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Comparative Evaluation Of Marginal Adaptability Of Custom Cast Post Using Different Pattern Material - An In Vitro Study

Research Article

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Abstract

Introduction: Marginal adaptability is of key concern while determining the longevity of a post and core in endodontically treated teeth. The present study compares the two commonly used materials used for fabrication of patterns for custom cast post
Aim: To evaluate the marginal adaptability of custom cast post using inlay wax pattern and resin pattern.
Materials and Methods: 10 single rooted teeth were selected for each group for the study.Teeth were decoronated .The teeth were mounted on wax occlusal rim and were scanned with CBCT in all the planes. Root Canal treatment was done and the canal were prepared for post space.10 Patterns were fabricated with inlay wax and resin pattern respectively and custom made cast post was done for the study once again CBCT was taken to find out the marginal adaptability of cast post to the tooth surface.
Conclusion: The marginal adaptation was analysed in the coronal ,middle and the apical third of the prepared post space of teeth. It was found that the marginal adaptation of cast post was more in the coronal and middle third of post space with cast post made by resin pattern compared to the one made with inlay wax pattern.

Keywords: Custom Cast Post; Pattern Resin; Inlay Wax; Marginal Adaptability.

Introduction

Custom cast post compared to the other prefabricated post improve the strength of the root canal treated tooth.The cast post and core is custom fitted to the prepared root canal space and designed to resist torsional forces.It has been reported that if a canal requires extensive preparation , a well adapted cast post and core will be more retentive than a prefabricated post that does not match the canal configuration.Post and cores can be fabricated either intraorally on the tooth or indirectly on the die.The final instrument used to prepare the post space corresponds to the size and shape of the final post. Hence an index of the same is made with vinyl polysiloxane impression material and used to fabricate a wax pattern [1]. Using an indirect technique, posts prepared with acrylic resin may become locked into the cast undercuts. Use of wax for the post fabrication reduces this problem however insertion and removal of wax may cause distortion or breakage of the pattern. The material used in the technique is inlay wax. The advantages of this technique include the precise fit of the post into the post space along with less chairside time, as the wax pattern is not fabricated inside the patient's mouth.If the selected post closely fits or conforms to the canal shape and size , it may be a more conservative option because less dentin removal is required, thus enhancing fracture resistance of the tooth, as well as retention of the post [2].

The accuracy of wax patterns is of major importance for obtaining a well fitting casting [3]. However, dental waxes have greater coefficient of thermal expansion, which may be a major contributing factor to the inaccuracy of the final restoration. Dimensional changes in wax pattern occur on the die and during removal of pattern from the die [1]. It is observed that pattern removed

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from die after initial carving and remodeling at the margin after replacement on the die has a more acceptable fit. The fabrication of acceptable wax patterns is an important variable that can affect marginal fit throughout the casting procedure. Proper manipulation with a thorough understanding of its properties and nature will help in fabrication of acceptable wax patterns. Generally the basic constituents of dental waxes come from three main sources, Mineral- eg. Paraffin wax, microcrystalline wax or ceresin, Insect- eg. Beeswax, Vegetable - Carnauba wax, Candelila wax, Resins and gums [4].

Paraffin waxes are mixtures of chiefly straight-chain saturated hydrocarbons which crystallize in plates or needles. Litene and barnsdahl have better micro-hardness than other hydrocarbon waxes. Montan waxes are obtained from various lignites, but unlike the other mineral waxes they are mixtures of long-chain esters accompanied by high molecular weight alcohols, acids and resins. As a result, montan wax is hard and brittle`. Carnauba and ouricury waxes are composed of a mixture of straight-chain esters, alcohols, acids and hydrocarbons [5]. They are characterized by high hardness, brittleness, and high melting points. Candelilla wax, although a plant wax, contains 40-60 percent paraffin hydrocarbon accompanied by esters, alcohols and acids. Japan wax is primarily a fat containing glycerides of palmitic, stearic and other higher molecular weight acids10. Beeswax, which is a complex mixture of esters, consists mainly of myricylpalmitate plus saturated and unsaturated hydrocarbons and organic acids. It is supplied in a number of grades, the bleached type being of higher purity.[6] The selection of waxes, therefore, include a wide range of sources, composition and properties. Properties of these waxes will control to a great extent the combination used for various applications in dentistry.

The paraffin wax exhibits a setting range between 51.50 C- 53.00C. This is the lowest setting range amongst the mineral waxes .Barnsdahl had the highest setting range 85.00 C - 87.00 C. Ceresin is an exception , with the setting range between 52.00 C - 73.00 C. Both yellow and bleached beeswax has a setting range between 61.00 C -63.00 C51.In the direct method, a resin pattern is produced by placing a preformed plastic "burnout" post into the post space and a resin material is used to build up the tooth to the proper dimensions [7].

When this is completed, the pattern post and core is removed from the tooth structure and sent to the dental lab. The technician will make a duplicate of the post and core using metal alloys. Acrylic dental resins are a group of resins made by polymerizing esters of acrylic or methyl methacrylate acids. Methyl methacrylate resin is a thermoplastic acrylic resin that is used by mixing liquid methyl methacrylate monomer with polymer powder which can then be packed into a mold [8]. Acrylic pattern resins are autopolymerizable polymers used for the fabrication of dental patterns, Resistance to Flow is important for pattern fabrication. The resistance to flow of acrylic pattern resins can be controlled by combining the powder and liquid components until the desired viscosity is obtained. The resistance to flow is higher in resins compared to waxes.• Dimensional Stability is controversial with regards to acrylic resins. [9]

Previously our team has a rich experience in working on various research projects across multiple disciplines [10-24]. Now the growing trend in this area motivated us to pursue this project.

Materials And Methods

The study involved the selection of 20 single rooted teeth, 10 samples for each group. The group 1 consisted of a custom cast post made of resin pattern and the group 2 also consisted 10 teeth for inlay wax. The teeth were mounted on wax occlusal rim and were scanned with CBCT in all the planes. The teeth were decoronated for the study so that custom cast posts can be fabricated. The measurements were made with the help of Carestreamkodak 9300 premium 3d CBCT software. The findings were tabulated in the excel sheet and further were imported to IBM SPSS statistical software version 22.0. The statistical analysis was carried out using the values obtained. The statistical test preferred was Anova tests and t tests.

Results & Discussion

The marginal fit is important for long term success of cast restorations. Deficiencies can result in damage to the teeth and periodontal structures. Retention of plaque leads to marginal inflammation as well as gingival recession. Insufficient marginal fit can cause secondary caries below the margins of the crown. These defects are frequent reasons for failure of the restorations. Marginal gap is defined as “the perpendicular measurement from the

Table 1. Values of the gap measured on Carestream Dental CBCT software obtained from custom cast post made from inlay wax pattern.

Serial no	Coronal	Middle	Apical
1	0.2mm	0.1mm	0.5mm
2	0.1mm	0.2mm	0.8mm
3	0.1mm	0.1mm	0.4mm
4	0.1mm	0.1mm	1.2mm
5	0.2mm	0.2mm	1.1mm
6	0.1mm	0.2mm	0.8mm
7	0.1mm	0.1mm	0.4mm
8	0.1mm	0.1mm	1.2mm
9	0.1mm	0.2mm	0.8mm
10	0.1mm	0.1mm	0.4mm

Table 2. Values of the gap measured on Carestream Dental CBCT software obtained from custom cast post made from resin pattern.

Serial no	Coronal	Middle	Apical
1	0.1mm	0.03mm	1.7mm
2	0.05mm	0.01mm	1.8mm
3	0.05mm	0.03mm	1.1mm
4	0.03mm	0.01mm	1.3mm
5	0.05mm	0.02mm	1.0mm
6	0.03mm	0.02mm	1.1mm
7	0.1mm	0.03mm	1.3mm
8	0.03mm	0.04mm	1.0mm
9	0.02mm	0.02mm	1.2mm
10	0.05mm	0.01mm	1.1mm

Table 3. ANOVA Test.

		Sum of Squares	df	Mean Square	F	Sig.
CORONAL	Between Groups	0.054	1	0.054	.	.
	Within Groups	0	0	.		
	Total	0.054	1			
MIDDLE	Between Groups	0.002	1	0.002	.	.
	Within Groups	0	0	.		
	Total	0.002	1			
APICAL	Between Groups	0.125	1	0.125	.	.
	Within Groups	0	0	.		
	Total	0.125	1			

3a.GROUPS * CORONAL.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.000[a]	1	0.157		
Continuity Correctionb	0.000	1	1.000		
Likelihood Ratio	2.773	1	0.096		
Fisher's Exact Test				1.000	0.5
Linear-by-Linear Association	1	1	0.317		
N of Valid Cases	2				

3b.GROUPS * MIDDLE.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.000[a]	1	0.157		
Continuity Correctionb	0.000	1	1.000		
Likelihood Ratio	2.773	1	0.096		
Fisher's Exact Test				1.000	0.5
Linear-by-Linear Association	1	1	0.317		
N of Valid Cases	2				

internal surface of the casting to the axial wall of the preparation at the margin" (Holmes, J. et al 1989) [25]. Gap measurements at the margin of restorations are frequently used to quantify fit (Groten, M. et al 2000) [26]. A study by Iglesias et al showed that marginal gaps ranged from 7 to 23 microns and that resin patterns had statistically smaller gaps than inlay wax patterns. Studies have shown that there is a wide range of acceptable values for the upper limit (50 to 150 microns) of a clinically acceptable marginal gap (Groten M. et al, 2000) [26]. At this time, there is no clinical evidence for a minimally acceptable marginal gap, however, acceptable marginal discrepancies of inlays are 20 microns at the occlusal surface and 74 microns at the gingival margin have been reported (Iglesias, A. et al 1996) [27]. Marginal gap differences less than 10 to 15 microns do not require intervention (Groten M. et all, 2000). Finally, the presence of a marginal gap provides space for cement between the internal surface of the casting and the prepared surface of the tooth. The ideal dimension for the cement space has been suggested at 20 to 40 microns for each wall of the restoration (Rosenstiel, S.F. 2001) [28]. According to the American Dental Association, the average space required for

3c. GROUPS * APICAL.

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	2.000[a]	1	0.157		
Continuity Correctionb	0.000	1	1.000		
Likelihood Ratio	2.773	1	0.096		
Fisher's Exact Test				1.000	0.5
Linear-by-Linear Association	1	1	0.317		
N of Valid Cases	2				

Table 4. T test.

	Groups	N	Mean	Std 8P Deviation	Std Error of mean
Coronal	inlay	10	0.038	0.02658	0.00841
	resin	10	0.012	0.00422	0.00133
Middle	inlay	10	0.022	0.01033	0.00327
	resin	10	0.14	0.05164	0.01633
Apical	inlay	10	0.76	0.32728	0.10349
	resin	10	1.26	0.27968	0.08844

Table 5. Independent T test.

		Levines Test		T test or equality						
									95% Confidence interval	95% Confidence interval
		F	Sig.	t	df	Sig 2.Tailed	Mean Diffrence	Std.Error Diffrence	Lower	Upper
Coronal	Equal variances assumed	9.397	0.007	3.055	18	0.007	0.026	0.009	0.008	0.439
	Equal variances not assumed			3.055	9.453	0.013	0.026	0.009	0.007	0.451
Middle	Equal variances assumed	116.217	0	-7.086	18	0	-0.118	0.017	-0.153	-0.083
	Equal variances not assumed			-7.086	9.719	0	-0.118	0.017	-0.155	-0.081
Apical	Equal variances assumed	0.564	0.462	-3.673	18	0.002	-0.5	0.136	-0.786	-0.214
	Equal variances not assumed			-3.673	17.573	0.002	-0.5	0.136	-0.787	-0.213

the cement ranges up to 25 microns thus a marginal gap of less than 25 microns is clinically acceptable. It was observed in a study that marginal gaps for samples prepared with both direct & indirect methods ranged from 7 to 46 μm and are within the range of clinical acceptability. In current study, patterns were fabricated using the two test materials (Inlay Wax and Resin pattern) on each of the ten natural prepared teeth. In Indirect technique, the property of wax flow is less critical, also the pattern may be removed from the die at a lower temperature and with greater ease.The wax was melted using a wax melting pot (Dentsply) at 50°C to maintain the same consistency throughout. A metallic sprue was fixed to the floor of the preparation using a small amount of the test wax. The sprue provides structural support for the wax pattern and enables its removal from the preparation when set [29]. A PK Thomas waxing instrument was used to retrieve the semi-solid wax from the heater and apply it to the preparation to build up the pattern .The wax pattern was built up incrementally and once solidified, the pattern was finished and polished. Examining the marginal fit of patterns on the natural tooth before investing allows evaluation of pattern material at this stage of fabrication. The marginal gaps were measured on the prepared natural teeth 1 hour after its fabrication. Removal of pattern from the teeth causes dimensional changes in average elevations of 29 to 56 μm depending on the load applied before removal.In the direct method, a resin pattern is produced by placing a preformed plastic "burnout" post into the post space and a resin

Figure 1. Image depicting the sample of natural single rooted teeth mounted on wax occlusal rim.

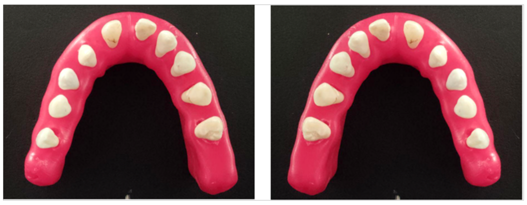


Figure 2. Image depicting the pre operativecbct of single rooted teeth taken in the study.

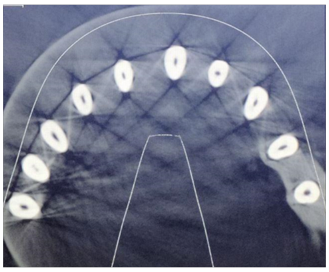


Figure 3. Image depicting the cross sectional view of the mounted teeth.

Figure 4. Image depicting the fabrication of custom cast post with pattern resin and inlay wax.

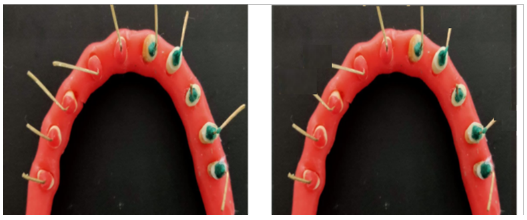


Figure 5. Image depicting the custom cast post fabricated in the laboratory from resin pattern and inlay wax.

Figure 6. Preoperative cbct of teeth undertaken in the study after decoronation.

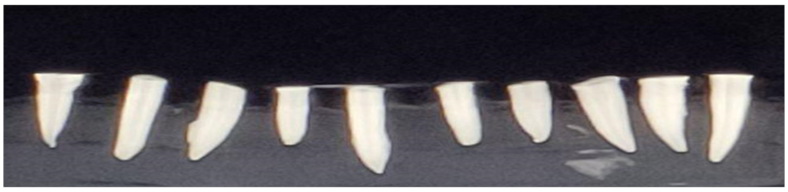
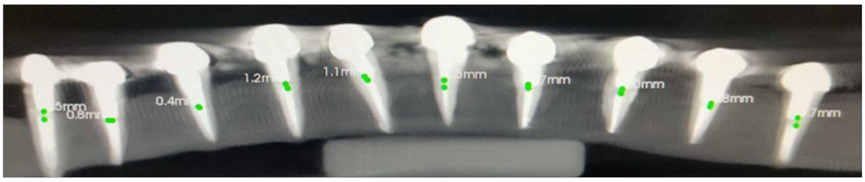


Figure 7. Postoperative CBCT with custom cast post made of resin pattern and inlay wax for assessment of marginal adaptability.



material is used to build up the tooth to the proper dimensions. When this is completed, the pattern post and core is removed from the tooth structure and sent to the dental lab. Acrylic dental resins are a group of resins made by polymerizing esters of acrylic or methyl methacrylate acids. Methyl methacrylate resin is a thermoplastic acrylic resin that is used by mixing liquid methyl methacrylate monomer with polymer powder which can then be packed into a mold .Acrylic pattern resins are autopolymerizable polymers used for the fabrication of dental patterns,Resistance to Flow is important for pattern fabrication. The resistance to flow of acrylic pattern resins can be controlled by combining the powder and liquid components until the desired viscosity is obtained. The resistance to flow is higher in resins compared to waxes.• Dimensional Stability is controversial with regards to acrylic resins. Reports range from 0.2 to 9% in dimensional changes over time period (Powers, J.M. et al. 2006)[30]. This factor is affected by the composition and processing of the material. According to several studies, the most accurate acrylics were produced using either a chemically activated pour resin or a microwave-activated resin. A visible light-activated resin was more accurate than a conventional heat-activated resin (Powers, J.M. et al. 2006).

Polymerization Shrinkage [31] has been shown to be one of the key elements that affect in the fit accuracy of acrylic resins. Mojon et al compared two acrylic pattern resins and found that after 24 hours, the volumetric shrinkage was 7.9% for DuraLay resin and 6.5% for Palaver G resin. This study showed that regardless of the type of resin used, polymerization shrinkage is observed. Cahi et al studied the dimensional stability of an autopolymerizing acrylic resin, a light-curing resin, and wax. They found that light-curing resin showed less shrinkage than autopolymerizing resin, however, the difference was not significant. Both the autopolymerizing and the light-curing resin exhibited less contraction than wax (Cahi, E. et al 2000).

Our institution is passionate about high quality evidence based research and has excelled in various fields [32-42].

Conclusion

The marginal adaptability of pattern resin is better in the coronal and the middle third of the root and in the apical region inlay wax has better marginal adaptability.

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