Original Article

Evaluation and comparison of retention of different aesthetic posts

C. Arora, M. Aras, V. Chitre
Department of Prosthodontics, Goa Dental College and Hospital, Bambolim, Goa - 403 202, India

For correspondence
Chetan Arora, 2A Rattan Chand Road, Mall Road, Amritsar, India. E-mail: drchetanarora@rediffmail.com

The primary function of a corono-radicular post is to provide retention for a core and this is essential for the longevity of restorations placed on endodontically treated teeth. Individually, cast metal post and core have been a commonly used technique in the past to improve the retention of crowns and bridges on nonvital teeth. With the increasing esthetic options available for restoring anterior teeth, tooth-colored post and core restorations have now become an option for restoring nonvital teeth. However, in the survey of literature very few articles were found addressing the retention of prefabricated esthetic posts.

This study was undertaken with the aim to determine and compare: 1. The retention of different Aesthetic posts within the root canal. 2. The effect of different bonding agents on the retention of posts. 3. The difference (if any) from conventional cast metal posts.

Key words: Bonding agent, cementation, glass fibre, Instron, lentulospiral, post and core, retention, tensile force

Endodontic therapy has allowed for retention of more teeth than ever before. Teeth that would otherwise be lost are treated and restored to occlusal function, preserving the stability of the dental arches and improving aesthetic.[1] However, following endodontic therapy, the dentist is faced with the dilemma of deciding how to restore these teeth. Teeth that have been endodontically treated often have little coronal tooth tissue remaining and require a post to retain the core and the restoration.[2]

The primary function of a corono-radicular post is to provide retention for a core, which replaces lost coronal tooth structure and retains the final restoration without compromising the apical seal of the endodontic filling. Therefore, it is important to select a post system that provides maximum retention, yet removes as little as possible of the remaining subgingival tooth structure.[3,4]

Individually cast metal posts and cores are a commonly used technique to improve the retention of dental crowns and bridges on nonvital teeth. Aesthetic requirements for posts and cores had not existed until recently, primarily because opaque porcelain-fused-to-metal restorations were utilized. With the increasing esthetic options available (IPS Empress, Ivoclar), tooth-colored post and core restorations have now become an option for restoring nonvital teeth.[3,4]

Since the introduction of Aesthetic posts has been fairly recent, not many studies in literature address the retention of these posts.

This study has been selected to:

1. Evaluate and compare the retention of different Aesthetic posts within the root canal.
2. Determine if the use of different bonding agents has any effect on the retention.
3. Determine the difference (if any) in retention of aesthetic posts from the conventional cast metal posts.

MATERIALS AND METHODS

This *in vitro* study used sound caries-free, single-rooted human maxillary central incisors of comparable root length and with adequate bulk of dentin to allow standard post placement. Each tooth was sectioned with a diamond point in a high-speed handpiece approximately 1 mm coronal to the cementoenamel junction (CEJ) and the root section was flattened to obtain a surface perpendicular to the longitudinal tooth axis. Notches were prepared in the roots to prevent dislodgment from the embedding material during testing [Figure 1].

Thereafter the teeth were randomly divided into two major groups depending on the type of bonding agent used for postcementation. Two different bonding agents (Prime and Bond, NT and Excite) were used for the cementation of posts along with dual cure resin cement

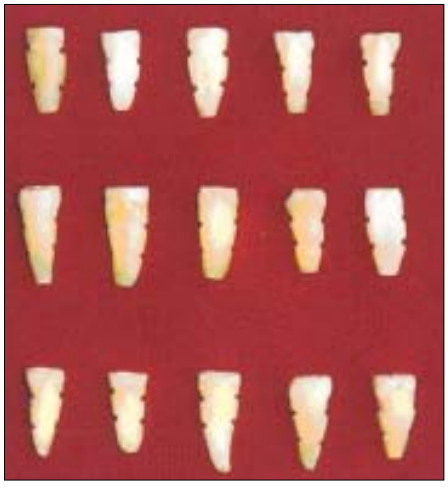

Figure 1: Teeth cut at CEJ and with retentive grooves

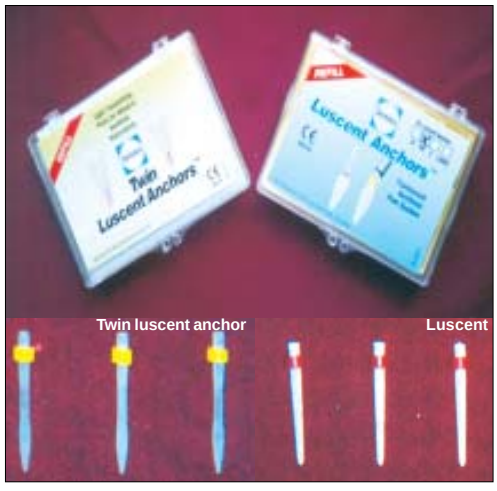

Figure 3: Luscent anchor and twin luscent anchor

Figure 2: Prime and bond NT, excite, variolink II, total etch

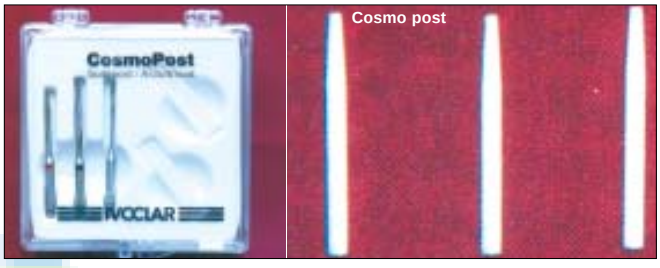

Figure 4: Cosmo post (assortment pack)

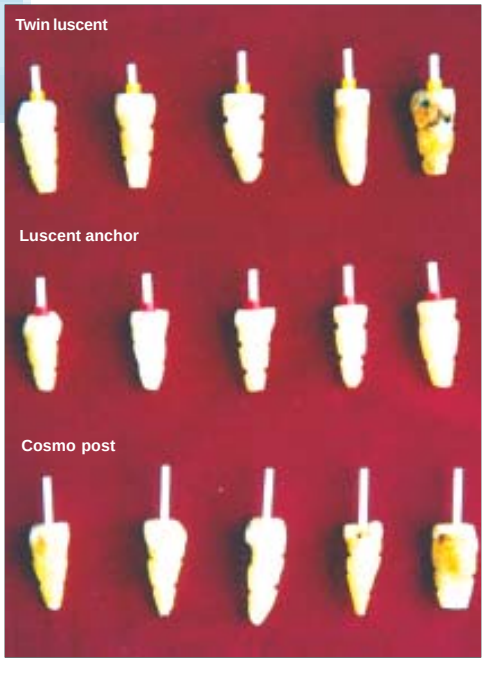

Figure 5: Teeth after post cementation

Variolink II (Ivoclar Vivadent) [Figure 2].

Each group was subdivided into three groups of 15 each, first group of 15 as prepared for CosmoPost (Ivoclar Vivadent), second group for Luscent Anchor Posts (Dentatus) and third for Twin Luscent Anchor (Dentatus) posts. Thus a total of six groups were present.

One group of 10 teeth as prepared for conventionally cast alloy posts cemented with zinc phosphate cement was kept as a control [Figures 3 and 4].

The root canal was prepared using the standardized burs for each post, to a uniform length of 10 mm for every specimen. The post space was rinsed and thoroughly dried (using air and paper points). Total etch (37% phosphoric acid) was applied into the postspace, for 15 s followed by a 10 s rinse. The preparation of postspace was then dried with a gentle air blast and paper points.

Dental adhesive was applied to post preparation using an unused brush tip. Contact with the tooth structure was kept for atleast 20 s. Postpreparation was then air dried with an air syringe. A single coat of adhesive was applied to the post with the same brush followed by gentle air-drying. Base and catalyst of dual cure composite resin (Variolink II) were mixed in the ratio of 1:1 and applied both on the postsurface and within the root canal.

Post was inserted into the canal with pumping action in order to prevent air from being trapped. Any excess

Figure 6: Dental surveyor used to mount teeth in plastic cylinder

Figure 8: Close up of samples being tested on Instron 5586

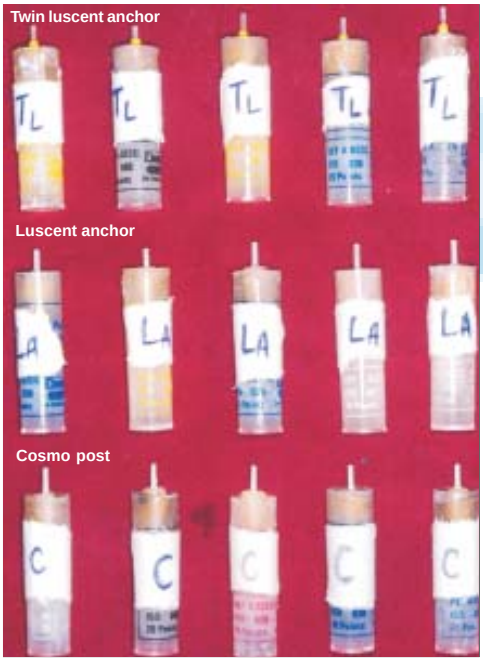

Figure 7: Posts after being mounted in plastic cylinders

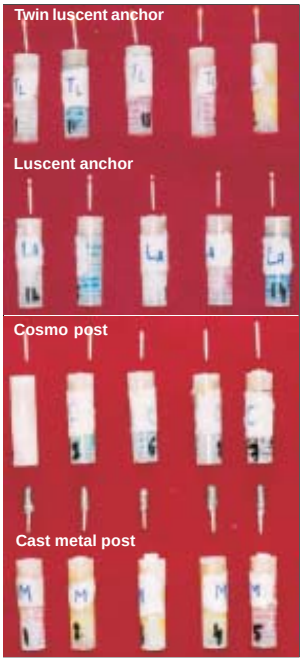

Figure 9: Posts after being dislodged from plastic cylinders

cement in the coronal area was removed with a brush. Continued slight pressure is placed on the post while the light-curing probe is placed directly over the post and the entire complex is light-cured multidirectionally for 2 min [Figure 5].

After the cement had set, the roots were embedded in acrylic resin boxes so that the vertical load to be applied on the posts would be as parallel as possible to the direction of the long-axis of the teeth. A dental surveyor was used to lower the teeth into the cylinder until the CEJ was even with the top of the cylinder. Teeth were stored in physiologic saline solution until tensile testing [Figures 6 and 7].

Bond strength testing

The force required to dislodge the restorations was determined with a universal testing machine. The free-end of the posts were gripped in the three-jawed chuck and the resin block was set in a custom-made holder. The chuck was connected to the testing machine through

a universal joint to direct the load along the longitudinal axis of the post and tooth [Figure 8]. The machine was run at a crosshead speed of 0.5 mm / min. Increasingly heavy tensile loads were applied until dislodgement of the post occurred.

The force necessary to loosen the post was automatically recorded (in Newtons) at the point when the force was of the highest level during the test before fracture was detected and the testing interrupted [Figure 9].

RESULTS

When the mean strength was compared between the three aesthetic posts and the cast post, ANOVA revealed there was a highly significant difference among all posts. Cast metal posts were found to have the highest values of retention among all the posts and this was significantly different from the other three posts.

Twin luscent posts were found to have the highest strength value among aesthetic posts, while Cosmoposts were found to have the least retentive strength value. Luscent anchor posts lied in between the twin luscent and Cosmoposts in their retentive value. The difference among these was also found to be significantly different.

The two-way analysis of variance indicates there is significant interaction between group and aesthetic posts. It shows that there are differences in strength for group and aesthetic posts. Twin Luscent is best in both the groups, followed by Luscent and Cosmopost.

The values recorded for each post were tabulated and compared. The results were statistically analyzed using ANOVA and *t*-test with Statistical Package for Social Scientists. [Tables 1-5]

1. When the mean strength was compared between the three aesthetic posts and the cast post, Cast metal posts were found to have the highest values of retention among all the posts and this was significantly different from the other 3 posts.
2. Twin luscent posts were found to have the highest strength value among aesthetic posts, while Cosmoposts were found to have the least retentive strength value. Luscent anchor posts lied in between the Twin luscent and Cosmoposts in their retentive value. The difference among these was also found to be significantly different.
3. When the retentive values attained from the use of different bonding agents (Excite and prime and bond) were analyzed, the results were quite variable. However, the difference was not statistically significant.

Table 1: Tensile force (in Newton) required for post dislodgement when cemented with Excite and compared to Cast metal posts cemented with zinc phosphate

S. No.	Cosmo post	Luscent	Twin luscent	Cast metal
1.	68.6	205.8	235.2	242.06
2.	88.2	117.6	382.2	178.36
3	39.2	117.6	235.2	544.88
4	137.2	166.6	343	609.56
5	156.8	186.2	204.82	590.94
6	74.48	254.8	159.74	310.26
7	117.6	215.6	191.1	243.04
8	111.72	225.4	313.6	212.68
9	92.12	215.6	264.6	189.88
10	58.8	156.8	284.2	312.27
11	109.76	164.64	264.6	-
12	152.88	225.4	333.2	-
13	127.4	212.66	323.4	-
14	137.2	200.9	244.02	-
15	125.44	137.2	303.8	-

Group	Aesthetic post	Mean	SD	*n*
Excite bond	Cosmo post	106.4800	35.17151	15
	Luscent	186.8533	41.68608	15
	Twin luscent	272.1787	61.94684	15

Table 2: Tensile Force (in Newton) required for postdislodgement, when cemented with Prime and Bond NT.

S. No.	Cosmopost	Luscent	Twin luscent
1	89.18	212.66	354.76
2	133.28	128.38	116.62
3	129.36	114.66	193.06
4	124.46	124.46	123.48
5	198.94	181.3	157.78
6	226.38	73.5	135.24
7	75.46	146.02	218.54
8	50.96	98	229.32
9	75.46	183.26	196
10	68.6	153.86	166.6
11	88.2	142.1	175.42
12	39.2	195.02	312.62
13	137.2	134.26	232.26
14	156.8	156.8	285.18
15	124.46	135.24	297.92

Group	Aesthetic post	Mean	SD	*n*
Prime and bond	Cosmo	114.5707	52.70397	15
	Luscent	145.3013	37.06915	15
	Twin Luscent	212.9867	72.58493	15

DISCUSSION

Clinically, post and core restorations are subjected to repeated tension, com-pression and torquing forces. Posts are probably dislodged when the cement fatigues and the bond to dentin is eventually lost. Unfortunately, there is no practical method to simulate the oral conditions. In our study, tensile force was applied to the posts to determine their retention. In view of Charlton's recommendations[5] effort was made to ensure that the tensile tests are carried out in the long axis of the post. This study, although it does not directly reflect intraoral dislodging forces, does indicate retentive properties of these posts.[6]

Although every effort has been made to select specimens of comparable physical characteristics and to standardize the procedures accurately, a wide range

of standard deviations cannot be avoided. The variability of physical properties of human teeth may be one reason for the data spreads. Dentin is a heterogeneous tissue. Its structure, degree of calcification and degree of cellularity vary from tooth to tooth. Even though similar sized single-rooted teeth (maxillary central incisors) were used, there is considerable variation in modulus of elasticity of dentin and root canal morphology.

Three different aesthetic post systems were analyzed. Cosmopost (Zirconia oxide post, Ivoclar), Luscent anchor and twin luscent anchor posts (glass fibre post, Dentatus). The posts were cemented into root canals of extracted human teeth (maxillary central incisors) using dual cure resin cement (Variolink II, Ivoclar). Two different bonding agents were used (Excite and Prime and Bond NT) to determine if the use of different bonding agents had any affect on the retentive strength of posts. The aesthetic posts were not provided with cores because of the possibility that stresses caused by the polymerizing shrinking of the core could pull the post in a coronal direction and weaken the bonding of the post to the luting agent and/or the root canal.[3]

About 10 cast metal posts (of approximately same diameter size and length as that of aesthetic posts) were cemented into extracted teeth using zinc phosphate cement and kept as a control, so as to facilitate the comparison of the values obtained for the new post systems evaluated in this study with a well-known and frequently used technique.[3]

All specimens used in our study were prepared to a

Table 3: Student t-test
Group statistics

Group	*n*	Mean	SD	SEM	
Strength	Excite bond	45	188.5040	82.75815	12.33686
	Prime and bond	45	157.6196	68.74567	10.24800

Independent sample test

Strength	Levene's test for equality of variance		*t*-test for equality of means						
						Mean difference	SE difference	95% CI difference	
	F	Sig.	*t*	*df*	Sig. (2-tailed)			Lower	Upper
Equal variance assumed	2.741	0.101	1.926	88	0.057	30.8844	16.03807	-0.98784	2.75673
Equal variance not assumed			1.926	85.136	0.057	30.8844	16.03807	1.00279	2.77168

Student '*t* test was performed to determine the difference (if any) in the retention of Aesthetic posts due to the use of different bonding agents.
H0: There is no significant difference in arithmetic means b/w two groups. **H1:** There is a significant difference in arithmetic means b/w two groups
If calculated *t* > Table value (1.96), reject H0, accept H1. If calculated *t* < Table value, accept H0.

Table 4: One way analysis

		Strength			Descriptive 95% confidence interval for mean			
	n	Mean	SD	SE	Lower bound	Upper bound	Minimum	Maximum
Cosmo	30	110.5253	44.21630	8.07275	94.0147	127.0360	39.20	226.38
Luscent	30	166.0773	44.14521	8.05978	149.5932	182.5614	73.50	254.80
Twin luscent	30	242.5827	72.81565	13.29426	215.3929	269.7725	116.62	382.20
Control	10	343.3930	170.94995	54.05912	221.1028	465.6832	178.36	609.56
Total	100	190.0949	103.2.2505	10.32251	169.6128	210.5770	39.20	609.56

ANOVA strength

	Sum of squares	*df*	Mean square	*F*	Sig.
Between groups	524896.8	3	174965.609	31.693	0.000
Within groups	529988.9	96	5520.718		
Total	1054886	99			

***Post hoc* test multiple comparison**
Bon Ferroni

Aesthetic post (I) (J)	Mean difference (I-J)	SE	Sig.	95% confidence interval	
				Lower bound	Upper bound
Cosmo luscent	-55.5520	19.18457	0.028	-107.2358	-3.8682
Twin luscent	-132.0573	19.18457	0.000	-183.7411	-80.3735
Cast metal	-232.8677	27.13108	0.000	-305.9596	-159.7758
Luscent cosmo	55.5520	19.18457	0.028	3.8682	107.2358
Twin luscent	-76.5053	9.18457	0.001	-128.1891	-24.8215
Cast metal	-177.3157	27.13108	0.000	-250.4076	-104.2238
Twin luscent	132.0573	19.18457	0.000	80.3735	183.7411
Cosmo luscent	76.5053	19.18457	0.001	24.8215	128.1891
Cast metal	-100.8103	27.13108	0.002	-173.9022	-27.7184
Cast metal cosmo	232.8677	27.13108	0.000	159.7758	305.9596
Luscent	177.3157	27.13108	0.000	104.2238	250.4076
Twin luscent	100.8103	27.13108	0.002	27.7184	173.9022

uniform root canal depth of 10 mm, so that variability of postlength does not have any influence on the retention of tested specimens.

The posts used for our study had near equal diameter. Cosmoposts used were of 1.7 mm diameter and Luscent anchor and twin luscent anchors had a diameter of 1.6 mm. This difference of 0.1 mm had no effect on the retention of posts, as the results showed that larger diameter Cosmopost had the lowest value of retentive strength within the root canal and this difference from luscent and twin luscent anchor posts was statistically significant.

Cosmopost is of cylindrico-tapered design; Luscent anchor posts are tapered posts while twin luscent anchor posts are hourglass shaped. Dentatus claims that the slim mid-section of twin luscent creates a 'physical choke' and protects against accidental debonding. This superiority of twin luscent anchors over other posts was evident by its high retentive value in the study. However, tapered luscent anchors showed higher retention as compared to cylindrico-tapered Cosmopost, which may have been due to the influence of other factors.

No intracanal medication and lubricant were applied within the root canal at any step in our study. So, their role was nullified. The final shape of root canal was prepared after the obturation process, so that all remnants of zinc oxide sealer that was used with GP points is removed. This produced fresh open dentinal tubules into which resin cement could adequately flow. Also, the inhibiting effect of eugenol on the polymerization of composite resin was nullified.[7,8]

Root canal etching was done using 37% phosphoric acid (total etch) for 10 sec, before the application of bonding agent. Etchant was flushed by a stream of water and the canal was dried using paper points. Etching the postspace not only removes the smear layer, but also exposes and widens the tubular apertures and produces micro-porosities on the channel walls, which allows the cement to enter the dentinal tubules to provide micro-mechanical retention.[8,9]

A lentulospiral was used to coat the root canal with adhesive resin. The posts were also coated with the cement before placement into the canal and were inserted with pumping action in order to prevent air from being trapped.

All posts, to a greater or lesser extent, gain their final retention by cementation into the prepared root canal. The ability of cement to retain a post influences the prognosis of the restoration. Cement that yields high retentive values will allow the use of shorter posts, thus maintaining the apical seal and preserving sound root structure.[10] Adhesive resin cements are being used for cementation of the post because of their stronger bond to tooth structure. In our study, a dual cure resin cement Variolink II (Ivoclar) was used for cementation of all the different aesthetic posts, so that variability in the resin cements does not play role in the retention of posts. Cast metal posts kept as a control were cemented using zinc phosphate cement.

One possible reason for the lower values obtained for the CosmoPost specimens is that, although the surfaces of the posts had already been sandblasted with Al_2O_3 when delivered from the manufacturer, the bonding of

Table 5: Two way analysis of variance for two groups excluding control

Descriptive statistics		Dependent Variable: Strength		
Group	**Aesthetic post**	**Mean**	**SD**	***n***
Excite bond	Cosmo	106.4800	35.17151	15
	Luscent	186.8533	41.68608	15
	Twin luscent	272.1787	61.94684	15
	Total	188.5040	82.75815	45
Prime and bond	Cosmo	114.5707	52.70397	15
	Luscent	145.3013	37.06915	15
	Twin luscent	212.9867	72.58493	15
	Total	157.6196	68.74567	45
Total	Cosmo	110.5253	44.21630	30
	Luscent	166.0773	44.14521	30
	Twin luscent	242.5827	72.81565	30
	Total	173.0618	77.22405	90

Tests of between-subjects effects dependent variable: Strength

Source	Type III sum of squares	*df*	Mean square	*F*	Sig.
Corrected model	303500.2048	5	60700.041	22.436	0.000
Intercept	2695534.103	1	2695534.103	996.342	0.000
GROUP	21461.600	1	21461.600	7.933	0.006
AST_POST	263782.300	2	131891.150	48.751	0.000
GROP´ ST_POST	18.256.303	2	9128.151	3.374	0.039
Error	227256.085	84	2705.430		
Total	3226290.392	90			
Corrected total	530756.289	89			

a.R^2 = 0.572 (Adjusted R^2 = 0.546)

the resin compos-ite to the ceramic posts seemed to be insufficient.[3] Visual inspection of the surfaces of the posts after the CosmoPost specimens were removed from the root canal, showed that there were no remnants of the luting agent on those posts. This implies an adhesive failure at the interface between the cement and the ceramic. Regarding the glass fibre posts, visual inspection of the specimens after they were removed from the root canals showed that more cement was retained than on the CosmoPost but there were areas free of cements, implying that the mode of failure was a combination of adhesive and cohesive failure at the ceramic-cement interface.[3]

In a few previous studies, metal posts cemented with zinc phosphate have been found to be more retentive than those cemented with resin cement.[11,9] Similar results were obtained in the present study. Our findings could possibly be because the cast posts that were used had a parallel design and the individual patterns that were made from each root canal were much more closely adapted than other prefabricated aesthetic posts.

Several other causative factors could be there:

1. The method of aesthetic post cementation using resin cements is highly technique sensitive and operator errors cannot completely be eliminated.
2. Retention is less dependant on compressive strengths or tensile strengths of cement and more closely related to its elastic property. The elastic properties of zinc phosphate and dental composites are similar. In reality, the initial failure of a cemented post is associated with initial deformation of the cement rather than complete failure. In spite of their higher ultimate strengths, composite cements are more apt to deform under lower stresses than the brittle zinc phosphate, which does not deform until it fractures under a higher stress thus determining its high strength.[12]
3. Resin cements are technically more difficult to manipulate. The cement may set prematurely as it has short working time thus preventing complete insertion of the post and reduced strength. However, this is more of a causative problem with self-cure resin cements. We used dual cure resin Variolink II, where ample working time was available.
4. Surface of composite resin is porous. Proper consideration must be given to proper mixing and placement of composite resin as a means of reducing voids and surface roughness, which would in turn increase the retention of post.[12]

It is very difficult to compare objectively the post-retention results in the literature, as different P:L ratios and cementation methods are employed. For objective comparisons of the different studies of post retention, P: L ratio and cementation method used must be recorded. Merely mixing the luting cement to a suitable consistency cannot be regarded as a satisfactory experimental method.

SUMMARY AND CONCLUSION

We know that the primary function of a corono-radicular post is to provide retention for a core, which replaces lost coronal tooth structure and retains the final restoration without compromising the apical seal of the endodontic filling. Therefore, it is important to select a post system that provides maximum retention, yet removes as little as possible of the remaining subgingival tooth structure.

Individually cast metal posts and cores are a commonly used technique to improve the retention of dental crowns and bridges on nonvital teeth. With the increasing esthetic options available for restoring anterior teeth, tooth-colored post and core restorations have now become an option for restoring nonvital teeth. e.g., carbon fibre posts in an epoxy fibre matrix, quartz fiber posts and all-ceramic posts. These posts are adhesively luted into the root canal using resin composites and the core is subsequently built up with a resin composite.

Since the introduction of Aesthetic posts has been fairly recent, not many studies in literature address the retention of these posts.

This study was selected to evaluate and compare:

1. Retention of different Aesthetic posts within the root canal.
2. Determine if the use of different bonding agents has any affect on the retention.
3. Determine the difference (if any) in retention of Aesthetic posts from the conventional cast metal posts.

Three different aesthetic post systems were analyzed. Cosmopost (Zirconia oxide post, Ivoclar), Luscent anchor and Twin luscent anchor posts (Glass fibre post, Dentatus). The posts were cemented into root canals of extracted human teeth (maxillary central incisors) using dual cure resin cement (Variolink II, Ivoclar). Two different bonding agents were used (Prime & bond NT) to determine if the use of different bonding agents had any affect on the retentive strength of posts.

About 10 cast metal posts, of approximately same diameter size and length as that of aesthetic posts, were cemented into extracted teeth using zinc phosphate cement and kept as a control.

The roots were embedded in acrylic resin boxes so that the vertical load to be applied on the apical surface of the posts would be as parallel as possible to the direction of the long-axis of the teeth.

The free-end of the posts were gripped in the three-jawed chuck and connected to the testing machine. The machine was run at a crosshead speed of 0.5 mm / minute. Increasingly heavy tensile loads were

applied until dislodgement of the post occurred and the force necessary to loosen the post was automatically recorded (in Newton).

BIBLIOGRAPHY

1. Rosenstiel SF, Land MF, Fujimoto J. Contemporary Fixed Prosthodontics, 3rd ed. Mosby: 2001.
2. Bateman G, Ricketts DN, Saunders WP. Fiber based post systems: A Review. Br Dent J 2003;195:43-8.
3. Hedlund SO, Johansson NG, Sjogren G. Retention of prefabricated and individually cast root canal posts in vitro. Br Dent J 2003;195:155-8.
4. Qualtrough AJ, Chandler NP, Purton DG. A comparison of retention of tooth colored posts. Quintessence Int 2003;34:199-201.
5. Charlton G. Design of post and cores for porcelain jacket crowns. University of Bristol: MDS Thesis; 1970.
6. Stegaroiu R, Yamada H, Kusakari H, Miyakawa O. Retention and failure mode after cyclic loading in 2 post and core systems. J Prosthet Dent 1996;75:506-11.
7. Goldman M, DeVitre R, Pier M. Effect of the dentin smeared layer on tensile strength of cemented posts. J Prosthet Dent 1984;52:485-8.
8. Chapman KW, Worley JL, von Fraunhofer JA. Retention of prefabricated posts by cements and resins. J Prosthet Dent 1985,54:649-52.
9. Ben-Amar A, Gontar G, Fitzig S, Urstein M, Liberman R. Retention of prefabricated posts with dental adhesive and composites. J Prosthet Dent 1986;56:681-4.
10. Stassler HE, Marchiori RH. Using luscent anchor to esthetically restore and reinforce flared root canals. Contemp Esthet Restorat Pract 2001:86-8.
11. Millstein PL, Nathanson D. Effect of eugenol and noneugenol cements on cured composite resin. J Prosthet Dent 1983;50:211-5.
12. Foxton RM, Nakajima M, Tagami J, Miura H. Bonding of photo and dual-cure adhesives to root canal dentin. Oper Dent 2003;28:543-51.

Source of Support: Nil, **Conflict of Interest:** None declared.