REVIEW ARTICLE

Prosthodontic Management of Endodontically Treated Teeth – A Review

Dr. Rubina[1], Dr. Manjit Kumar[2], Dr. Rashim Garg[3], Dr. Rishi Saini[4], Dr. Shaveta Kaushal[5]

[1]Post Graduate Student
Department of Prosthodontics and Crown & Bridge
Genesis Institute of Dental Sciences and Research,
Ferozepur, India
E-Mail: bansalrubina87@gmail.com

[2]Professor and HOD
Department of Prosthodontics and Crown & Bridge
Genesis Institute of Dental Sciences and Research,
Ferozepur, India
E-Mail: manjitkiran@yahoo.co.in

[3]Post Graduate Student
Department of Prosthodontics and Crown & Bridge
Genesis Institute of Dental Sciences and Research,
Ferozepur, India

[4]Post Graduate Student
Department of Prosthodontics and Crown & Bridge
Genesis Institute of Dental Sciences and Research,
Ferozepur, India
E-Mail: rishisainibds@gmail.com

[5]Post Graduate Student
Department of Prosthodontics and Crown & Bridge
Genesis Institute of Dental Sciences and Research,
Ferozepur, India
E-Mail: shaveta.doc7@gmail.com

Corresponding Author

Dr. Rubina
Post Graduate Student
Department of Prosthodontics and Crown & Bridge
Genesis Institute of Dental Sciences and Research,
Ferozepur, India
Contact No. +91-9988803825
E-Mail: bansalrubina87@gmail.com

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Abstract

The goal of dental treatment is to provide optimal oral health, esthetics and function. Therapeutic efforts should produce predictable treatment results that are easily maintainable and reliable over the long term. After endodontic therapy a tooth must be restored to functional and esthetic demands. Endodontically treated teeth which are to be used as abutments in prosthodontic reconstructions, must be judged carefully regarding their ability to withstand a higher load than a single tooth normally is exposed to.

Key words: Post, Core & Ferrule

Introduction

Various methods of restoring pulpless teeth have been reported for more than 200 years. In 1747, Pierre Fauchard described the process by which roots of maxillary anterior teeth were used for the restoration of single tooth and the replacement of multiple teeth. Posts were fabricated of gold or silver and held in the root canal space with a heat-softened adhesive called "mastic."

An endodontically treated tooth can resume full function and serve satisfactorily as an abutment for a fixed or removable partial denture. However, special techniques are needed to restore such a tooth. The loss of tooth structure makes retention of subsequent restorations more problematic and increases the likelihood of fracture during functional loading. Different clinical techniques have been proposed to solve

these problems and opinions vary about the most appropriate one.[1]

Today, both endodontic and prosthodontic aspects of treatment have advanced significantly, new materials and techniques have been developed and a substantial body of scientific knowledge is available on which clinical treatment decisions are based.[2]

The dowel is a post usually made of metal that is fitted into a prepared root canal of a natural tooth. When combined with an artificial crown or core, it provides retention & resistance for the restoration. Core refers to properly shaped and well substructure, which replaces missing coronal structure and retains the final restoration (Fig.1).

Review of Literature

Steele D.G. (1973)[3] suggested supporting an endodontically treated tooth using a reinforced composite resin foundation with an internal "crutch" to combat horizontal forces. This crutch was the composite resin with a metal-reinforced dowel.

Stahl J.G. and O'Neal B.R. (1975)[4] suggested the composite resin dowel and core as a practical alternative to the cast gold dowel and core and which fulfilled the objective of restoring the pulpless tooth to health, function and esthetics.

Wood W.W. (1983)[5] concluded that cast posts without grooves are more retentive when cemented with zinc phosphate than with composite resin.

Stegaroiu R. (1996)[6] suggested that if a canal required extensive preparation, a well-adapted cast post and core restoration may be more retentive than a prefabricated post restoration that does not match the canal shape.

Sahafi A. (2004)[7] concluded that parallel posts showed superior retention compared with tapered posts. The positive effect of several surface treatments on adherence between post and cement was not manifested as improved retention because of limited adherence of the cement to the root canal.

Albashaireh Z.S. et al (2010)[8] concluded that airborne-particle abrasion of the surface of the post significantly improved post retention.

Pretreatment Evaluation

Clinical evaluation should include endodontic, restorative, periodontal and esthetic evaluation. Tooth should not be mobile and tender on percussion. No sinus tract should be present which indicates remaining infection within the root canal system with a periradicular exudate that has progressed through cancellous bone, the cortical plate and the mucoperiosteum to discharge through the mucosal surface. Due consideration should be given to the strategic location of the tooth in the dental arch. If it is the most distally placed tooth and/or has an opposing tooth, then providing the endodontic and restorative procedures are predictable, it would be advantageous to attempt treatment. However, if a tooth is thought to be unrestorable the remaining dentition should be assessed so that other treatment options such as fixed partial denture, implants or removable prostheses can be discussed with the patient. [9]

If adequate canal length is available, prefabricated posts are a good choice, particularly in thin roots such as maxillary premolars. Cast post and cores are easier to retrieve when endodontic retreatment is necessary. But they cannot be used in areas that require an esthetic temporary restoration. They have fallen from favor as they require two appointments, temporization and a laboratory fee.[12]

Indications for Post Placement

The decision regarding post placement should be made according to position of the tooth in the arch, the amount of coronal remaining tooth structure and the functional requirements of the tooth.

The main purpose of the post is to retain the core and in multirooted teeth, more than one post may be needed to improve core retention. Determination of the need for a post is related to the presence of sufficient tooth structure to achieve a ferrule circumferentially. When a minimum of 2mm of ferrule can be achieved to retain the crown, posts may not be required to retain the core.

Posterior teeth

If an endodontically treated premolar has increased functional stresses acting on the crown due to loss of the periodontium and is

to serve as an abutment for a removable partial denture, a post may be indicated. Unless a large percentage of coronal tooth structure is missing, posts are rarely required in endodontically treated molars. When a post is required, it should generally be placed only in the largest canal; that is, the palatal canal in the maxillary molar and the distal canal in the mandibular molar.

Anterior teeth

Because of the shearing forces (off axis loading) that act on them, anterior endodontically treated teeth are restored with posts more often than posterior teeth. When there is no functional or aesthetic requirement for a full-coverage restoration, a post is not indicated.[10]

Factors influencing Post selection

Following are the factors which affect post selection[11]

1. Root length
2. Tooth anatomy
3. Root width
4. Canal configuration
5. Amount of coronal tooth structure
6. Torquing force
7. Stresses
8. Development of hydrostatic pressure
9. Post design
10. Post material
11. Material compatibility
12. Bonding capability
13. Core retention
14. Retrievability
15. Esthetics
16. Crown material

Commonly used Prefabricated Post systems

Commonly used active and passive post systems are Aestheti-Plus, D.T. Light-Post, Cosmopost and Parapost.[12] (Table 1 and Table 2)

Principles of Tooth Preparation

1. Conservation of Tooth Structure

a) Preparation of the canal

In creating post space, remove only minimum tooth structure from the canal. The thickness of the remaining dentin is the prime variable in fracture resistance of the root. Adequate apical seal, minimal canal enlargement, adequate post length, positive horizontal stop (to minimize wedging), vertical walls to prevent rotation and extension of the final restoration margin onto sound tooth structure are six important features for successful design.

b) Preparation of Coronal Tissue

The amount of remaining tooth structure is probably the single most important predictor of clinical success. If more than 2 mm of the coronal tooth structure remains, then the post and design plays little role in the fracture resistance of the restored tooth. Extension of the axial wall of the crown apical to the missing tooth structure provides what is known as a ferrule and helps to bind the remaining tooth structure together, preventing root fracture during function.[1]

2. Retention Form

Post retention refers to the ability of a post to resist vertical dislodging forces.[18] In mandibular molars (Fig. 2), the larger distal canal is recommended for post placement and in maxillary molars, the palatal canal is used.[1]

The factors that have been identified to affect the retention of post systems are post length, post diameter, post design, luting agents, luting method, canal shape, preparation of canal space and tooth and location in the dental arch.

Retention increases as the post length increases but too long may damage the seal of the root canal filling or root perforation can occur if apical third is curved or tapered. Ideally, post should be as long as possible without jeopardizing the apical seal or the strength of the remaining root structure. Most endodontic texts advocate maintaining a 5-mm apical seal. However, if a post is shorter than coronal height of the clinical crown of the tooth, the prognosis is considered to be unfavorable, because stress is distributed over a smaller surface area, thereby increasing the probability of root fracture. In case of a short root and a tall clinical crown, an apical seal of 3 mm is considered acceptable[1] (Fig. 3).

Adequate width of the post is important for post strength and resistance to post fracture. Wider post lead to an increased risk of lateral root perforation, greater cervical stresses within the root structure, decrease

in impact resistance and decreased resistance to root fracture. Work has been carried out to determine the optimum post diameter and it has been suggested that a post should not exceed 1 mm in diameter at its tip.

Some studies reported that the parallel-sided posts provided superior retention when compared with tapered posts; however, others have indicated that threaded posts are the most retentive, followed by parallel posts, with tapered posts the least retentive.

Tapered posts produced the greatest stress at the coronal shoulder and parallel posts generated their greatest stress at the apex of the canal preparation. Parallel posts resisted tensile, shear and torquing forces better than tapered posts and distributed stress more uniformly along their length during function.[13]

Several studies have reported that a well-adapted, passively luted, parallel-sided post provided the most retentive post with the least stress. A serrated or roughened post is more retentive than a smooth one and controlled grooving of the post and root canal considerably increases the retention of a tapered post.[1]

3. Resistance Form

Resistance refers to the ability of the post and tooth to withstand lateral and rotational forces. It is influenced by the remaining tooth structure, the post's length and rigidity, the presence of anti-rotation features and the presence of a ferrule.[14]

Rotational Resistance

In areas where coronal dentin has been completely lost, a small groove placed in the canal can serve as an anti rotational element. The groove is normally located where the root is bulkiest, usually on the lingual aspect (Fig. 4).

Ferrule Effect

The term ferrule probably originates from the Latin word ferrum meaning iron and viriola meaning bracelet (Brown 1993).[14] It is also defined as a metal band or ring used to fit the root or crown of a tooth. The ferrule should be a minimum of 1 – 2 mm high, have parallel axial walls, completely encircle the tooth, end on sound tooth structure and not invade the attachment apparatus of the tooth. The purpose of the ferrule is to improve the structural integrity of the pulp less tooth by counteracting functional lever forces, wedging effect of tapered dowels and lateral forces exerted during insertion of the dowel.

A ferrule increases the mechanical resistance of a post/core/crown restoration by reducing the potential for displacement (labial and axial rotation) and compressive stresses within labial dentine and the canal wall. By comparison, a restoration without ferrule is prone to fail primarily by debonding and subsequently by root fracture through the lever action of the loose post. Crown lengthening did not alter the levels or pattern of stress when compared with standard ferrule preparations. In those clinical situations where there is insufficient ferrule length, even where margins are placed subgingivally, surgical crown lengthening or orthodontic extrusion may be considered.

Techniques

Removal of Root Filling Material in Preparation for Posts

1. Chemical removal by solvents such as oil of eucalyptus, oil of turpentine and chloroform have been used to soften gutta-percha for removal, with the latter two being the most efficient.
2. Thermal removal by a heated instrument such as a lateral compactor that can be inserted into the gutta-percha to the desired length to remove the gutta percha.
3. Mechanical removal by a non-end cutting bur such as a Gates-Glidden or Peeso reamer is efficient and probably the most commonly used technique, but it is a technique that can result in the most damage to tooth tissue.[13]

Enlargement of the Canal

Before enlargement of the canal, the type of post system to be used for fabrication of the post and core must be chosen. For prefabricated posts**, e**nlarge the canal one or two sizes with a drill, endodontic file or reamer that matches the configuration of the post. Use a prefabricated post that matches standard endodontic instruments. A tapered post will conform better to the canal than a parallel-sided post and requires less removal of dentin to achieve an adequate fit. However, it will be slightly less retentive and will cause greater stress concentrations, although retention may be

improved by controlled grooving. Be careful not to remove more dentin at the apical extent of the post space than is necessary. Use custom-made posts in canals that have a noncircular cross section or extreme taper. Enlarging canals to conform to a preformed post may lead to perforation. Often very little preparation will be needed for a custom made post. However, undercuts within the canal must be removed and some additional shaping usually is necessary. Be careful on molars to avoid root perforation. In mandibular molars the distal wall of the mesial root is particularly susceptible. In maxillary molars the curvature of the mesiobuccal root makes mesial or distal perforation more likely.[1]

Preparation of the Coronal Tooth Structure

After the post space has been prepared, the coronal tooth structure is reduced for the extracoronal restoration. Anterior teeth requiring a post-and-core are most effectively restored with a metal-ceramic crown.

Ignore any missing tooth structure (from previous restorative procedures, caries, fracture or endodontic access) and prepare the remaining tooth as though it were undamaged. Remove all internal and external undercuts that will prevent withdrawal of the pattern. Because of positive casting defects like nodule, metal post may fracture due to wedging effect on the root. These defects are not encountered with prefabricated posts. Modulus of elasticity of metal posts is higher than dentin whereas it is comparable to dentin for fiber posts. Remove any unsupported tooth structure, but preserve as much of the crown as possible. Be sure that part of the remaining coronal tissue is prepared perpendicular to the post because this will create a positive stop to prevent overseating and splitting of the tooth. Complete the preparation by eliminating sharp angles and establishing a smooth finish line.[1]

Post Fabrication

Prefabricated Posts- The post should be 10 to 15 mm in length[15], depending on the length of the tooth. The post should be parallel in shape. It should be cemented rather than screwed into the root. It should be standardized to the size of existing drills and reamers. This allows for accuracy and ease of placement. It should be vented for the extrusion of excess cement to alleviate the hydraulic pressure during cementation.

Custom-made Posts- A custom-made post can be cast from a direct pattern fabricated in the patient's mouth or an indirect pattern can be fabricated in the dental laboratory. A direct technique using autopolymerizing or light-polymerized resin is recommended for single canals, whereas an indirect procedure is more appropriate for multiple canals.[1]

Core Fabrication

It can be shaped in resin or wax and added to the post pattern before the assembly is cast in metal. This prevents possible failure at the post-core interface. The core can also be cast onto most prefabricated post systems. A third alternative is to make the core from a plastic restorative material such as amalgam, glass ionomer or composite resin.

Provisional Restorations

To prevent drifting of opposing or adjacent teeth, an endodontically treated tooth requires a proper provisional restoration immediately following completion of endodontics. If a cast post-and-core is made, an additional provisional restoration is needed while the post and core is being fabricated. This can be retained by fitting a wire (e.g. a paper clip or orthodontic wire) into the prepared canal. The restoration is then conveniently fabricated with autopolymerizing resin by the direct technique.

Investing and Casting

A cast post-and-core should fit somewhat loosely in the canal. A tight fit may cause root fracture. The casting should be slightly undersized, which can be accomplished by restricting expansion of the investment i.e. by omitting the usual ring liner or casting at a lower mold temperature.[1]

Cementation of Posts

All post space preparations should be clean, free from saliva and bacterial contamination and dry before the post is cemented. The actual method of post cementation is critical to ensure complete seating within the post space and that the luting cement adapts completely to both the dentine and post, thus completely sealing the interface between the two.

Cementation techniques include placing cement lute over the post and/or placing it in the post hole with a lentulo-spiral, paper point or an endodontic explorer. The most successful method is to place the cement into the post hole with a lentulo-spiral and coating the post before inserting with a gentle pumping action to allow adequate venting of the post coronally. If the cement is applied to the post alone a reduction in retention is observed.[16]

The luting agent must fill all dead space within the root canal system. Voids may be a cause of periodontal inflammation via the lateral canals. The post and core is inserted gently to reduce hydrostatic pressure, which could cause root fracture. If a parallel- sided post is being used, a groove should be placed along the side of the post to allow excess cement to escape.[1]

Five types of cements are available for post cementation – Resin cements, Polycarboxylate cements, Glass ionomer cement, Resin-modified glass ionomer cement and Zinc phosphate cement. Resin cements are best for fber-reinforced posts. Resin-modified glass ionomer cement is widely used for cementation. Zinc phosphate cement has adequate physical properties, is inexpensive and remains an excellent choice for post cementation. It gives superior retention to polycarboxylate cement when tapered posts are used.

Clinical Failures

Post dislodgment due to inadequate retention, contamination of the cement with saliva, residual lubricant or temporary cement and root fracture due to the design of the post such as tapered, parallel sided and threaded or the hydraulic pressure during cementation are some of the clinical failures.

Prognosis

Bergman concluded a 105 failure rate after 6 years with cast post and cores. Ellner recorded a success rate of 100% for the group with custom fabricated post and cores with an excellent success probability in the observation period of 10 years. Ferrari compared in their study custom-fabricated post and cores with fiber posts. After 4 years in service, custom-fabricated post and cores showed a failure rate of 14%.

Removal of Posts

1. Masserann technique

Masserann developed and designed an instrument for extracting posts or rigid instruments that are broken deeply within the roots with minimum damage. The method involves gripping the object through a tube or trephine which acts as a tube-vice. This method is relatively harmless to the tooth and periodontium. The advantages of this technique are its simplicity, little generation of heat and elimination of excessive forces (Fig. 5).

2. Eggler post remover

The Eggler device can be easily applied to anterior teeth and to most first premolar teeth, but its size prevents it from being used in most second premolars and virtually all molar teeth (Fig. 6).

3. Ultrasonic scalers

For posts that extend into the pulp chamber, vibrations from the ultrasonic scaler are able to break the cement bond between the canal and the post by touching the post with the ultrasonic tip.

Recent Advances and Future trends

Fiber Reinforced Composite (FRC) Posts

First introduced in 1990, fiber posts were rapidly accepted by clinicians and provided a viable alternative to cast metal posts for the restoration of root filled teeth. The major advantage of fiber posts is their similar modulus of elasticity to that of dentin, producing a stress field similar to that of natural teeth whereas metal posts exhibit high stress concentrations of the post dentin interface. Moreover, fiber posts are ready to use whereas the construction of a cast post and core is time consuming.

Fiber reinforced post systems contain a high volume percentage of continuous fibers embedded in polymer matrixes which are commonly epoxy polymers that keep the fibers together. They are available as carbon fiber, glass fiber and quartz fiber posts.

In 1990, Duret et al proposed carbon-fiber posts. They are manufactured from continuous and unidirectional pyramidal carbon fibers in an epoxy resin matrix. Their main disadvantages are their black color and they are radiolucent and hence impossible to detect radiographically.

Glass fiber posts and quartz fiber posts are esthetic alternatives. Novais et al conclude in their study that carbon fibers have a higher flexural strength than post reinforced with glass fibers.[12]

Ceramic and Zirconium Posts

Metal posts are visible through the more translucent all-ceramic restorations and even with less translucent restorations may cause the marginal gingiva to appear dark. These concerns have led to the development of posts that are white and/or translucent. Among the materials used for esthetic posts are zirconium and other ceramic materials.[10] Use of zirconia as a post-and-core material began in 1993 when introduced by Meyenberg. Prefabricated zirconia posts present positive qualities such as high strength to bending forces and appropriate optical properties. The use of zirconia posts is not recommended for the posterior region because of the higher occlusal forces in that area and should be avoided in patients with parafunctional habits.[12]

Retrieval of zirconium and ceramic posts is very difficult if endodontic retreatment is necessary or if the post fractures. The all-zirconium posts are white and radiopaque. They are quite rigid, with a modulus of elasticity higher than stainless steel. Clinical data to support the all-zirconium post are minimal, although there are several short-term clinical studies that show favorable results. These are not widely used due to the relative stiffness of the post compared to tooth structure leading to vertical root fracture when failure occurs.

Conclusion

Although the restoration of endodontically treated teeth has been rationalized considerably by recent laboratory research data, information from controlled long-term clinical trials is still necessary and difficult to obtain. Different clinical procedures have been advocated, many of which are successful if properly used. Most post systems can be used successfully if these principles are followed, but some posts should be excluded because of inadequate strength and difficulty in retrieval. [1]

Table 1 – Common passive post systems

Brand Name	Type of Post	Manufacturer
C-Post	Carbon fiber	RTD/Bisco
Aestheti-Plus	Quartz fiber	RTD/Bisco
D.T. Light-Post	Quartz fiber	RTD/Bisco
FiberKor	Glass fiber	Jeneric/Pentron
Cosmopost	Zirconium	Vivadent
Snow Post	Zirconium	Danville
Dentatus metal post	Brass, titanium	Dentatus
Lucent Anchor	Glass fiber	Dentatus
Parapost	Stainless steel, titanium	Coltene/Whaledent
Parapost	White Glass fiber	Coltene/Whaledent

Table 2 – Common active post systems

Brand Name	Type of Post	Manufacturer
V-Lock	Titanium	Brassler
Flexi-Post	Titanium	Essential Dental Systems

References

1. Rosensteil SF, Land MF, Fujimoto J. Contemporary Fixed prosthodontics, 4th ed, 2006, USA, Elsevier, 336-374.
2. Ingle JI, Bakland LK. Ingle's Endodontics, 5th ed, 2002, London, BC Decker, 913-950.
3. Steele GD. Reinforced composite resin foundations for endodontically treated teeth. J Prosthet Dent 1973;30:816-819.
4. Stahl GJ, O'Neal RB. The composite resin dowel and core. J Prosthet Dent 1975;33:642-648.
5. Wood WW. Retention of posts in teeth with nonvital pulps. J Prosthet Dent 1983;49:504-506.
6. Stegaroiu R et al. Retention and failure mode after cyclic loading in

7. two post and core systems. J Prosthet Dent 1996;75:506-511.
8. Sahafi A et al. Retention and Failure Morphology of prefabricated Posts. Int J Prosthodont 2004;17:307-312.
9. Albashaireh ZS, Ghazal M, Kern M. Effects of endodontic post surface treatment, dentin conditioning and artificial aging on the retention of glass fiber-reinforced composite resin posts. J Prosthet Dent 2010;103:31-39.
10. Tait CME, Ricketts DNJ, Higgins AJ. Restoration of the root-filled tooth: pre-operative assessment. British Dental Journal 2005;198:395-404.
11. Robbins WJ. Restoration of the endodontically treated tooth. Dent Clin N Am 2002;46:367–384.
12. Fernandes AS, Shetty S, Coutinho I. Factors determining post selection: literature review. J Prosthet Dent 2003;90:556-562.
13. Schwartz RS, Robbins JW. Post Placement and Restoration of Endodontically Treated Teeth: A Literature Review. J Endod 2004;30:289-301.
14. Tait CME, Ricketts DNJ, Higgins AJ. Tooth preparation for post-retained restorations. British Dental Journal 2005;198:463-471.
15. Stankiewicz NR, Wilson PR, The ferrule effect: a literature review. Int Endod J 2002;35:575-581.
16. Goerig AC, Muenonghoff LA, Management of the endodontically treated tooth. Part I: Concept for restorative designs. J Prosthet Dent 1983;49:340-345.
17. Tait CME, Ricketts DNJ, Higgins AJ. Post and core systems, refinements to tooth preparation and cementation. British Dental Journal 2005;198:533-541.

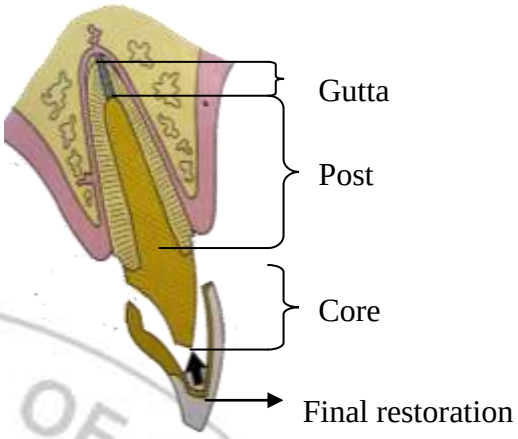


Fig. 1

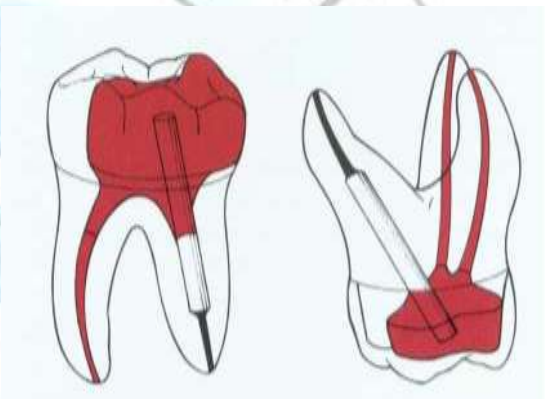


Fig. 2

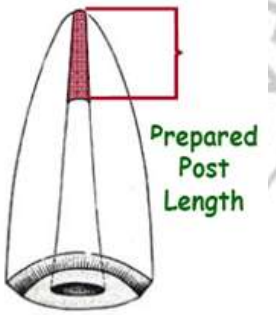
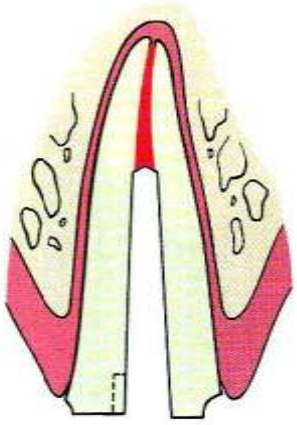


Fig. 3

Legends

Fig. 1: Post and core restoration
Fig. 2: Mandibular molars - distal canal, Maxillary molars - palatal canal
Fig. 3: Apical seal of 3-5mm
Fig. 4: Rotational resistance obtained by preparing a small groove in the root canal



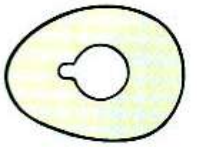


Fig. 4

Fig. 5

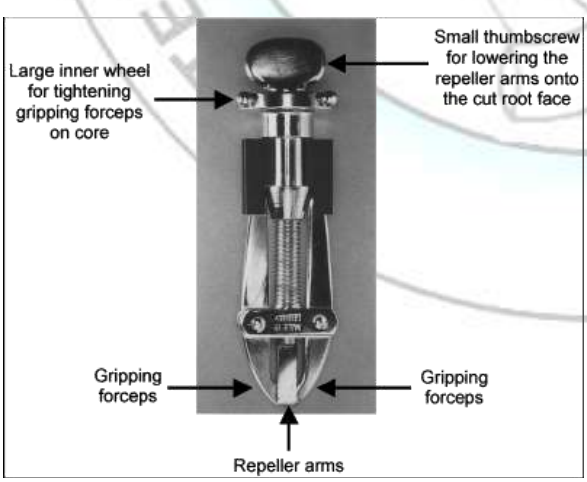


Fig. 6