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Review Article

The science of strength: Enhancing post-core restorations with modern luting agents

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ABSTRACT:
Although the topic of endodontic tooth repair has been well researched, it is still debatable from a variety of angles. This paper examines the most important relevant literature with a focus on key decision-making factors for both post-placement and restoration of teeth that have received endodontic treatment. Organizing this topic into its constituent pieces and offering evidence-based guidelines that are valid from both an endodontic and restorative standpoint are the goals of this review.
The article focuses primarily on recent publications on the principles of post placement, classification, criteria for selection and various luting cements required during the placement of post.

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INTRODUCTION

As there is tremendous success of endodontic therapy, teeth that have undergone endodontic restoration can now be restored and reintegrated into the oral cavity as a long-term functioning unit. By removing the canal's essential contents, endodontic therapy leaves the tooth pulpless and produces teeth with calcified tissues and far lower moisture content than viable teeth.[1] It was believed that this would dramatically weaken the tooth structure, increasing its vulnerability to fracture under masticatory stresses.

A pivot (what is today termed a post) was used to retain the artificial porcelain crown into a root canal, and the crown-post combination was called a "pivot-crown". Porcelain pivot crowns were described in the early 1800s by a well-known dentist of Paris, Dubois de Chemant.[2]With the advent of scientific endodontic therapy in the 1950s, it has lead to change and introduction of newer methods for restoring the endodontically treated tooth like pin retained restorations, pin retained core build ups, coronal radicular build ups, cast-post cores, and pre fabricated posts. Teeth that were extracted without hesitations were now successfully treated with predictable endodontic therapy; and a satisfactory restorative solution .[3]

If there is not enough remaining tooth material to support the coronal final restoration, a post's primary purpose is to retain a core.[2]The reason that many different types of posts with different designs and materials are available is because they all have certain strengths and weaknesses.

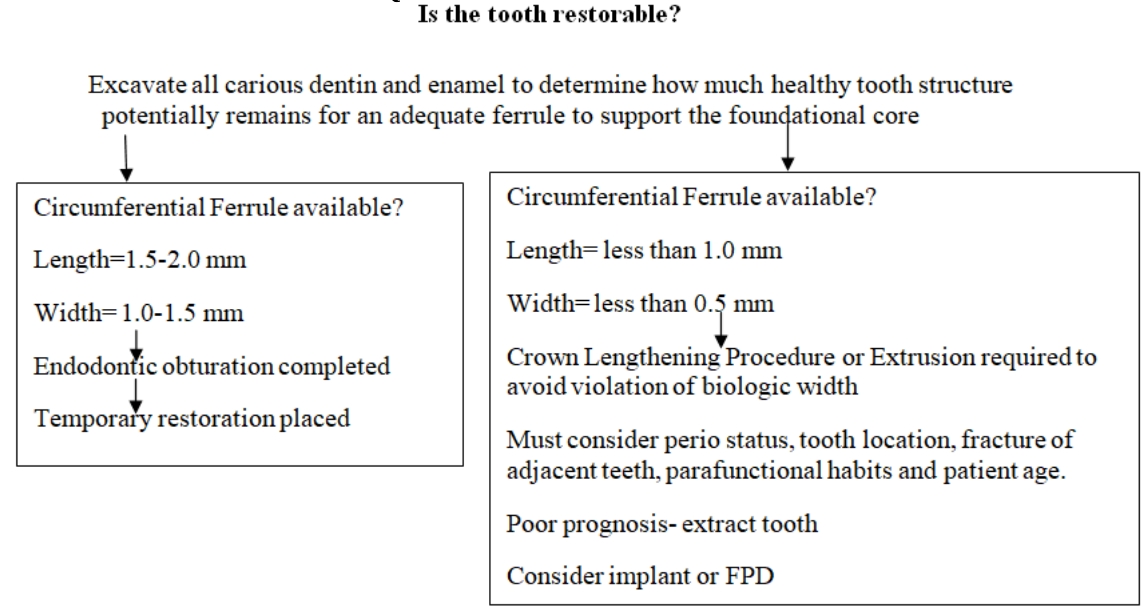
CRITERIA FOR SELECTION

Placing a post for either front or posterior teeth depends on the response to the question: Is a post necessary to maintain the build-up? The intention to reinforce the tooth should not be the deciding factor when placing a post.[2] There is no proof, according to Sorensen and Martinoff that the placement of a post and/or crown on an anterior tooth significantly affects the tooth's prognosis. The length of the post and the residual apical seal can have a significant impact on the likelihood that the restoration will be successful in cases where a post is required to maintain the build-up.[3]

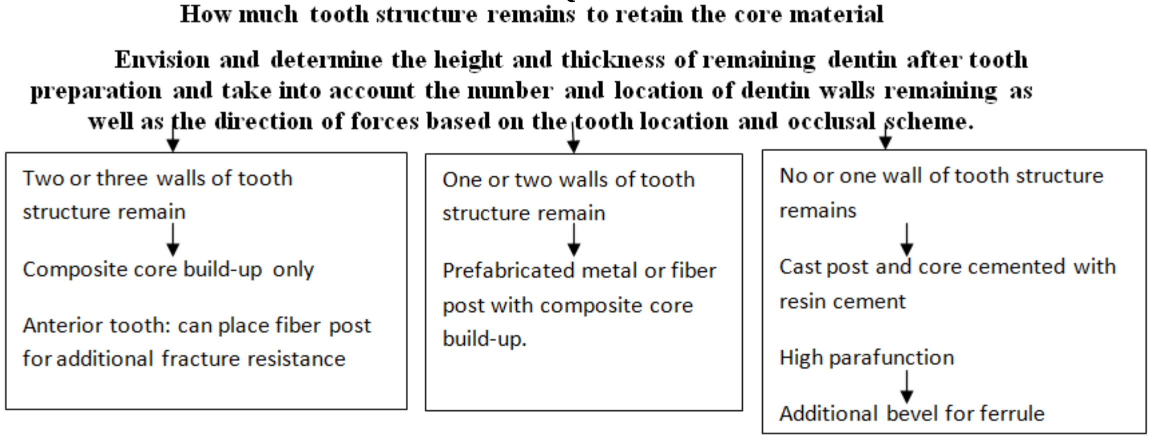
The minimal length of a tooth that is still solid after endodontic treatment and requires a post is determined by adding the biologic width (2.5 mm), ferrule length (2 mm), apical seal (4 mm), and a post length (equivalent to crown length) (8.5 mm + post length beyond crown margin).

The criteria for teeth without posts are biologic width plus ferrule length, or 4.5 mm of supra-bony solid tooth; this is based on the assumption that there is sufficient bone support to allow for a clinically acceptable degree of mobility. "Solid tooth" in both cases means that the dentin is at least 1 mm thick after preparation.[3]

FIRST TREATMENT PLANNING QUESTION



SECOND CRITICAL TREATMENT PLANNING QUESTION



The selection of specific materials and technique for the restoration of endodontically treated teeth is influenced **by the changes that accompany root canal therapy**[4]**:**

1. The amount of remaining tooth structure
2. Physical changes in tooth structure
3. The anatomic position of the tooth
4. The occlusal forces on the tooth
5. The restorative requirements of the tooth
6. The esthetic requirements of the tooth

INDICATIONS

Anterior

1. When there is severe damage or loss of natural crown of root canal treated tooth.

2. If full restorative coverage is required for root canal treated teeth for functional or aesthetic purpose.
3. Functional obligation: - if the resistance form of the crown portion of the tooth doesn't meet the adequate requirement for the prosthesis.
4. Teeth which are malposition.
5. When endodontic access is present lingually with loss of two proximal surfaces which leads to weakening of the tooth.
6. When RC treated tooth is to be used as anchor abutment for prosthesis.
7. In which basic requirement of axial position needs to be more than 1mm.[5]

Posterior

1. In case of core retention when conservative resistance and retention features like amalgam pins, chamber retention are not useful.
2. Where a tooth is prepared as a load bearing entity for removable partial denture.
3. In case of premolars, the dimensions of coronal tooth structure are not sufficient. Likewise, if the abutment is undergoing severe lateral stresses.
4. In case of maligned teeth.
5. A shorter tooth as a result of the undermined, unwanted tooth structure being removed or destroyed.
6. When the patient is having good oral health both periapically and periodontally.[5]

CONTRAINDICATIONS

1. Severe curvature of the root-eg: Dilacerations of the root.
2. Persistent periapical lesion
3. Poor periodontal health
4. Poor crown to root ratio
5. Weak or fragile roots
6. Teeth with heavy occlusal contacts
7. Patients with unusual occupational habits
8. Economic factor
9. Inadequate skill of operator.

Ideal properties

A post ought to incorporate as many of the subsequent clinical characteristics as feasible62:

1. The root's maximum protection against fracture
2. Maximum retrievability and retention inside the root
3. Optimal preservation of the crown and core
4. The crown margin seal's maximum defense against coronal leaking
5. Aesthetics
6. High radiographic visibility
7. Biocompatibility

Table 1.3 CRITERIA THAT DETERMINE LONG-TERM PROGNOSIS IN RESTORATION OF ENDODONTICALLY TREATED TEETH[6]:

CRITERIA	PARAMETER	VARIABLE
Force	Intensity	Area of mouth, Jaw angle, Muscle strength, Parafunctional habits, Type of contact/food, crown to root ratio, periodontal support tooth mobility.
	Frequency	Chewing, Clenching, Grinding Parafunctional
	Duration, Direction (lateral/rotational/ compressive/ retentive)	Tooth, cusp, Occlusal table, inclination, position, Size
Restoration Component	Operative Restoration Core, Post, Cement, Tooth	Material strength: Compression, shear/tensile, elasticity modulus, modulus of deformation, yield strength, pre-stress effects, thermal coefficient of expansion, internal stress, stability and fatigue.
Interface	Restoration to core, to post, to cement, to tooth Core to post, to cement, to tooth Post to cement, to tooth Cement to tooth	Surface area: Overall height, width, length, cross sectional shape, box formation, micro/macro mechanical contact, chamber shape, box formation, pins. Mechanical contact: size of contact, position and type (flat, point, wedge). Interaction of material: Wettability, chemical interaction, oxidation, electrolysis, mechanical wear, stress, mechanical wedging, thermal coefficient of expansion

BIOMECHANICAL CONSIDERATIONS

The study of living things' mechanics, particularly energy and force dynamics and how they affect dental structures, is known as biomechanics. A structure experiences stress as a result of theweight placed on it.[7]

A tooth that has been restored with a post, core, and crown has a stress distribution pattern that is very different from a tooth that is undamaged. During mastication, the "post–core–crown–tooth system" in a post–core repaired tooth bends or flexes as a single unit. Periodontal bone loss in teeth with metal posts may be explained by the variation in the "firing pattern" of a post-core repaired tooth compared to a typical intact tooth.[8]

The key differences between intact tooth and tooth restored using post–core are

1. The occurrence of stress concentration zones
2. The increase in tensile stresses generated inside the residual tooth structure of a post-core restored tooth are the two fundamental distinctions between an intact tooth and a tooth repaired using post-core technology. Biting pressures oriented away from the tooth's long axis have been found to result in a considerable increase in both the tensile strains and the intensity of stress concentration.[9]

The following variables account for the different stress distribution pattern in teeth with post-core restorations:

(1) the endodontic cast post and core restoration are more rigid;
(2) the post is angled relative to the occlusal load line of action; and
(3) The residual reduced tooth structure's increased flexure. The remaining tooth structure would experience significant tensile strains and areas of stress concentration as a result of these variables.

Stress concentrations at the apical region are often caused by the root canal's taper and the post's features, whereas stress concentrations at the cervical region are mostly caused by the damaged tooth structure's greater flexure. The apical terminal of the post is likewise connected to the areas of high concentration of stress.

Localized stress concentration zones can also result from imperfections like sharp threading from a post or pin, or a notch, ledge, or crack made in the dentine during root canal preparation. These locations may serve as the site of a potential fatigue failure.[10]

PRINCIPLES OF TOOTH PREPARATION

Tooth preparation procedures for an endodontically treated tooth includes:

1. Conservation of Tooth Structure
a. Preparation of the canal
b. Preparation of the coronal tissue
2. Retention Form
a. Anterior teeth
b. Posterior teeth
3. Resistance Form
a. Stress distribution
b. Rotational resistance

1. CONSERVATION OF TOOTH STRUCTURE

A. Preparation of the canal:

To create post space, the least amount of tooth structure needs to be removed.

A root that is too enlarged may become weaker or perforated, which could lead to a split during post-cementation or later function. The primary factor influencing the root's ability to withstand fracture is the thickness of the surviving dentin.

Most roots have proximal concavities that are hidden on a typical intra-oral radiograph and are typically narrower mesiodistally than faciolingually. Because there is very little dentin thickness left, it was discovered that these concavities are the source of the majority of fractures. In order to ensure strength and retention, the root canal should only be expanded to the extent necessary to allow the post to fit precisely and passively. [11]

B. Preparation of coronal tissue: (fig.1.3)

Teeth that have had endodontic treatment frequently exhibit significant tooth structural loss due to caries, prior restorations, or endodontic access cavity preparation. As much of the coronal tooth structure as feasible should be preserved since it helps to lessen stress concentrations near the gingival margin[11].

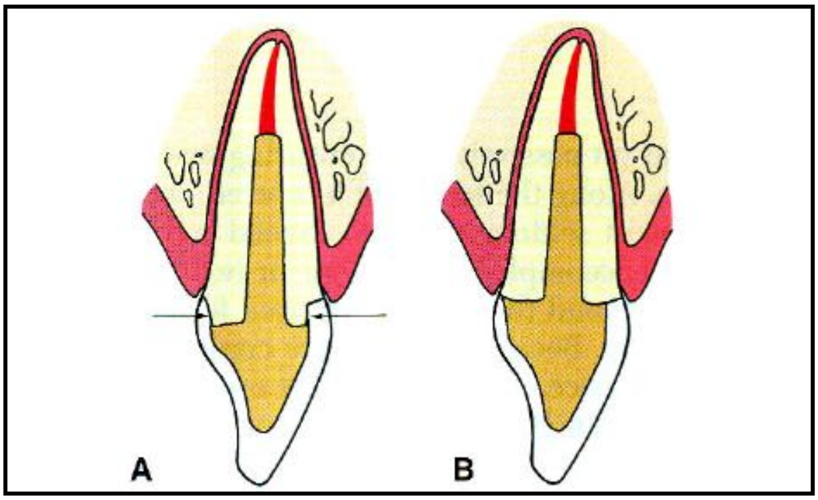


Fig 1.3 Extending the preparation apically creates a ferule and helps prevent fracture of an endodontically treated tooth during function. A, Preparation with a ferrule (arrows). B, Preparation without a ferrule.

Probably the most significant indicator of clinical effectiveness is the amount of tooth structure that is still present. If there is still more than 2 mm of coronal tooth structure, the post design most likely plays a minor part in the repaired tooth's ability to withstand fracture68.

What is known as a restoration with a ferrule—a metal band or ring that fits the root or crown of a tooth—is made possible by the crown's axial wall extending apically to the missing tooth structure as compared to a crown that just encircles core material.

2. RETENTION FORM:

Retention is defined as the force that resists a tensile or pulling force from dislodging the restoration away from its path of insertion. (tenso-frictional retention).

Retention Triad of Post and Core

Three methods of Retention:

1. Suitable linear measurement of the post in canal
2. **Post pattern:** use of active post design in the canals with short length
3. Post cementation using various **Luting agent**[12]

The palatal root in maxillary teeth and distal root in mandibular teeth is a better choice for post placement.[2]

Post retention is affected by:

1. Preparation geometry:

A few canals have a cross-section that is almost exactly round, especially those in the maxillary central incisors. These can be made ready for the use of a prefabricated post of the appropriate size and configuration by using a twist drill or reamer to create a cavity with parallel walls or little taper.

In contrast, elliptical cross-section canals need to be prepared with a limited amount of taper (often 6 to 8 degrees) in order to guarantee proper retention and prevent unwanted undercuts.[4]

2. Post Length

Clinical guidelines for post length are[13]:

- When treating teeth with long roots, make the post about three quarters the length of the root.
- When dealing with roots of ordinary length, save 5 mm of the apical gutta percha and extend the post to the gutta percha.
- In the instance of a short root and a tall clinical crown, the physician must make the tough choice of whether to sacrifice the mechanics, the apical seal, or both. In these cases, an apical seal of 4 mm is considered suitable19.
- The length of molar posts into the root canal apical to the pulp chamber base should not exceed 7 mm.
- Stresses build up quickly and are focused in the dentin close to the root when teeth have less bone support.
- Circumstances. [13]
- The length of the molar posts into the root canal apical to the pulp chamber base should not exceed 7 mm.
- Stresses are localized in the dentin close to the root apex and rise sharply when teeth have less bone support. The post should extend more than 4 mm apical to the bone in order to reduce tension in the dentin and in the post.[13]

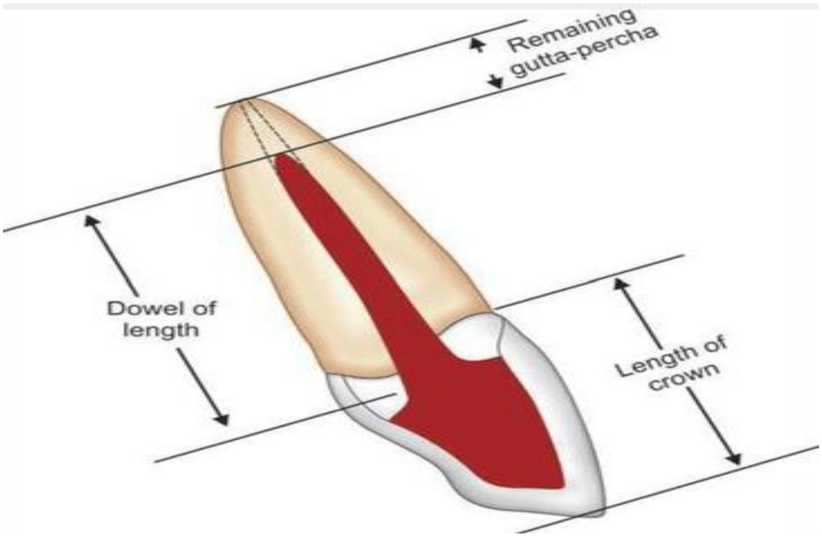


Fig 1.4 Adequate post length

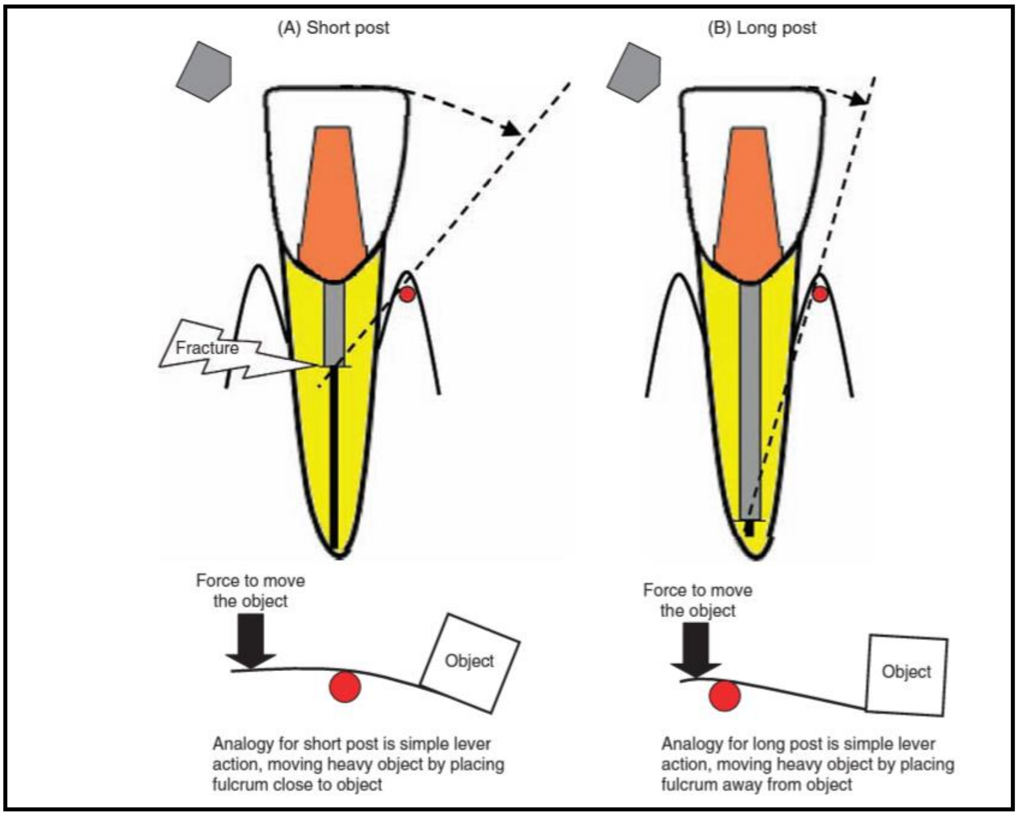


Fig 1.5 Showing the lever arm from the occlusal aspect of a tooth to the height of bony attachment in case of (A) short post and (B) long post.

3. Post diameter

It is not advised to increase the post diameter in an attempt to boost retention as this will only result in a negligible retentive gain and needless weakening of the existing root.

Three different post-space preparation concepts are identified by Lloyd and Palik69

i. The environmentalists were one group that promoted using the narrowest diameter possible when fabricating a specific post length.

ii. The second group (the proportionists) suggested a space whose diameter is no more than one-third of the root diameter.

iii. The preservationist, who belonged to the third group, recommended maintaining at least 1 mm of sound dentin encircling the entire post.

Even with instruments of the proper diameter, molar posts longer than 7 mm should be avoided due to the increased risk of perforations.[12]

4. Post Design

The most retentive posts are threaded, and parallel-sided posts are more retentive than taperedposts, according to laboratory tests.

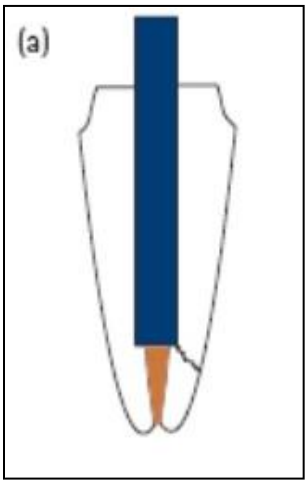
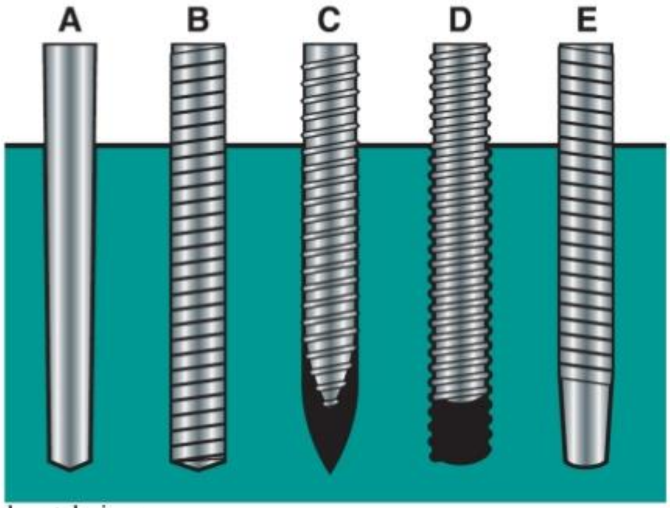


Fig 1.7 Parallel post



Prefabricated post designs.

A. Tapered, smooth.

B. Parallel, serrated.

C. Tapered, self-threading..

D. Parallel, threaded. [Note that the post fits into pretapped threads cut into the dentin]

E. Parallel, serrated, tapered end

Fig 1.8 Various post design

Since most prepared post spaces have a significant flare in the occlusal half, circular parallel-sided post systems are only functional in the most apical section of the post space. In a similar vein, a parallel-sided post is ineffective in an elliptical root canal unless the channel is greatly extended, which would needlessly weaken the root.[11]

5. Post Surface Texture

A tapered post's retention is significantly increased by controlled root canal and post grooving, and a serrated or roughened post is more retentive than a smooth one. [11]

6. Luting Agent

The most common complication of post and cores is loosening of the post[3]. Post cementation and retention in the root is a critical factor in the longevity of prosthetic restorations. Retention for all types of posts is affected by cement selection.

The adhesive characteristics of luting cements, which help to form a bond between the post and radicular dentin, as well as their compressive and tensile strengths, are important attributes.[15]

Traditional cements (e.g., **zinc phosphate cement**) provide retention through mechanical means.

Resin cements bond to dentin in the root and residual tooth and to most post materials. They also show less microleakage than traditional cements. Complete sealing of dentin tubules in the apical third is desirable to protect the apical seal.

The bond strength of resin cements is affected by various solvents and materials used during endodontic procedures including EDTA, NaOCl and eugenol. Poor visibility and access for the microbrushes till the apical end of the preparation does not allow the adhesive to penetrate completely.

Light activated resin cements rely on translucent posts to transmit curing light to the depths of the canal. But as one gets farther away from the light source, the light intensity rapidly decreases and might not be enough to fully cure the light-cured resin cement at the apical end. Dual-cured resin cements are therefore recommended. [4]

Dentin, resin cement, post and core together are often described as forming a strong monoblock foundation restoration. The adhesive cement is the unifying bond between these components. Decementation of fiber posts has been reported to be the result of adhesive fractures between the resin cement and the dentin wall or at the cement/post junction[13]. Failure of fiber posts occurs primarily from post decementation rather than root fracture.

1. Luting Methods and Venting:

To deal with intraradicular hydrostatic pressure which is formed during cementation of post, a path is needed for the outflow of the.

Technquies for placing luting agents into the prepared canal space:

1. Lentulospiral
2. Paper point
3. Endodontic explorer
4. Direct application technique [12]

PROPERTIES	IDEAL REQUIREMENTS
Biological Should be/have	Non toxic and non irritant Non-carcinogenic No systemic reactions. Prevents secondary caries formation.
Chemical	Inert chemically . The cement's solubility in the patient's oral fluids or any other fluids they take should be minimal; the maximum amount of cement that can dissolve in oral fluids is 0.2%. Should be able to bond to enamel and dentin chemically. neutral pH
Rheological Should be/ have	for easy flow of luting cement Low film thickness required Longer mixing and working time. Shorter setting time.
Mechanical Should be/have	To withstand the masticatory forces high compressive strength is required. To reduce the brittleness high tensile strength is required. High modulus of elasticity. Exhibit minimum dimensional changes on setting. Restoration should take and retain a smooth surface finish. Should bond chemically to the enamel and dentin.
Thermal Should be/have	Good thermal insulator The tooth and prosthetic prosthesis should have comparable coefficients of thermal expansion.
Optical/ aesthetic	The color of the tooth and any artificial restoration or prosthesis shouldn't be changed. Must possess sufficient radiopacity to allow for the identification of secondary caries and cavities that are not fully filled because of trapped air.
Miscellaneous Should be/have	Easy to manipulate Inexpensive Longer shelf life

Most commonly used luting agents are- Zinc phosphate,glass ionomer, resin-modified glass ionomer, and resin composite cements.

Zinc phosphate cement

This cement brings out an acceptable performance likewise, when used to lute the casted post & core for tooth. In cases where root canals are severely tapered or short, cement with high cohesive strength are used to enhance the restoration of post. Since, zinc phosphate cement having low cohesive strength, glass ionomer cement or resin cement are used in these situations as they have high cohesive strength.[16]

The low shrinkage while setting, low shrinkage during handling, and dimensional stability are advantages. Zinc-phosphate cements' solubility in oral fluids and lack of adhesive qualitiesare their main drawbacks. Glass ionomer cements have the ability to release fluoride and offer a low coefficient of thermal expansion in addition to a chemical bind to the tooth substrate. It is debatable if glass ionomer luting cements are capable of this.[17]

In comparison to conventional GIC, resin-modified GIC cement demonstrated rapid adhesion to cementum, dentin, and enamel. There are multiple ideas that could be responsible for the superior bonding performance of RMGIC over Conventional GIC at the same time. First, there can be variations in the rates of crosslinking in the material's bulk regions and adsorption on the surface of calcified tissue.

Because of the photoinitiator's ability to produce acid, light-curing RMGI first increases the ionization rate, which creates a highly strong adsorbed layer. In the meantime, procedures involving free radical polymerization give rise to internal cross-linking reactions.

The unsaturated methacrylate groups will therefore polymerize and co-polymerize with the modified polyacrylic acid, entwining a network of polyacrylic acid within the collagen web.

Glass ionomer cements have a drawback in that they set slowly—it takes several days. or perhaps a few weeks to get to your strongest point.

Because vibrations created during recountouring a cast post and core with a bur can cause retentive failure of the post, these cements are therefore less appropriate for use with cast posts core.

On observing glass ionomer cement, it was seen that it has adhesive as well as viscoelastic characteristics which helps in dissipating the vibrations likewise, ultrasonic energies that are given out to the post. But the bond strength noticed was low. Hence, the post retention is more depended on slide friction. But, when compared with zinc phosphate luting, it was seen the post removal time is shorter because of the solubility rate which is more for glass ionomer cement in comparison to zinc phosphate i.e., 1.25 versus 0.06. Secondly, the dissolvability of glass ionomer cement rises when it is used in lower powder liquid ratio. Also, it is noticed the water from ultrasonic unit fasten the solubility of glass ionomer cement. Therefore, leads in post removal.[18]

Fluoride is also released by glass ionomer cements treated with resin. Fluoride leakage from these core materials varies, peaking in the first 24 hours and then progressively declining thereafter. The fact that glass ionomer cements treated with resin absorb water and then swell over time is concerning.[19]

In comparison with zinc phosphate cement, glass ionomer cement and resin cement showed more cohesive strength and can be used in these scenarios. Also, these materials give out a viable bond strength to the dentin in the root canal walls.[20]

Increased water sorption, which leads to plasticity and hygroscopic expansion, is caused by HEMA. The polymerization shrinkage stresses may be partially offset by initial water sorption; however, persistent water sorption causes significant dimensional changes that make them unsuitable for use in the cementation of all-ceramic crowns and posts in non-vital teeth when expansion-induced fractures arise. Because they are insoluble, resin cements show better retention for intra-radicular posts in vitro than zinc phosphate and glass ionomer cements. One element possibly contributing to the uneven results could be the root canal geometry, where the ratio of the bound and the free non-bonded surface areas of the resin composite cement layer (C-factor) is highly unfavorable.[21]

When used for crown restorations, adhesive resin composite cements have been shown to perform better in terms of leakage than non-adhesive cements.[22]

No long-term clinical investigations showing the superiority of a particular cement have been conducted on cemented posts. An appropriate luting agent (e.g., sticky or non-adhesive) must be chosen based on the type of post system.

Post which is placed using resin cement needs prolonged application of ultrasonic unit when the procedure of post removal is to be carried out.

The reason behind this is because of the higher mechanical properties of resin material. Regardless of having this higher mechanical strength the ultrasonic vibrations were strong enough to break the cement lining which was obtained by resin cement.

Resin cement takes prolonged duration of ultrasonic vibration in comparison to glass ionomer and zinc phosphate cements.[23]

Table 1.5 Mode of application of different resin cements

S. No	Cementation system/ Manufacturer/ abbreviation	Mode of application (Batch number)
1.	Adaper Scotchbond Multi-Purpose/3M ESPE + RelyX ARC 3M ESPE(SBMP+ ARC)	1) 35% phosphoric acid should be applied for a duration of 15 sec. 2) Before air drying wash with water for a duration of 15 sec. 3) Using paper points absorb the moisture. 4) Apply adhesive using micro applicators and with use of two way syringe remove the excess and air dry the field. 5) Application of primer is to be done inside the canal and excess primer is to be removed by air drying for approximate 5second. 6) Application of catalyst is done inside the canal 7) Mixing of the cement has to be done on the cement mixing pad for a during of 10 second. 8) Application of cement is done inside the canal 9) Application of cement is done over the post and then post is placed inside the canal 10) Wipe of the extra cement while holding the post in place. 11) The polymerization has to be done with the UV light for 40 sec from an occlusal direction.
2.	Adaper single bond 2/3 ESPE+ RelyX ARC/3M ESPE(SB+ARC)	1) 35% phosphoric acid is to be applied for the duration of 15 s 2) Before air drying wash with water for a duration of 15 sec. 3) Using paper points absorb the moisture. 4) Apply adhesive using micro applicators and with use of two-way syringe remove the excess and air dry the field. 5) Polymerize using UV light for a duration of 10 s 6) Mixing of the cement has to be done on the cement mixing pad for a during of 10 second. 7) Application of cement is done inside the canal 8) Application of cement is done over the post and then post is placed inside the canal

		9) Wipe of the extra cement while holding the post in place. 10) The polymerization has to be done with the UV light for 40 sec from an occlusal direction.
3.	RelyXU100 (Rely X Unicem) 3M ESPE U100)	1) Use sodium hypochlorite 2.5% along with distilled water to irrigate the canals 2) Using paper points absorb the moisture 3) Mixing of the cement has to be done on the cement mixing pad for a during of 10 second. 4) Application of cement is done inside the canal 5) Application of cement is done over the post and then post is placed inside the canal 6) Wipe of the extra cement while holding the post in place. 7) The polymerization has to be done with the UV light for 20 sec from an occlusal direction.
4.	RelyX U200	1) Using distilled water for irrigation and absorbent paper points for drying 2) RelyX U200 cement is inserted into the root canal. 3) the post's placement inside the root canal 4. A 40-second light-polymerizing period

Table 1.6 Composition of various resin cement

S. No.	Material	Composition
1.	Adaper Scotchbond Multi-Purpose (SBMP)	Activator: ethanol-based solution of a sulphuric acid and a photoinitiator component. Primer: aqueous solution solution of HEMA(Hydroxyethyl methacrylate) and polyalkenoic acid copolymer. Catalyst: HEMA and Bis GMA(Bisphenol-A-glycidyl methacrylate)
2.	Adper Single Bond 2 (SB)	Bis-GMA, HEMA, dimethacrylate, ethanol,water,photoinitiator system, and a methacrylate functional copolymer of polyacrylic and polyitaconic acids.
3.	RelyX ARC (ARC)	Paste A: Bis-GMA, triethyleneglycol dimethacrylate, zircon/silica filler, photoinitiators, amine, pigments Paste B: Bis-GMA, triethyleneglycol dimethacrylate, benzoic peroxide, zircon/silica filler.
4.	RelyX U100 (U100)	Paste base: glass fiber, methacrylated phosphoric acid esters, dimethacrylates, silanatedsilica, sodium persulfate Paste catalyst: glass fiber,dimethacrylates,silanated silica,p-toluene sodium sulphate, calcium hydroxide.
5.	RelyX U200	Base paste: silane-treated glass powder, 2-propenoic acid, 2-methyl, 1,1-[1- (hydroxymethyl)-1,2-ethanodiyl] ester, triethylene glycol dimethacrylate (TEG-DMA), silica with silane, glass fiber, sodium persulfate and t-butyl per-3,5,5- trimethyl-hexanoate. Catalyst paste: silane-treated glass powder, substitute dimethacrylate, silica with silane, sodium p-toluenesulfonate, 1-benzyl-5-phenyl-baric acid, calcium salts, 1,2-dodecane dimethacrylate, calcium hydroxide and titanium dioxide

Table 1.7 Mechanical properties of luting cement

Mechanical Properties	Zn phosphate (Mpa)	Polycarboxylate (Mpa)	GIC (Mpa)	ARC (Mpa)	RMGIC (Mpa)
Diametral T.S.	10	12	14-21	44-50	17-27
Flexural Strength	4-7	14.3-20	7-19	70-100	50-53

Table 1.8

Properties	Zinc phosphate	Polycarboxylate	GIC	Resin Ionomer	Compomer	Adhesive resin cement
Film thickness	≤25	<25	<25	>25	>25	25
Working time	1.5-5	1.75-2.5	2.3-5	2.4	3.10	0.5-5
Setting time	5-14	6-9	6-9	2	3-7	1-15
Comp. Strength (Mpa)	62-101	67-91	122-162	40-141	194-200	179-255

Elastic modulus	13.2	-	11.2	-	17	4.5-9.8
Pulp irritation	Moderate	Low	High	High	High	High
Solubility	High	High	Low	Very low	Very low	Very low
Microleakage	High	Very high	Low-high	Very low	High to very low	Very low to low
Removed of	Easy	Medium	Medium	Medium	Medium	Difficult
Retention	Moderate	Low-moderate	Moderate-high	Moderate -high	Moderate	High

3. The Resistance Triad for Post and Core:

1. **Crown Bevel:**

It is a segment of crown perimeter which reaches out the post and core margin onto natural tooth structure. To be precise the encirclement of tooth completely is needed. Likewise, extension of minimum 1.5mm tooth structure under the post and core margin is required.[24]

2. **Natural remaining tooth structure:**

Maximum tooth structure should be conserved so as to elevate the resistance of final restoration[44].

3. **Antirotation feature:**

An antirotational feature should be included while preparing canal space for post and core.Keyways prepared in the face of the root prior to construction of the post are the most common anti-rotational devices.

CONCLUSION

Complete knowledge regarding the selection of the best post and core systemsalong with the suitable luting cement for endodontically treated tooth is complex. Understanding their indications, benefits, and drawbacks, as well as the significance of residual tooth structure and aesthetic standards, can help. The first step in recovering a tooth that has had endodontic treatment is to determine how predictable the restoration will be. Detailed perception in the fields of the anatomy, endodontic, periodontal, restorative, and occlusal concepts, as well as the teeth's physical and biomechanical characteristics, is the first step in adequately restoring root canal treated teeth. As there are so many options, choosing the best one requires a deep comprehension of literature in order to achieve long-term clinical success. Hence this review article helps in providing useful information regarding the final repair, luting cements, and core material selection.

REFERENCES

1. Charles J. Goodacre, Joseph Y. K. Kan. Restoration of Endodontically Treated Teeth. Ingle JI, Bakland LK, Baumgartner JC. Ingle’s Endodontics. 6th Edition. 1432-1470.
2. Franklin S. Weine . Endodontic therapy. 6th ED. Mosby 2003: 546-584.
3. Abou-Rass M. Endodontics. The restoration of endodontically treated teeth. New answers to old problem. The Alpha Omegan. 1982; 75(4):68-97.
4. Hargreaves, Cohen. Cohen’s Pathways of the pulp, Elsevier, Missouri, 2011,10th Edition: 786-821.
5. LR Nageshwar Rao. Advanced Endodontics, Jaypee Brother, Delhi,2009, 1st edition, 226-235.
6. Helfer AR, Melnick S, Schilder H. Determination of the moisture content of vital and pulpless teeth. Oral Surg 1972;34(2):661-670.
7. Papa J, Cain C, Messer HH. Moisture content of vital vs endodontically treated teeth. Dent Traumatol.1994;10(2):91-93.
8. McKerracher PW. Rational restoration of endodontically treated teeth.Principles, techniques and materials. Aus Dent J 1981;26(4):205-208.
9. Felton DA et al. Threaded endodontic dowels: effect of post design on incidence of root fracture. J Prosthet Dent. 1991;65(2):179-187.
10. Kane JJ, Burgess JO, Summitt JB. Fracture resistance of amalgam coronal-radicular restorations. J Prosthet Dent. 1990;63(6):607-13.
11. Ferrari MA, Vichi AL, Garcia-Godoy FR. Clinical evaluation of fiber-reinforced epoxy resin posts and cast post and cores. Am J Dent. 2000 ;13(Spec No):15B-8B.
12. Vimal K Sikri Textbook of endodontics CBS Publishers and Distributors Delhi 2nd Edition 2017: 373-407.
13. Merriam Webster Dictionary. Merriam-Webster, Inc, Massachusetts, 11th edition,2003, 750-51.
14. Lloyd PM, Palik JF. The philosophies of dowel diameter preparation: a literature review. J Prosthet Dent 1993; 69(1);32-36.
15. Rouhani A, Zoormand Ghasemi F, Akbari M, Mosivand S. Effect of Post-space Preparation with Rotary Devices and Heated Instruments on Microbial Leakage of Gutta-percha and Resilon-Epiphany Obturated Canals. Dent Mater J. 2018; 7(3):129-134.
16. Soares JA, Júnior MB, Fonseca DR et al :Influence of luting agents on time required for cast post removal by ultrasound: J Appl Oral Sci. 2009;17(3):145-149
17. Mitchell CA, Doughlas WH, Cheng YS. Fracture toughness of conventional, resin modified glass ionomer and composite luting cements. Dent Mater 1999;15(1):7-13.
18. Balto H, Al-Nazhan S, Al-Mansour K, Al-Otaibi M, Siddiqu Y. Microbial Leakage of Cavit, IRM, and Temp Bond in Post-prepared Root Canals Using Two Methods of Gutta-percha Removal: An. J Contemp Dent Pract. 2005;6(3):53-61.
19. Kasam S, Mariswamy AB. Efficacy of different methods for removing root canal filling material in retreatment-an in-vitro study. Journal of clinical and diagnostic research: J Clin Diagnostic Res. 2016;10(6):ZC06-ZC10.
20. Hochstedler J, Huband M, Poillion C. Porcelain-fused-to-metal post and core: an esthetic alternative. J Dent Technol. 1996;13(8):26-29.
21. Robertello FJ ,Coffey JP, Lynde TA, King P. Fluoride release of glass ionomer based luting cements in vitro. J Prosthet Dent 1999;82(2):172-176.

22. Stadlee JP, Caputo AA. Endodontic dowel retention with resinous cements, J Prosthet Dent. 1992;68(6):913-917.
23. Fan B, Wu MK, Wesselink PR. Coronal leakage along apical root fillings after intermediate and delayed post space preparation. Endod Dent Traumatol 1999;15(3):124-126
24. Sancheti T, Mandke L. Clinical performance of a new post system: I post. JInt Clin Dent Res Organ. 2016;8(1):76.