²² showed that a relatively large percentage (17.6%) of palatally displaced canines present with accompanying peg laterals. Other studies have suggested that Class II Div 2 malocclusion and other tooth anomalies may present with higher rates of peg-laterals incisors.^{22,23} The treatment of these malocclusions are often addressed with orthodontic treatment, creating a bias in orthodontic patients toward increased prevalence of peg lateral incisors. This was confirmed by Hua and colleagues which found peg lateral incisors to be nearly twice as common in the orthodontic population compared to the general population.⁴ Though perceived confidence was related to the type of practitioner, confidence was not related to the number of years in practice for either orthodontists or general dentists. Individual practitioners that felt more confidence in managing peg lateral incisors reported greater satisfaction with the final result, a trend that was especially prominent in the group of general dentists. The findings suggest a larger gradient of familiarity with peg lateral incisors among general dentists, but general dentists that felt more confident were able to achieve improved treatment outcomes.

Treatment Planning and Sequencing

Both orthodontists and general dentists were in agreement that the preferred time to create the comprehensive treatment plan is prior to the beginning of any orthodontic treatment and that they were generally successful in meeting this preference. The results support that both practitioners are aware of the preferences and applying this preference adequately. However an area of difference between orthodontists and general dentists in the management and planning was the use of diagnostic wax-ups. Orthodontists rarely used a diagnostic wax-up while a large percentage of general dentists employed diagnostic wax-ups at least some of the time. While a wax-up can certainly be useful for diagnostic purposes for both clinicians¹⁰, the diagnostic wax-up may be further utilized by the restoring dentist for the creation of provisional restorations or stents to help guide the contours of the restoration.²⁴ Orthodontists are less likely value wax-ups for purposes beyond diagnosis and treatment planning. The findings also demonstrate that more experienced general dentists are more likely to utilize wax-ups. It is possible that more experienced practitioners may have gained a greater appreciation for the usefulness of additional diagnostic tools throughout their career. This disparity may also reflect a difference in dental training philosophy over time, with more recent graduates placing less emphasis on diagnostic simulations. General dentists and orthodontists strongly disagreed on which member of the interdisciplinary dental team is responsible for making the decision to complete restorations. General dentists prefer that general dentists decide if restorations are indicated while orthodontists preferred that orthodontists make the decision to pursue restorations. Though this disagreement may stem from both practitioners wanting optimal outcomes for the patient, it may certainly add confusion for the patient in choosing to complete restorative treatment. The results indicate that patient care and professional relationships would improve if orthodontists worked

more collaboratively and not executively in recommending restorations, providing information and allowing general dentists to make the final decision together with the patient.

Likewise, both practitioner groups could not reach consensus on the treatment goals in patients with peg lateral incisors. Orthodontists prioritized Class I canine relationship and overbite/overjet more than general dentists while general dentists had a stronger preference for tooth proportions more than orthodontists. This disagreement suggests an increased emphasis on occlusion among orthodontists and a stronger emphasis on ideal esthetic tooth proportions among general dentists. General dentists secondly prioritized overbite/overjet, followed by Class I canines, and finally absence of spacing. The results of Hall, et al²⁵ disagree with this prioritization of goals, as Hall found Class I/guiding canine relationship was the most important treatment goal desired by referring dentists, followed by absence of spacing, then overbite/overjet. The variability in these results suggests that the orthodontist should have a thorough discussion regarding the preferences and treatment priorities with the dentists with which he or she frequently collaborates.

Both orthodontists and general dentists preferred to utilize composite restorations in adolescent patients while composite restorations and veneers were equally preferred in adult patients. The selection of composite restorations in adolescents agrees with the guidelines of Kokich and Spear¹⁰, which strongly recommend against indirect restorations in patients still undergoing growth and more significant compensatory tooth eruption. Kokich and Spear¹⁰ additionally suggested that restorations be placed prior to the completion of orthodontic treatment (or prior to treatment if space allows) to allow for orthodontic tooth movement following placement. However, this study showed that most general dentists preferred to place the restoration immediately after orthodontic treatment compared to a much smaller group of orthodontists.

More orthodontists were in favor of placement before orthodontic treatment than general dentists and orthodontists generally preferred earlier completion of the restoration. One possible explanation for this difference is the need for modifications after orthodontic treatment. It is possible imperfections introduced by tooth positioning would require modifications to the restoration, requiring additional time and procedures of the general dentist and the patient. Another possible explanation is the desire for both practitioners to direct the final result. The earlier the restoration is placed, more of the leadership in determining the final result is held by the orthodontist. Thus, this decision would likely be affected by the individual dynamics of each dentist-specialist relationship and the confidence of each practitioner.

Final Tooth Positioning

In the majority of cases, the restoration is not placed prior to orthodontic treatment, allowing both practitioners the opportunity to establish the tooth position before restoring. The final positioning of the tooth should be a collaborative effort between both the orthodontist and general dentist and be driven by a variety of factors¹⁰. General dentists and orthodontists, however, disagreed on the level of collaboration that was typically achieved in the positioning process. The majority of orthodontists felt they routinely asked for input while less than one third of general dentists felt that input was routinely sought by orthodontists. This large disconnect highlights an obvious shortcoming in interdisciplinary communication practices. A similar result was obtained by Bibona et al²¹ which showed a significant difference in the frequency that orthodontists asked for input regarding malformed teeth and the frequency general dentists reported being asked for input. Recall bias is possible and each group may be over or underestimating their individual involvement. In deciding the tooth position, both groups generally preferred to have the tooth centered mesio-distally. This finding disagrees with the

recommendations previously stated in literature which suggest the tooth be positioned more mesially as to enable the most ideal emergence profile¹⁸. The likely explanation of this distinction is a practical difference between theory and clinical execution. It is easy to communicate that a centered tooth is preferred, which will still provide the restoring dentist with the flexibility and space to complete an acceptable restoration. In the facio-lingual positioning, the results varied and difficult to draw consensus. It was surprising that the decision of more general dentists considered the ideal tooth angulation, while more orthodontists were driven by the material desired for the restoration. This relationship was opposite the results that were expected and suggest both practitioners attempting to strongly consider the goals of each other. In the vertical dimension, both groups highlighted the gingival margins as the primary determining factor. A small, but statistically significant group of general dentists preferred to use the incisal edges as a guide. This result is not surprising, since gingival esthetics have been identified in the literature^{16,26} as key area of concern in the esthetic zone and one of the most difficult issues to treat address restorative treatment. It is logical and predictable to first maximize the gingival esthetics with tooth positioning and account for any differences in tooth height with the restorative treatment.

Areas of Improvement

Understanding the areas of dissatisfaction and misunderstanding between practitioners is critical to improving the specialist-generalist relationship and achieving outstanding treatment results. The results of this study show that orthodontists were primarily dissatisfied with the quality of the restoration, while general dentists were significantly more dissatisfied with the tooth positioning and the gingival contours of the final result (Figure 5). These results highlight the discord that may be present in the vision of the final esthetic result and the discrepancy in the

communication practices of orthodontists and general dentists. Coordination in more difficult cases should be thorough and offer two-way communication for both clinicians²¹. Interestingly, both groups seemed to agree on the area in which orthodontists need to improve: communication with the dentist. However, the groups disagreed on the area which general dentists need to improve. The responses were varied and insufficient to establish a consensus of the main areas of improvement needed. Though some orthodontists felt the quality of the restoration could be improved, the overall degree of variation was high and yielded no reliable conclusions.

Assessment of the Study

Though this study did elucidate some preferences and clinical realities of treating peg-shaped lateral incisors, did not provide a comprehensive guide. The planning of every case will vary based on the presentation, patient attitudes, circumstances and other factors. This study was intended to discover and categorize some of the perceptions regarding treatment of peg laterals and to find areas where general dentists and orthodontists can work more effectively to maximize results. It did not consider the full range of treatment options, instead focusing on a particular subset of restorative options. For instance, extraction and implant placement or extraction and canine substitution are both potentially excellent options in treating peg-shaped laterals, depending on the prognosis of the tooth.^{27,28} However, peg-shaped laterals have not been found to be at increased risk for root resorption or caries²⁹ and maintaining these teeth is frequently a goal of treatment. Therefore, treatment options involving extraction were not included in this investigation. This omission is a potential weakness of the study as is the minimal attention given to the option of not correcting the esthetics of peg-shaped lateral incisors.

Another potential weakness of the study was the adoption of generally “ideal” circumstances, which did not include considerations such as cost, insurance coverage and patient/parent attitudes. These were factors consistently mentioned by both groups of practitioners in the comments section as lacking in the survey considerations. Though lateral incisor microdontia is the primary presentation of maxillary anterior tooth size reduction, small central incisors, worn/restored teeth, and retained primary teeth may also have unacceptable reduction in size and dictate the need for interdisciplinary treatment. The results of this study could be reasonably applied to many more situations involving the coordination of orthodontic treatment and anterior esthetic restorations.

CONCLUSIONS

- There was a consensus preference to establish the final treatment plan for each patient prior to treatment. Both orthodontists and general dentists appeared to generally accomplish this goal.
- Orthodontists had a greater level of perceived confidence and but lesser satisfaction with the treatment outcome when restoring peg lateral incisors than general dentists.
- Decision-making responsibility varied between dentists and orthodontists as each practitioner perceived it to be their role to decide whether restorations were indicated.
- Orthodontists and general dentists disagree on the frequency with which input was sought in tooth positioning. Orthodontists should strive to seek input routinely regarding tooth positioning to better incorporate the insight of the restoring dentist.
- Composite restorations are the preferred treatment choice in adolescent patients, with composite restorations and porcelain veneers equally preferred in adult patients.

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APPENDICES

APPENDIX A

Survey Sent to Orthodontists

Restoring Peg Laterals: An Interdisciplinary Approach Orthodontist Questionnaire



VCU

VIRGINIA COMMONWEALTH UNIVERSITY

Thank you for your participation in this investigation of the diagnosis, treatment planning, and interdisciplinary communication between orthodontists and general dentists. The study focuses on the coordination of cases where orthodontic treatment (traditional fixed appliances and/or clear aligners) is combined with restorative treatment to maximize the esthetic result for patients with small (ie “peg”) laterals. Restorative treatment will be employed to enhance the esthetics of the maxillary dentition only and would not be to treat any active disease process (caries, etc). For the purposes of this study, peg laterals are defined as maxillary laterals determined by the practitioner to have a severely decreased relative size and unesthetic morphology therefore compromising the overall esthetic appearance.

Treatment Planning: Orthodontic-Restorative Cases

A patient presents with severely undersized “peg laterals” and has other malocclusion requiring orthodontic correction.

- 1) In general, how confident do you feel in treatment planning and treating this case (excluding placement of any restorations)? 10 is most confident, 1 is least.
10 9 8 7 6 5 4 3 2 1
- 2) When is the final treatment plan, including restorative plans, usually decided between you and the restoring dentist?
 - Before orthodontic treatment begins
 - Early in orthodontic treatment
 - Towards the end of orthodontic treatment
 - After orthodontic treatment
- 3) When would the determination of the final treatment plan, including restorative plans, be PREFERRED to be completed?

- Before orthodontic treatment
 - Early in orthodontic treatment
 - Towards the end of orthodontic treatment
 - After orthodontic treatment
 - Doesn't matter
- 4) In what percentage of these cases is a diagnostic wax-up/simulation completed?
- Less than 5%
 - 5-25%
 - 26-50%
 - 51%+
- 5) Who is primarily responsible for deciding IF restorations are the best choice to enhance the esthetic outcome?
- The restoring dentist
 - The orthodontist
 - The patient/patient's parents

Restoring Peg Laterals in Adolescents

The following questions would apply to a case where an ADOLESCENT patient presents for treatment with correctable (non-surgical) malocclusion and peg laterals. The PRIMARY or provisional restoration would be the restoration treatment planned in coordination with orthodontic treatment at this age, with the DEFINITIVE restoration defined as the treatment modality desired in adulthood. This patient would be assumed to NOT be fully completed with growth or passive tooth eruption. All questions would apply to the MAJORITY/TYPICAL cases.

- 6) Of your treatment priorities for the anterior dentition during adolescence for this patient, which is the most important treatment goal?
- Achieving ideal overbite and overjet
 - Restoring the ideal ratio of tooth size relative to central incisors and canines
 - Eliminating any existing spaces
 - Eliminating a relative (Bolton) tooth-size discrepancy
 - Finishing patient with class I canine relationship
- 7) Which is your PREFERRED RESTORATIVE TREATMENT for the laterals during this phase of treatment (adolescence)?
- Composite resin bonding
 - Porcelain veneers
 - Full coverage crowns (PFM, all porcelain, etc)
 - Do not restore laterals, close all spaces
 - Do not restore laterals, leave anterior spacing
- 8) When would you PREFER this initial restoration be placed?

- Early or before orthodontic treatment, assuming space is available
- During final stages of orthodontic treatment to allow for tooth movement following placement
- Immediately after orthodontic treatment
- Some time after completion of orthodontic treatment
- Doesn't matter
- I prefer not to restore peg laterals

For the definitive or final restoration, envisioned to be the most esthetic long-term solution:

- 9) Which treatment modality do you PREFER to utilize, assuming all are viable options?
- Composite resin bonding/veneers
 - Porcelain veneers
 - Full coverage crowns (PFM, all porcelain, etc)
 - I prefer not to restore peg laterals
- 10) When is the approximate PREFERRED time to place the DEFINITIVE restoration?
- Immediately after orthodontic treatment
 - Before age 15
 - Age 15-18
 - Age 18-21
 - Age 21+
 - When growth is determined to be complete
 - When the provisional restoration fails

Tooth Positioning and Finishing

- 11) During the finishing stage, HOW OFTEN do you ask for input from the restoring dentist regarding tooth positioning?
- Less than 5% of the time
 - 5-25%
 - 26-50%
 - 51-75%
 - Over 75% of the time

Please select the factor that in general you feel is MOST IMPORTANT in deciding the final tooth positioning in each of three planes of space

- 12) Mesiodistally?
- Centered mesiodistally
 - The shape of the existing tooth
 - The desired emergence profile
 - The material desired for the restoration
 - Does not matter

- 13) Faciolingually?

- The material desired for the restoration
- Ideal overbite and overjet
- With the angulation of the tooth as close to ideal as possible
- Does not matter

14) Incisogingivally?

- The incisal edges of the adjacent teeth
- The gingival margins of the adjacent teeth
- The level of the CEJ of the adjacent teeth
- The material desired for the final restoration
- Does not matter

Overall Impressions

15) Overall, how satisfied are you with the final result in the completion cases involving restorations of laterals and orthodontic treatment? (10 is the most satisfied and 1 is the least) Please select one.

10 9 8 7 6 5 4 3 2 1

16) What area represents your biggest source of dissatisfaction with the final result?

- The shade/morphology of the restoration
- The size of the restoration
- The final tooth positioning
- The gingival contours
- The efficiency in the time it takes to complete the treatment
- The efficiency of communication between practitioners

17) In which area do you think ORTHODONTISTS could improve most in the coordination and completion of these cases?

- The ability to position the tooth/teeth properly
- The establishment of a cohesive interdisciplinary treatment plan
- The communication with the restoring dentist
- The communication with the patient/patient's family
- The ability to understand the technical challenges of the restoring dentist

18) In which area do you think the RESTORATIVE DENTISTS could most improve in the coordination and completion of these cases?

- The quality of the restoration
- The establishment of a cohesive interdisciplinary treatment plan
- The communication with the myself and other specialists
- The communication with the patient/patient's family
- The ability to understand the technical challenges of the orthodontic treatment

Other Information

19) How long have you been practicing orthodontics?

- Less than 5 years
- 6-15 years
- 16-25 years
- 26+ years

20) Which methods do you primarily use to keep up to date with current literature/practices in correction of esthetics? (Select all that apply)

- Continuing education courses
- Study groups/clubs
- Orthodontic Journals
- General Dental Journals
- My orthodontic residency and dental school training

Comments

APPENDIX B

Survey Sent to General Dentists

Restoring Peg Laterals: An Interdisciplinary Approach

General Dentist Questionnaire



Thank you for your participation in this investigation of the diagnosis, treatment planning, and interdisciplinary communication between orthodontists and general dentists. The study focuses on the coordination of cases where orthodontic treatment (traditional fixed appliances and/or clear aligners) is combined with restorative treatment to maximize the esthetic result for patients with small (ie “peg”) laterals. Restorative treatment will be employed to enhance the esthetics of the maxillary dentition only and would not be to treat any active disease process (caries, etc). For the purposes of this study, peg laterals are defined as maxillary laterals determined by the practitioner to have a severely decreased relative size and unesthetic morphology therefore compromising the overall esthetic appearance.

Treatment Planning: Orthodontic-Restorative Cases

A patient presents with severely undersized “peg laterals” and has other malocclusion requiring orthodontic correction.

- 1) In general, how confident do you feel in treatment planning and treating this case. 10 is most confident, 1 is least.

10 9 8 7 6 5 4 3 2 1

- 2) When is the final treatment plan, including restorative plans, usually decided between you and the orthodontist?
- Before orthodontic treatment begins
 - Early in orthodontic treatment
 - Towards the end of orthodontic treatment
 - After orthodontic treatment

- 3) When would the determination of the final treatment plan, including restorative plans, be PREFERRED to be completed?
- Before orthodontic treatment
 - Early in orthodontic treatment
 - Towards the end of orthodontic treatment
 - After orthodontic treatment
 - Doesn't matter
- 4) In what percentage of these cases is a diagnostic wax-up/simulation completed?
- Less than 5%
 - 5-25%
 - 26-50%
 - 51%+
- 5) Who is primarily responsible for deciding IF restorations are the best choice to enhance the esthetic outcome?
- The restoring dentist
 - The orthodontist
 - The patient/patient's parents

Restoring Peg Laterals in Adolescents

The following questions would apply to a case where an ADOLESCENT patient presents for treatment with correctable (non-surgical) malocclusion and peg laterals. The PRIMARY or provisional restoration would be the restoration treatment planned in coordination with orthodontic treatment at this age, with the DEFINITIVE restoration defined as the treatment modality desired in adulthood. This patient would be assumed to NOT be fully completed with growth or passive tooth eruption. All questions would apply to the MAJORITY/TYPICAL cases.

- 6) Of your treatment priorities for the anterior dentition during adolescence for this patient, which is the most important treatment goal?
- Achieving ideal overbite and overjet
 - Restoring the ideal ratio of tooth size relative to central incisors and canines
 - Eliminating any existing spaces
 - Eliminating a relative (Bolton) tooth-size discrepancy
 - Finishing patient with class I canine relationship
- 7) Which is your PREFERRED RESTORATIVE TREATMENT for the laterals during this phase of treatment (adolescence)?
- Composite resin bonding
 - Porcelain veneers
 - Full coverage crowns (PFM, all porcelain, etc)

- Do not restore laterals, close all spaces
- Do not restore laterals, leave anterior spacing

8) When would you PREFER this initial restoration be placed?

- Early or before orthodontic treatment, assuming space is available
- During final stages of orthodontic treatment to allow for tooth movement following placement
- Immediately after orthodontic treatment
- Some time after completion of orthodontic treatment
- Doesn't matter
- I prefer not to restore peg laterals

For the definitive or final restoration, envisioned to be the most esthetic long-term solution:

9) Which treatment modality do you PREFER to utilize, assuming all are viable options?

- Composite resin bonding/veneers
- Porcelain veneers
- Full coverage crowns (PFM, all porcelain, etc)
- I prefer not to restore peg laterals

10) When is the approximate PREFERRED time to place the DEFINITIVE restoration?

- Immediately after orthodontic treatment
- Before age 15
- Age 15-18
- Age 18-21
- Age 21+
- When growth is determined to be complete
- When the provisional restoration fails

Tooth Positioning and Finishing

11) During the finishing stage, HOW OFTEN does the orthodontist ask for input regarding final tooth positioning?

- Less than 5% of the time
- 5-25%
- 26-50%
- 51-75%
- Over 75% of the time

Please select the factor that in general you feel is MOST IMPORTANT in deciding the final tooth positioning in each of three planes of space

12) Mesiodistally?

- Centered mesiodistally
- The shape of the existing tooth
- The desired emergence profile
- The material desired for the restoration
- Does not matter

13) Faciolingually?

- The material desired for the restoration
- Ideal overbite and overjet
- With the angulation of the tooth as close to ideal as possible
- Does not matter

14) Incisogingivally?

- The incisal edges of the adjacent teeth
- The gingival margins of the adjacent teeth
- The level of the CEJ of the adjacent teeth
- The material desired for the final restoration
- Does not matter

Overall Impressions

15) Overall, how satisfied are you with the final result in the completion cases involving restorations of laterals and orthodontic treatment? (10 is the most satisfied and 1 is the least) Please circle one.

10 9 8 7 6 5 4 3 2 1

16) What area represents your biggest source of dissatisfaction with the final result?

- The shade/morphology of the restoration
- The size of the restoration
- The final tooth positioning
- The gingival contours
- The efficiency in the time it takes to complete the treatment
- The efficiency of communication between practitioners

17) In which area do you think ORTHODONTISTS could improve most in the coordination and completion of these cases?

- The ability to position the tooth/teeth properly
- The establishment of a cohesive interdisciplinary treatment plan
- The communication with the restoring dentist
- The communication with the patient/patient's family
- The ability to understand the technical challenges of the restoring dentist

18) In which area do you think the RESTORATIVE DENTISTS could most improve in the coordination and completion of these cases?

- The quality of the restoration
- The establishment of a cohesive interdisciplinary treatment plan
- The communication with the myself and other specialists
- The communication with the patient/patient's family
- The ability to understand the technical challenges of the orthodontic treatment

Other Information

19) How long have you been practicing dentistry?

- Less than 5 years
- 6-15 years
- 16-25 years
- 26+ years

20) Which methods do you primarily use to keep up to date with current literature/practices in correction of esthetics? (Select all that apply)

- Continuing education courses
- Study groups/clubs
- Orthodontic Journals
- General Dental Journals
- My dental school training

Comments

VITA

Matthew Sandretti was born February 13, 1987 to Ronald and Linda Sandretti of Roseville, California. Following his graduation from Granite Bay High School in 2005, Matthew received a Bachelor of Science Degree in Chemistry at the University of California, Los Angeles June 2009. He decided to embrace the challenging, multifaceted and outstanding career of dentistry, graduating from the University of California, Los Angeles School of Dentistry in 2013. Deciding to specialize in the field of orthodontics, he completed his graduate orthodontics residency at Virginia Commonwealth University School of Dentistry. He received a Certificate of Orthodontics and Master of Science in Dentistry in 2015. He plans to enter private practice in Sacramento, California.