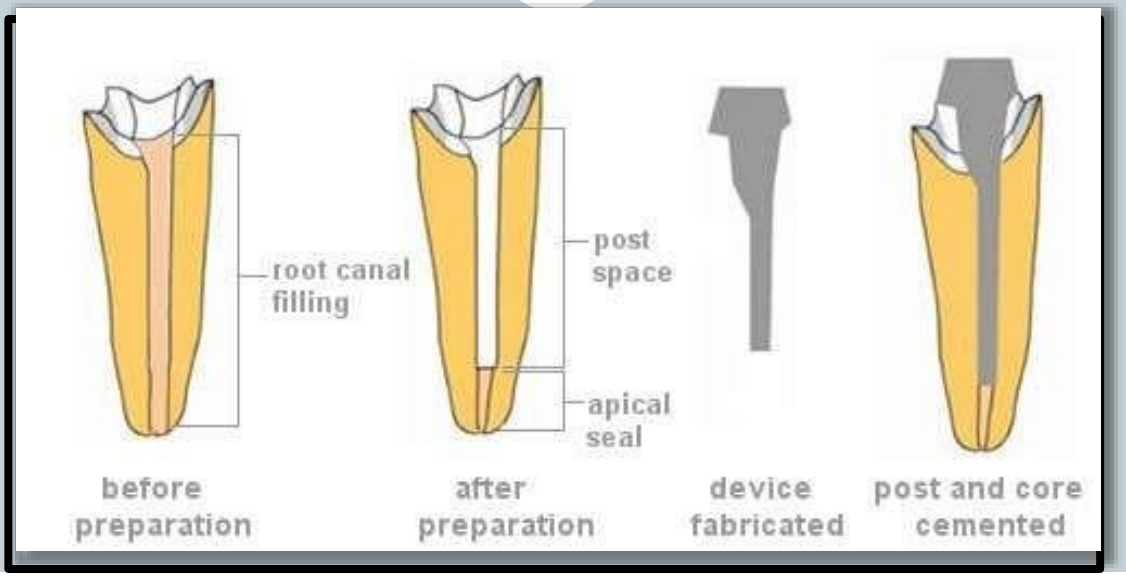
POST AND CORE



PRESENTED BY : DR. NUPUR DHANAK

Restorations of endodontically treated (ET) teeth are designed to:

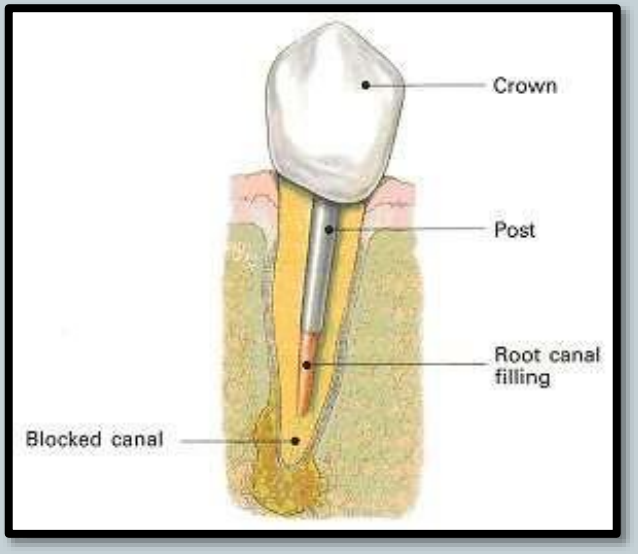
1. protect the remaining tooth from fracture,
2. prevent reinfection of the root canal system, and,
3. replace the missing tooth structure.

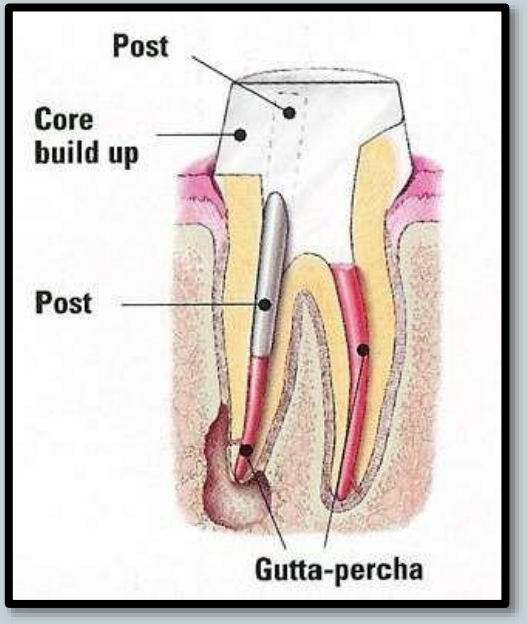
- Restorations that encompass the cusps of endodontically treated posterior teeth have been found to increase the clinical longevity of these teeth. Therefore, crowns should be placed on endodontically treated posterior teeth that have occlusal intercuspation with opposing teeth of the nature that places expansive forces on the cusps.
- Since crowns do not enhance the clinical success of anterior endodontically treated teeth, their use on relatively sound teeth should be limited to situations where esthetic and functional requirements cannot be adequately achieved by other more conservative restorations

- In a few cases, the crown can be directly built on the remaining coronal structure which has been prepared accordingly

- More frequently, the cementation of a post inside the root canal is necessary to provide retention for the core material and the crown.

A post and core is a restoration consisting of a post that fills a prepared root canal and a core inserted into the pulp chamber that establishes the proper coronal tooth preparation.





DEFINITIONS

- Dowel (Post): The dowel is a metal post or other rigid restorative material placed in the radicular portion of a non vital tooth. A dowel, usually made of metal, is fitted in to a prepared canal of a natural tooth. When combined with an artificial crown or core, it provides retention and resistance for the restoration. (Glossary of Prosthodontics)

- Core: Refers to properly shaped and well substructure, which replaces missing coronal structure and retains the final restoration. The core is designed to resemble or become the crown preparation or crown itself. (Glossary of Prosthodontics)

INDICATIONS FOR POST AND CORE

- Where the natural crown of root-filled teeth either has been lost or is extensively damaged.
- Where the root-filled tooth is to be used as bridge abutment.
- Where a change in axial position greater than 1mm is required.
- In a crowned anterior endodontically involved tooth, to reinforce the crown covered tooth at cervical area susceptible to fracture.

CONTRAINDICATIONS

- Severe curvature of the root-eg: Dilacerations of the root.
- Persistent periapical lesion
- Poor periodontal health
- Poor crown to root ratio
- Weak / fragile roots
- Teeth with heavy occlusal contacts
- Patients with unusual and occupational habits
- Economic factors
- Inadequate skill.

HISTORY

- In **1728, Pierre Fauchard** described the use of “TENONS” which were metal posts screwed into the roots of teeth to retain the prosthesis
- **1745 – Claude Mouton** published his design of a gold crown with a gold post that was to be inserted into the root.
- **1830-1870** –Wood replaced metal as the material of choice for posts.
- **1839 Harris** proposed that gold and platinum were superior to brass, silver and copper which tended to corrode.

- **G.V. Black 1869** developed porcelain fused to metal crown held in by a screw inserted into a canal filled with gold foil
- **“Pivot crown”** – a wooden post fitted to an artificial crown and to root canal.
- In **1966** prefabricated posts and composite resin cores came into use.
- **In1990 Duret *et al***. described a non-metallic material for the fabrication of posts based on the carbon-fibre reinforcement principle.

An ideal post system according to Wagnild et al (2002) should have the following features

- Provide maximal retentiveness to the core.
- Physical properties compatible to core
- Maximum retention with minimum removal of dentin
- Even distribution of functional stresses along root surfaces
- Esthetic compatibility
- Minimal stress during placement and cementation
- Resistance to displacement.
- Easy retrievability
- Ease of use
- Reasonable cost

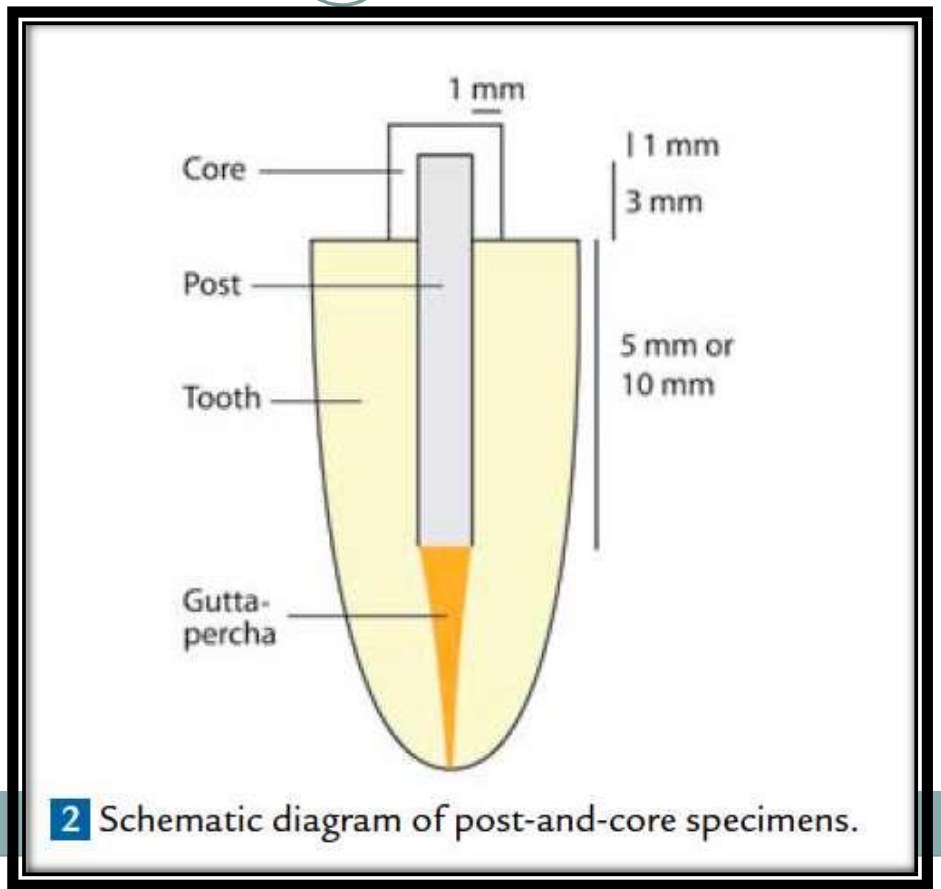
Grossman

According to Cohen

Posts should provide as many of the following clinical features as possible:

- Maximal protection of the root from fracture
- Maximal retention within the root and retrievability
- Maximal retention of the core and crown
- Maximal protection of the crown margin seal from coronal leakage
- Pleasing esthetics, when indicated
- High radiographic visibility
- Biocompatibility

CLASSIFICATION OF POSTS



2 Schematic diagram of post-and-core specimens.

According to Weine

1. Custom-cast Posts
2. Prefabricated Posts
   - Tapered, smooth sided post systems
   - Parallel-sided, serrated and vented posts
   - Tapered, self-threading post systems
   - Parallel- sided, threaded post systems
     - Self-threading
     - Threaded with use of matched taps
   - Parallel-sided, threaded, split-shank post systems

According to Ingle

1. Custom-cast Posts
2. Prefabricated Posts
   - Tapered, smooth-sided posts
   - Parallel-sided posts
   - Tapered, self-threading screws
   - Parallel-sided, threaded posts
   - Parallel-sided, tapered apical end posts

According to Robbins

1. Metallic Posts
   - Custom-cast Posts
   - Prefabricated Posts
     i. Passive Tapered Posts
     ii. Passive Parallel Posts
     iii. Active Posts

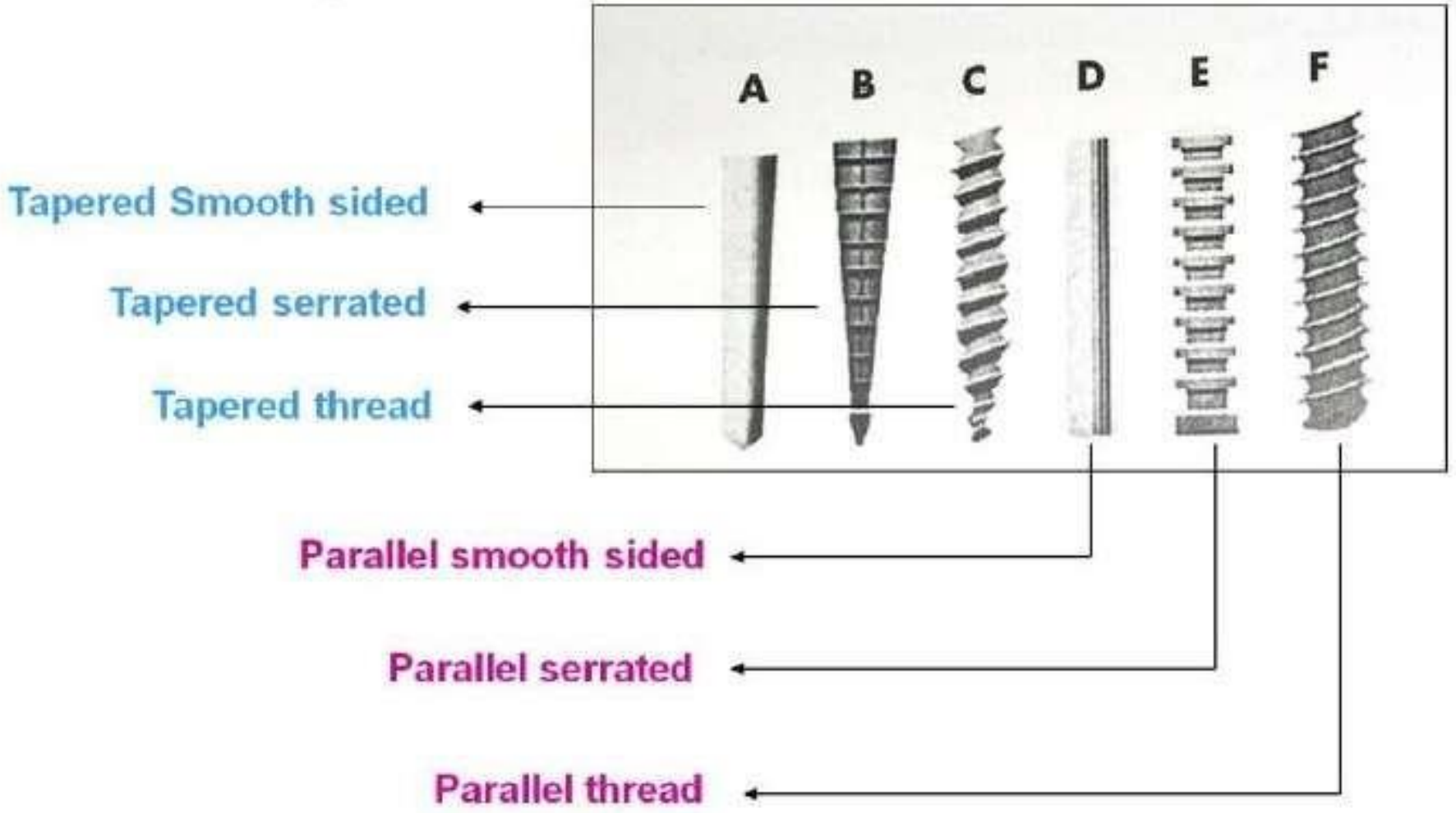
2. Non-metallic Posts
   - Carbon Fiber Posts
   - Tooth Colored Posts

According to Schwartz

1. Active versus Passive Posts
2. Parallel versus Tapered Posts
3. Prefabricated versus custom made
4. According to material composition:
   i. Metal posts
   ii. Ceramic and Zirconium Posts
   iii. Fiber Posts
      a. Carbon Fibre posts
      b. Quartz fibre
      c. Glass fibre
      d. Silicon fibre

According to Rosensteil

1. Tapered, smooth-sided posts
2. Tapered, serrated posts
3. Tapered, threaded posts
4. Parallel, smooth-sided posts
5. Parallel, serrated posts
6. Parallel, threaded posts


A
B
C
D
E
F
Tapered Smooth sided
Tapered serrated
Tapered thread
Parallel smooth sided
Parallel serrated
Parallel thread

A. CLASSIFICATION OF CAST POST

- According to type of alloy.
  - Gold alloy
  - Chrome-Cobalt alloy
  - Nickel-Chromium alloy

- According to number of posts:
  - Single Post
  - Multiple Post
    - One Piece Post
    - Two Piece Post
      - Two piece cast post
      - Combination of cast post

Singh, Chandra, Pandit, A New Classification of Post and Core; Indian Journal Of Restorative Dentistry,Sept-Dec2015;4(3):56-58.

B. CLASSIFICATION OF PREFABRICATED POST

- According to Taper
  - Parallel
  - Tapered
  - Parallel Tapered
- According to surface character
  - Smooth
  - Serrated
  - Self threading
- According to fit
  - Active
  - Pasive

Singh, Chandra, Pandit, A New Classification of Post and Core; Indian Journal Of Restorative Dentistry,Sept-Dec2015;4(3):56-58.

- According to material
  - Metallic
    - Titanium
    - Stainless steel
    - Brass
  - Non-metallic
    - Non esthetic
      - Carbon fibre post
    - Esthetic
      - Polyethelene Fibre
      - Glass fibre
      - Quartz
      - Ceramic

Singh, Chandra, Pandit, A New Classification of Post and Core; Indian Journal Of Restorative Dentistry,Sept-Dec2015;4(3):56-58.

- According to light transmission
  - Light transmitting
  - Non-Light transmitting
- According to Vent
  - With Vent
  - Without Vent
- According to Monoblock formation
  - Monobloc formation
  - No Monobloc formation

Singh, Chandra, Pandit, A New Classification of Post and Core; Indian Journal Of Restorative Dentistry,Sept-Dec2015;4(3):56-58.

TYPES OF POSTS

CUSTOM CAST POSTS

Indications:

1. When the remaining coronal tooth structure supporting an artificial crown is minimal so that it can't resist torsional forces.
2. When multiple cores are being placed in the same arch and small teeth such as mandibular incisors,
3. When there is minimal coronal tooth structure available for antirotation features or bonding.

- Classically, smooth-sided, tapered posts conforming to the taper of the root canal are fabricated from high noble alloys, although noble and base-metal classes of dental alloys have also been used.
- Noble alloys used for post and core fabrication have:
  - high stiffness (approximately 80 to 100 GPa),
  - strength (1500 MPa),
  - hardness,
  - excellent resistance to corrosion

Cast gold alloy (type III or IV) is an inert material with modulus of elasticity (stiffness of 14.5 ×106 psi) and coefficient of thermal expansion similar to those of enamel, and yet it has good compressive strength that can withstand normal occlusal forces.

- Advantages:
  - It offers the advantages of easy retrievability of post,
  - greater strength
  - excellent core retention.
  - Better adaptation in cases of elliptical and extremely tapered canals
- Disadvantages:
  - Esthetics, as the metal shows through the newer all ceramic restorations.
  - Increased susceptibility to root fracture
  - Two visit procedure
  - Additional lab fee.

PREFABRICATED POSTS

- Prefabricated metallic posts are frequently used for the fabrication of a direct foundation restoration. These posts are classified several ways, including by alloy composition, retention mode, and shape
- Materials used to fabricate metallic posts include gold alloys, stainless steel, or titanium alloys

Advantages of pre-fabricated post-core systems over cast post

- They are simple to use.
- Require less chair side time.
- Can be completed in one appointment.
- Are easy to temporize.

Major disadvantages of pre-fabricated Post-Core systems

- The root is designed to accept the post rather than the post being designed to fit the root.
- Their application is limited when considerable coronal tooth structure is lost.
- Chemical reactions are possible when the post and core materials are made of dissimilar metals.
- Attachments for removable prostheses cannot be applied, unless a separate casting is fabricated to place over it.

Advantages of cast post over Pre- fabricated post-core systems

- They are custom fit to the root configuration.
- Are adaptable to large irregularly shaped canals and orifices.
- Can be adapted to be used with pre fabricated plastic patterns.

Disadvantages of cast-post

- Expensive
- Requires two or more appointments.
- Temporization between appointments is more difficult.
- Risk of casting inaccuracies
- May require the removal of additional coronal tooth structure

Metallic Posts

Stainless steel Posts

- have been used for a long time in prefabricated posts.
- contains nickel, and nickel sensitivity is a concern, especially among female patients.
- A recent study indicates that the flexural strength of stainless steel posts is about 1430 MPa and that flexural modulus approximates 110 GPA
- Stainless steel and brass have problems with corrosion.

Titanium Posts

- less rigid (66 GPa)
- flexural strength (1280 MPa) similar to stainless steel.
- least corrosive
- most biocompatible
- low fracture strength and tend to break more easily compared with stainless steel posts during removal in retreatment cases.
- titanium alloys used in posts have a density similar to that of gutta-percha when seen on radiographs, which makes them more difficult to detect

Non-Metallic Posts

Fibre Post

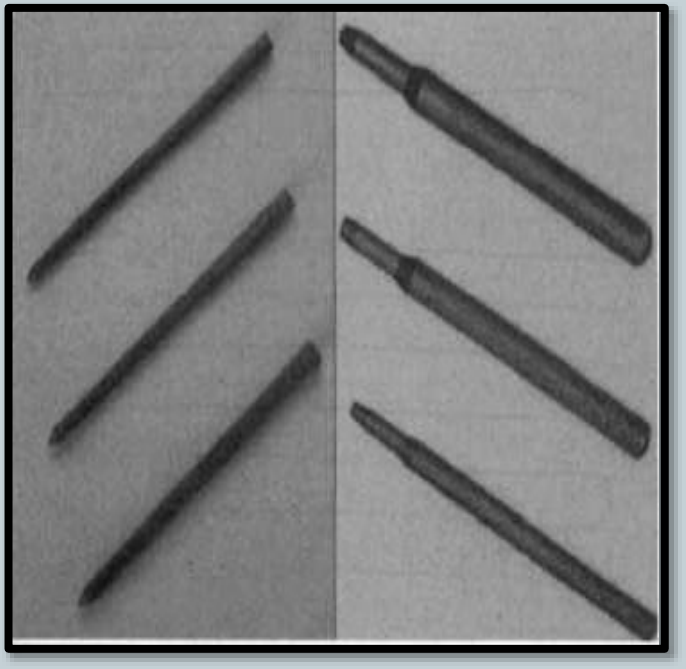
- A fiber post consists of reinforcing fibers embedded in a resin polymerized matrix.
- Monomers used to form the resin matrix are typically bifunctional methacrylates (Bis-GMA, UDMA, TEGDMA), but epoxies have also been used.

- Common fibers in today's fiber posts are made of carbon, glass, silica, or quartz
- The fibers are 7 to 10 micrometers in diameter and are available in a number of different configurations, including braided, woven and longitudinal.
- The lower flexural modulus of fiber-reinforced posts (between 1 and 4 × 106 psi), measures closer to that of dentin (≈ 2 × 106 psi) and can decrease the incidence of root fracture.
- Current fiber posts are radiopaque and may also conduct the light for polymerization of resin-based luting cements.
- A light- transmitting post results in better polymerization of resin composites in the apical area.

- Bonding fiber posts to root canal dentin can improve the distribution of forces applied along the root, thereby decreasing the risk of root fracture and contributing to the reinforcement of the remaining tooth structure.

Carbon Fibre Post

- The carbon fibre prefabricated post, introduced in the early 1990s, is comprised of longitudinally aligned carbon fibres embedded in an epoxy resin matrix (approx 36%).
- This type of post has no radiopacity and is black in colour – both significant clinical disadvantages.



- In a prospective clinical trial more failures were seen in the carbon-fibre-posted teeth than those with conventional prefabricated posts.

- Also, a longer term follow up of the 236 teeth in the favourable Fredericksson report concluded that the carbon-fibre restored teeth had shorter survival times than those previously documented for cast posts

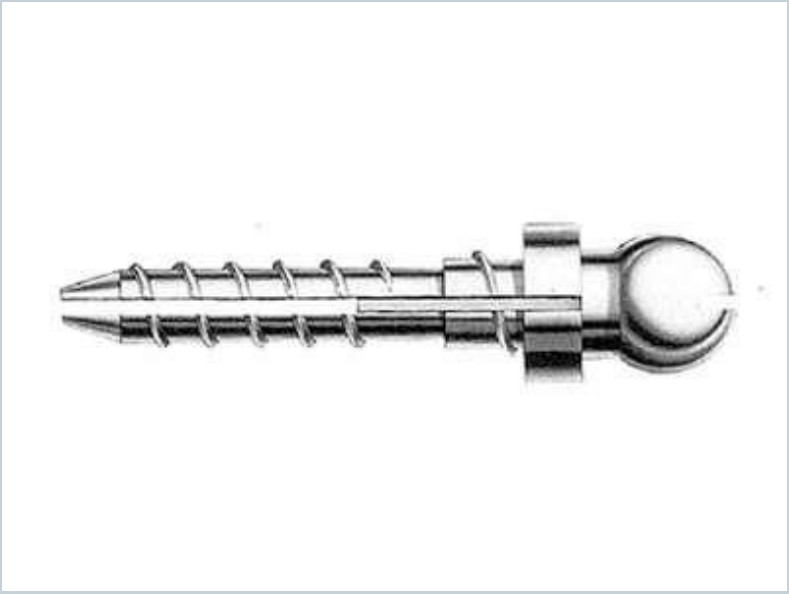
Zirconia Posts

- Zirconia posts are composed of zirconium dioxide (ZrO_2) partially stabilized with yttrium oxide and exhibit a high flexural strength.
- Zirconia posts are
  - esthetic,
  - partially adhesive,
  - very rigid,
  - but also brittle.

- Zirconia posts cannot be etched, and available literature suggests that bonding resins to these materials is less predictable and requires substantially different bonding methods than conventional ceramics. When a composite core is built on a zirconia post, core retention may also be a problem
- Other reports indicate that the rigidity of zirconia posts negatively affects the quality of the interface between the resin core material and dentin when subjected to fatigue testing

ACTIVE POSTS

- Active posts derive their primary retention directly from the root dentin by the use of threads. Most active posts are threaded and are intended to be screwed into the walls of the root canal.



- A major concern about threaded posts has been the potential for vertical root fracture during placement. As the post is screwed into place, it introduces great stresses within the root, causing a wedging effect. Therefore, it is generally accepted that *the use of threaded posts should be avoided.*
- Active posts are more retentive than passive posts, and can be used safely, only in substantial roots with maximum remaining dentin.
- Their use should be limited to short roots in which maximum retention is needed.

PASSIVE POSTS

- Passive posts are passively placed in close contact to the dentin walls, and their retention primarily relies on the luting cement used for cementation.

PARALLEL AND TAPERED POSTS

- A parallel post is more retentive than a tapered post but also requires removal of more root dentin during the preparation of the post space
- The lower retention obtained with the tapered-end post is attributed to the lack of parallelism in the apical portions
- Although tapered post shape requires less dentine removal and is more consistent with root anatomy, a growing body of evidence suggests that tapered, unbonded posts exert a wedge effect that puts the root at risk of fracture and predisposes to loss of retention

PRETREATMENT EVALUATION AND TREATMENT STRATEGY

- ✓ ENDODONTIC,
- ✓ PERIODONTAL,
- ✓ BIOMECHANICAL, AND
- ✓ ANATOMIC EVALUATIONS.

Endodontic Evaluation

- Endodontic retreatment is indicated for teeth showing radio- graphic signs of apical periodontitis or clinical symptoms of inflammation.
- Canals obturated with a silver cone or other inappropriate filling material should be endodontically retreated before starting any restorative therapy.

Figure 7: Post restoration radiograph.

Periodontal Evaluation

The following conditions are to be considered as critical for treatment success:

- Healthy gingival tissue
- Normal bone architecture and attachment levels to favor periodontal health
- Maintenance of biologic width and ferrule effect before and after endodontic and restorative phases

Biomechanical Evaluation

All previous events, from initial decay or trauma to final root canal therapy, influence the biomechanical status of the tooth and the selection of restorative materials and procedures

Important clinical factors include the following:

- The amount and quality of remaining tooth structure
- The anatomic position of the tooth
- The occlusal forces on the tooth
- The restorative requirements of the tooth
- Teeth with minimal remaining tooth structure are at increased risk for the following clinical complications
  - Root fracture
  - Coronal-apical leakage
  - Recurrent caries
  - Dislodgment or loss of the core/prosthesis
  - Periodontal injury from biologic width invasion

Anatomic Evaluation

- Root anatomy can also have significant influence over post placement and selection. Root curvature, furcations, developmental depressions, and root concavities observed at the external surface of the root are all likely to be reproduced inside the root canal. Within the same root, the shape of the canal will vary between the cervical level and the apical foramen
- The tooth is also weakened if root dentin is sacrificed to place a larger- diameter post. Following normal and appropriate endodontic instrumentation, teeth can possess less than 1 mm of dentin, indicating that there should be no further root preparation for the post.

BIOMECHANICAL PRINCIPLES

CONSERVATION OF TOOTH STRUCTURE

RETENTION FORM

RESISTANCE FORM

I. CONSERVATION OF TOOTH STRUCTURE

1. PREPARATION OF THE CANAL

- Remove minimal structure from the canal
- Excessive enlargement can weaken or perforate the tooth
- Thickness of remaining dentin - fracture resistance form
- Helfer AR et al 1972. stated that teeth cemented with thicker posts (1.8 mm) fractured more easily than those with a thinner (1.3 mm) one.
- Photo elastic studies also have show that internal stresses are reduced with thinner posts.

- Most roots have proximal concavities

- Felton DA 1991, said that most root fractures originate from these concavities because the remaining dentin thickness is minimal. Root canal should be enlarged only enough to enable the post to fit accurately yet passively while insuring strength and retention.

2. PREPARATION OF CORONAL TISSUE :

- As much of the coronal tooth structure should be conserved as possible because this helps reduce stress concentration at the gingival margin.
- Milton P and Stein R S 1992 stated that if more than 2 mm of coronal tooth structure remains, the post design probably has a limited role in the fracture resistance of restored tooth. A key element of tooth preparation when using a dowel and core is the incorporation of a ferrule

J Prosthet Dent 1990;64:515-19.

FERRULE

FERRUM – Iron

VIRIOLA – Bracelet

- A ferrule is a metal ring or cap used to strengthen the end of a stick or tube.

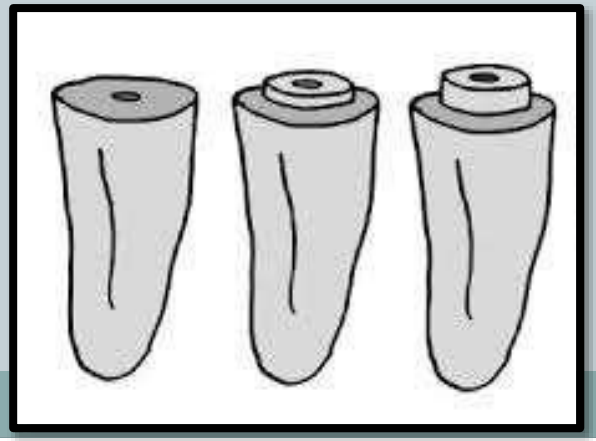
A dental ferrule is an encircling band of cast metal around the coronal surface of the tooth. (Brown 1993)

- A Subgingival collar or apron of gold which extends as far as possible beyond the gingival seat of the core and completely surrounds the perimeter of the cervical part of the tooth. It is an extension of the restored crown which, by its hugging action, prevents shattering of the root.(Rosen 1961)

- The ferrule effect be defined as "a 360 metal collar of the crown surrounding the parallel walls of the dentine extending coronal to the shoulder of the preparation". (Sorensen & Engelman)

- It is often confused with the remaining amount of sound dentine above the finish line.

- A ferrule, in respect to teeth, is a band that encircles the external dimension of residual tooth structure. A 2 mm height of tooth structure should be available to allow for a ferrule effect.

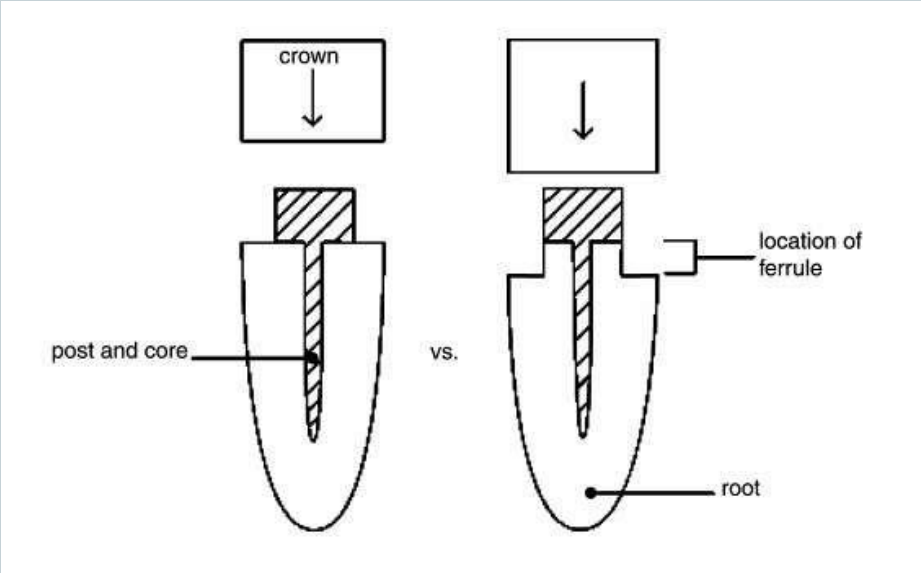


Galen WW, Mueller KI: Restoration of the Endodontically Treated Tooth. In Cohen, S. Burns, RC, editors: Pathways of the Pulp, 10th Edition

Stankiewicz & Wilson.The ferrule effect International Endodontic Journal, 35, 575-581, 2002

- Twenty extracted maxillary central incisors were divided into two groups; those with and those without a collar. Both the groups had 1 mm of buccal dentine, but the test group had a 2-mm collar preparation with approximately 3 degrees of wall taper, and a total convergence of 6 degrees.
- Cast post and cores were then cemented but no crowns were used. The teeth then underwent compressive loadinguntil root fracture.
- Barkhordar et al. (1989) found that a metal collar signi¢cantly increased resistance to root fracture. They also observed di¡erent fracture patterns in the collared teeth compared to those without collars. The collared group predominantly underwent patterns of horizontal fracture whereas the teeth without collars mainly exhibited patterns of vertical fracture (splitting).

- CROWN FERRULE: Ferrule created by the overlying crown engaging tooth structure.
- CORE FERRULE: Ferrules that are part of a cast metal.



REVIEW OF LITERATURE

SIGNIFICANCE OF FERRULES

Roubna Shamseddine and Farid Chaaban, "Impact of a Core Ferrule Design on Fracture Resistance of Teeth Restored with Cast Post and Core," Advances in Medicine, vol. 2016, Article ID 5073459, 8 pages, 2016

- In presence of circumferential 2 mm of ferrule a secondary ferrule added to the cast post and core will not enhance the strength of crowned anterior teeth. A ferrule added to the cast post and core complicates the escape of the zinc phosphate during the cementation procedure.

Kim et al. Effect of ferrule on the fracture resistance of mandibular premolars with prefabricated posts and cores. J Adv Prosthodont. 2017 Oct;9(5):328-334

- Endodontically treated mandibular premolars restored with prefabricated posts and metal crowns with 2 mm ferrule have a fracture resistance similar with that of intact teeth with metal crowns.
- Moreover, ETT without posts have no significant difference fracture resistance in comparison to those teeth with 0 mm or 1 mm ferrules.
- Within the limitations of this study, it could be concluded that fracture resistance of endodontically treated premolars was dependent on the length of ferrule, displaying significantly increased fracture resistance in the group with 2 mm ferrule in comparison to the groups with shorter ferrule lengths (F0, F1) and without post (NP).

Jovanovski, S., Popovski, J., Dakskobler, A., Marion, L., & Jevnikar, P. The Influence of Crown Ferrule on Fracture Resistance of Endodontically Treated Maxillary Central Incisors,*Balkan Journal of Dental Medicine*. 2017; *21*(1): 44-49

- **Within the limitations of this in vitro study, it can be concluded that zirconia post with press-ceramic cores and crowns, can be used for restoration of endodontically treated teeth.**
- **The teeth prepared with 2 mm external dentin ferrule length were found to be more fracture resistant than teeth without ferrule.**

Lazari et al. Survival of extensively damaged endodontically treated incisors restored with different types of posts-and-core foundation restoration material, The Journal of Prosthetic Dentistry. 2018; 119 (5):769-776

- The survival of extensively damaged endodontically treated incisors without a ferrule was slightly improved by the use of a fiber post with a bulk-fill composite resin core foundation restoration.
- However, none of the post-and-core techniques was able to compensate for the absence of a ferrule

Naumann et al. Ferrule Comes First. Post Is Second!" Fake News and Alternative Facts? A Systematic Review, JOE; 2018, 44 (2):212-219

- Ferrule effect and maintaining cavity walls are the predominant factors with regar dto tooth and restoration survival of endodontically treated teeth.
- Most studies do not confirma positive effect of post placement.

FACTORS AFFECTING FERRULE EFFECT

Trushkowsky RD:restoration of endodontically treated teeth:criteria and technique considerations. Quintessence int 2014;45:557–67

Ferrule Height

- Greater the height of remaining tooth structure better the fracture resistance.
- Ferrule height of 1.5 to 2 mm of vertical tooth structure would be the most beneficial.
- The crown should encompass at least 2 mm past the tooth core connection to achieve the most protective ferrule effect.

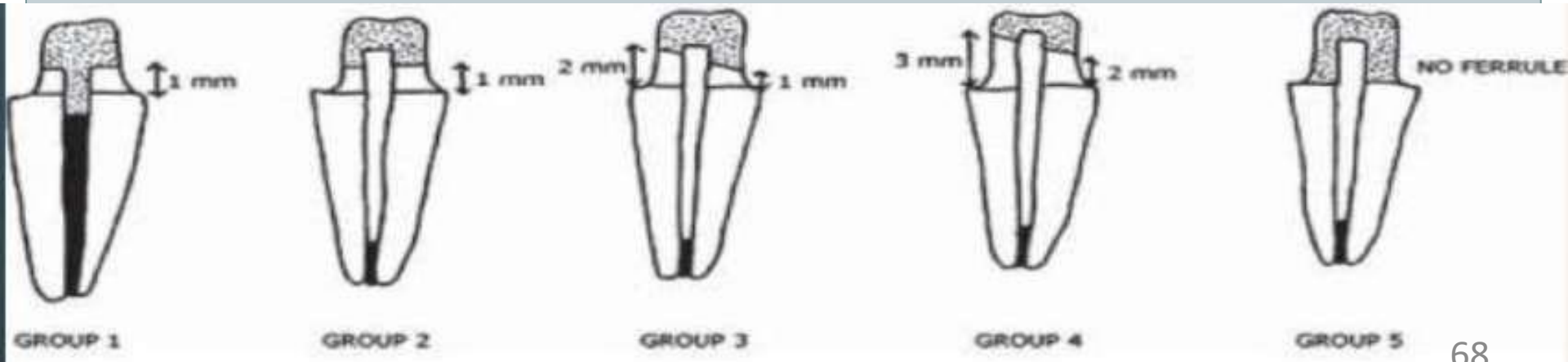
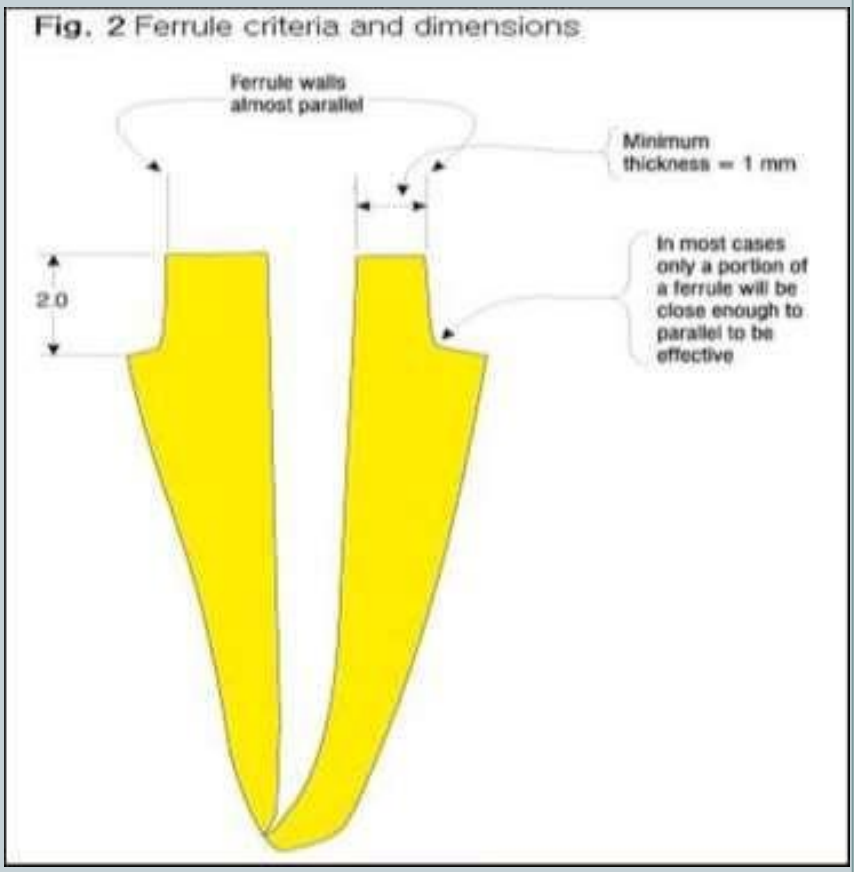


Figure 1- Schematic representation of the different tested groups

Ferrule Width

- Esthetic restorations often require fairly aggressive preparations at the gingival margin and sometimes buccal defects such as abfraction may compromise the buccal dentin wall.
- It has been accepted that the walls are considered too thin if they are less than 1 mm in thickness, and would negate the ferrule effect.



Number of walls and ferrule location

- A circumferential ferrule would be optimal but caries may affect the interproximal areas and abrasion or erosion the buccal walls.
- A crown preparation will further reduce the wall thickness and only a partial ferrule will remain.
- Ng et al said that good palatal ferrule is as effective as having a complete “all around” ferrule.
- Al-Wahadni and Gutteridge found having a 3- mm ferrule on the buccal aspect was better than having no ferrule at all

Type of tooth and extent of lateral load

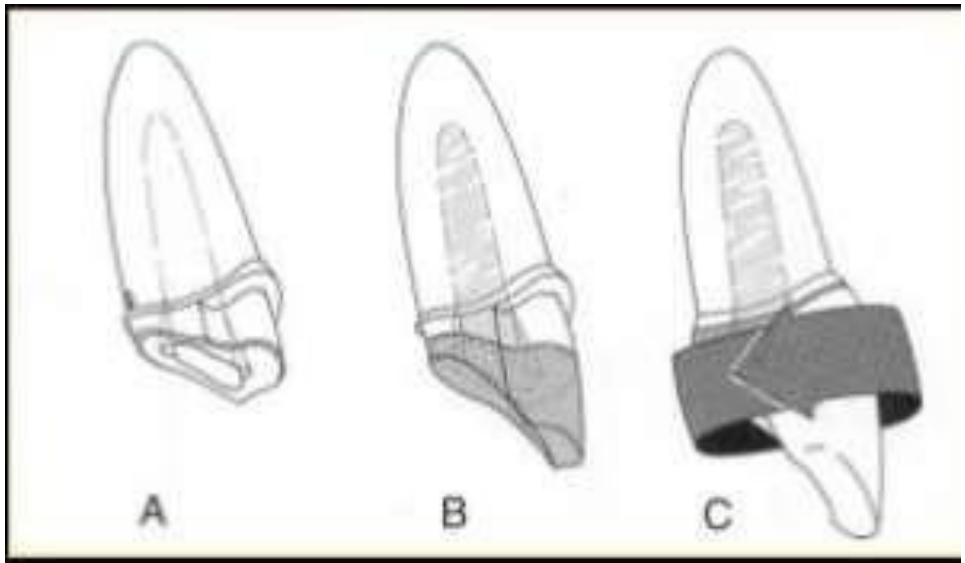
- Anterior teeth are loaded non-axially
- Posterior teeth are loaded occluso-gingivally.
- Anterior teeth with a deep overbite and parafunction are at a higher risk of failure.
- Teeth that are in group function with long maxillary buccal cusps produce higher lateral forces than if there was canine guidance.

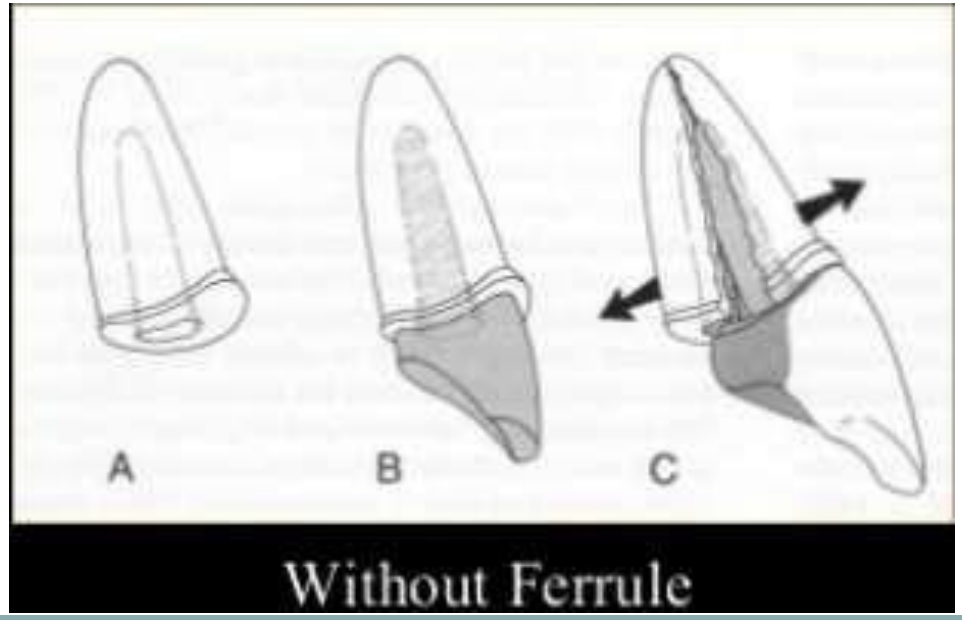
ADVANTAGES OF FERRULE

1. Promoting hugging action,
2. Preventing the shattering of the root,
3. Antirotational effect
4. Reducing the wedging effect of a tapered dowel, and
5. Resisting functional lever forces and the lateral forces exerted during dowel insertion

Rosen H: Operative procedures on mutilated endodontically treated teeth. J Prosthet Dent 1961;11:973-986.

Sorensen JA, Engelman MJ: Ferrule design and fracture resistance of endodontically treated teeth. J Prosthet Dent 1990;63:529-536


A
B
C
With Ferrule


A
B
C
Without Ferrule

How to create ferrule in a no ferrule case

1. Crown lengthening
2. Forced eruption

II. RETENTION FORM

Post retention is defined as the ability of a post to resist vertical dislodging forces

1. Preparation Geometry
2. Post Configuration
3. Post length and diameter
4. Surface Texture
5. Luting Agent
6. Number of posts

1. PREPARATION GEOMETRY

- Circular cross section canals should be prepared with parallel walls or mimum taper,allowing use of parallel-prefabricated post.
- Elliptical or excessively flared canals cannot be prepared to give parallel walls and require custom cast posts or tapered prefabricated posts.

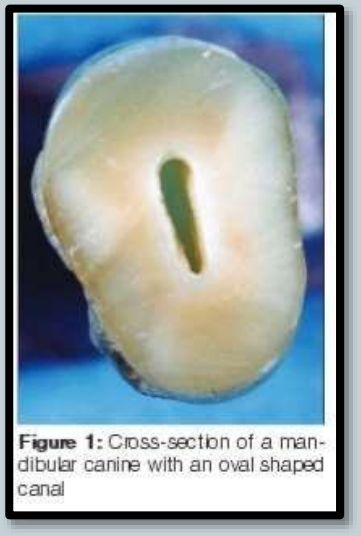


Figure 1: Cross-section of a mandibular canine with an oval shaped canal

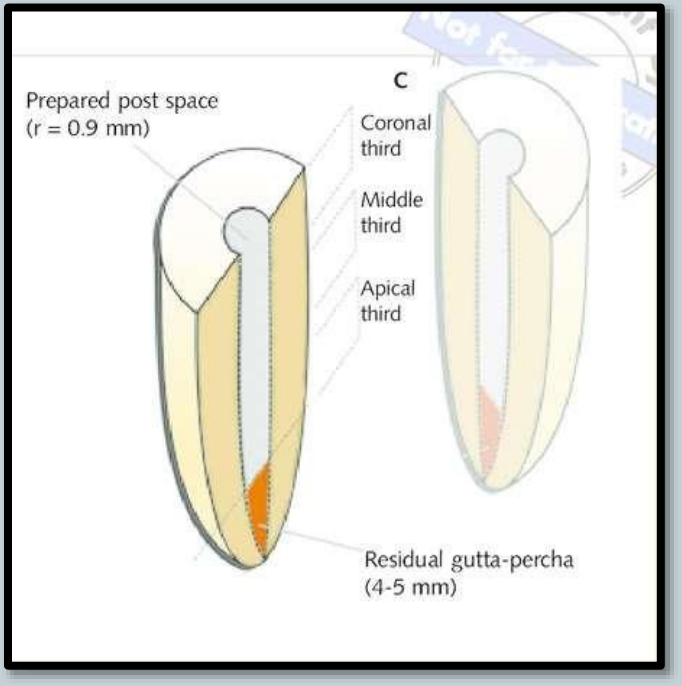
2. POST CONFIGURATION

- Custom made posts are more retentive then the prefabricated as they are designed according.
- Laboratory testing has confirmed that –
  - Parallel sided posts are more retentive than tapered posts. –
  - Threaded posts are the more retentive than smooth posts.

J Prosthet Dent 1995;73:139-44.

3. POST LENGTH

- Retention increases with increase in post length.
- One study shows that retention increases by more than 97% when post length equals or is greater than crown length.
- However, this length must be well within constraints of tooth length, canal morphology and root diameter in the apical area.
- When average root length is encountered, post length is dictated by retaining 5 mm of apical gutta-percha and extending the post down to the gutta-percha



- Whenever possible, posts should extend atleast 4mm apical to the bone crest to decrease dentin stress.
- Molar posts should not be extended more than 7 mm into the root canal apical to the base of the pulp chamber

Figure 10 Five millimeters of gutta-percha was retained in the maxillary premolar and the post extended to that point.

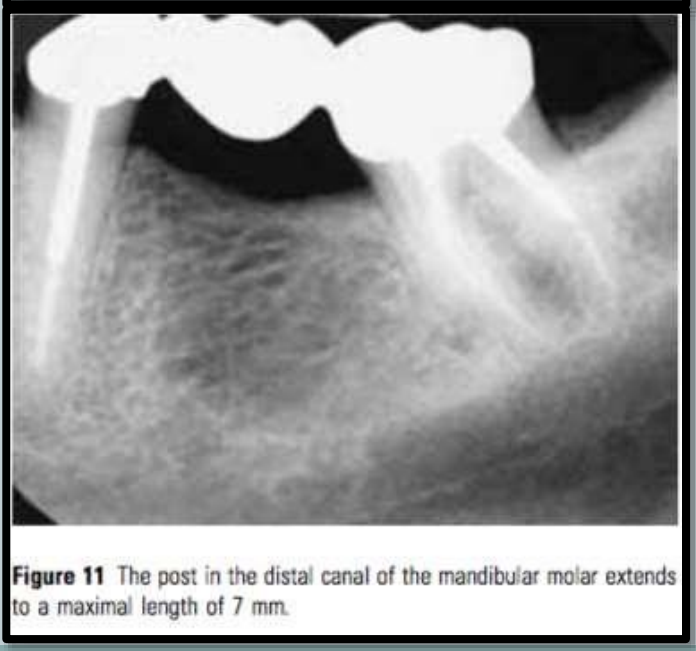


Figure 11 The post in the distal canal of the mandibular molar extends to a maximal length of 7 mm.

Guidelines for Post Length

1. The post length should equal the incisocervical or occlusocervical dimension of the crown (Harper RH et al; 1976, Mondelli J et al; 1971, Goldrich N; 1970, Rosenberg PA et al; 1971)
2. The post should be longer than the crown (Silverstein WH et al; 1964).
3. The post should be one and one third of the crown length (Dooley BS; 1967)
4. The post should be one half of the root length (Baraban DJ; 1967, and Jacoby WE;1976).
5. The post should be two thirds of the root length (Dewhirst RB et al; 1969, Hamilton AI;1959, Larato DC et al; 1966, Christy JM et al; 1967, and Bartlett SO; 1968).

6.The post should be four fifths of the root length (Burnell SC; 1964).

7.The post should be as long as possible without disturbing the apical seal (Henry PJ et al; 1977).

8.The post preparation for molars should be limited to a depth of 7mm apical to the canal orifice (Abou-Rass M et al; 1982).

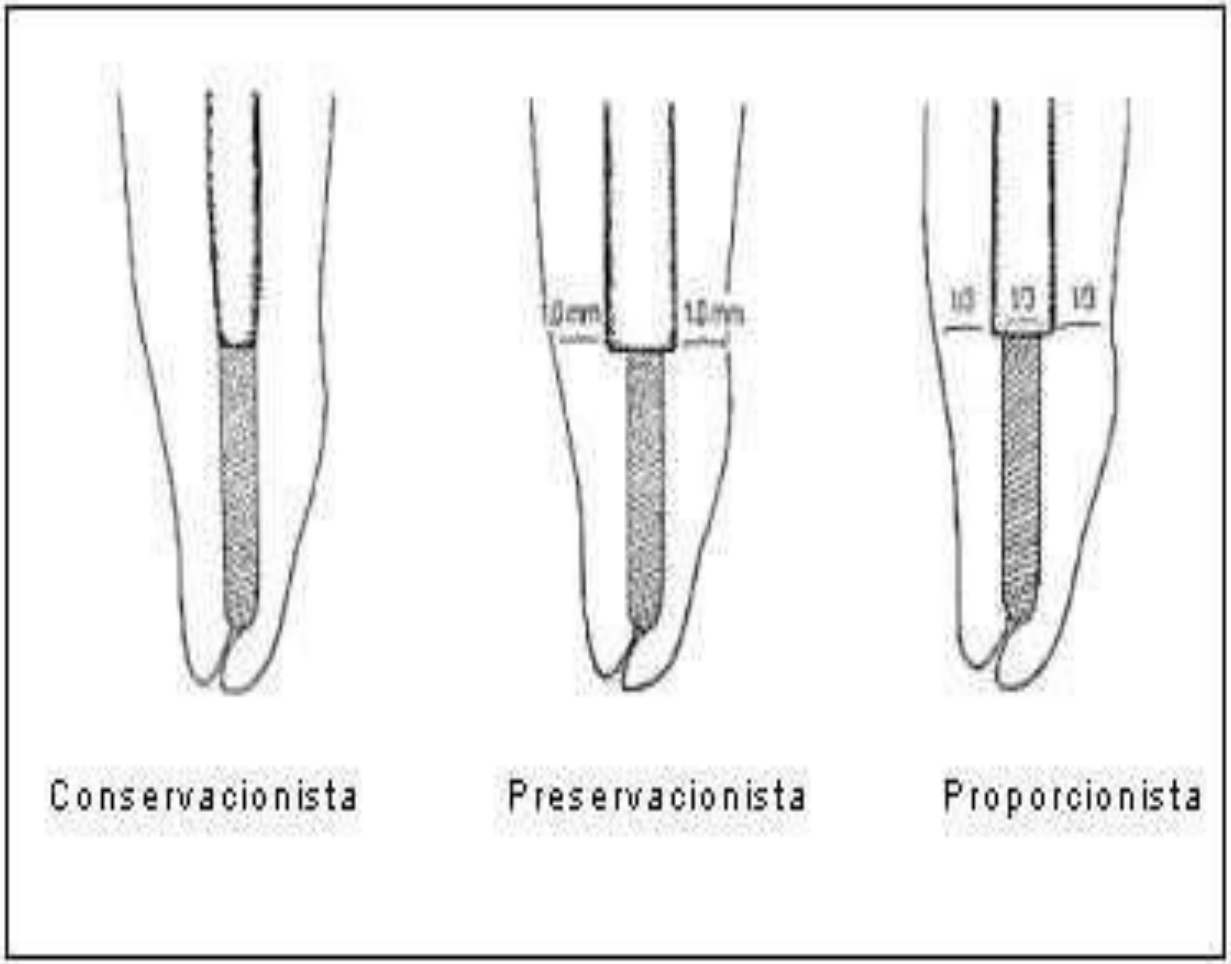
9.Perel and Muroff (1972) recommended that the post be at least half the length of root in bone.

10.To minimize stress in the dentin and in the post, the post should extend more than 4mm apical to the bone crest to decrease dentin stress

4. POST WIDTH

- Whether posts are cemented or threaded, diameter makes little difference in retentive ability.
- Instead, if the post diameter is increased, the amount of remaining dentin between the post and the external surface of the root is decreased.
- This diminished remaining dentin becomes an area of high stress concentration under load and, consequently, an area with a high potential for failure.
- The smallest diameter post that is practical should be used for a given clinical situation.
- Deusch et al determined that there was a six fold increase in the potential for root fracture with every millimeter the tooth's diameter was decreased.

- There are three schools of thoughts regarding the post diameter –
- Conservationist (Advocated by Mattison) : The post should be of the narrowest diameter that allows its fabrication for desired length
- Preservationist (Advocated by Halle): – The entire surface of the dowel was surrounded by atleast 1mm of sound dentin
- Proportionist (Advocated by Stern and Hirschfeld) : The apical diameter of the post space should be equal to one third the narrowest dimension of the root diameter at the terminus of root space


Conservacionista
Preservacionista
Proporcionista

Post space width according to Shillinburg

Reamer Number	Diameter	Teeth
1	0.7mm	Mandibular incisor
2	0.9mm	Maxillary first premolar Maxillary second molar (DF) Mandibular first molar (ML) Mandibular second molar (MF, ML)
3	1.1mm	Maxillary second premolar Maxillary first molar (MF, DF) Maxillary second molar (MF) Mandibular first molar (MF, D) Mandibular second molar (D)
4.	1.3 mm	Maxillary lateral incisor Mandibular premolar Maxillary molar (L)
5	1.5mm	Canine
6	1.7 mm	Maxillary central incisor.

6. SURFACE ROUGHNESS

- D'Arcangelo C et al has shown that by acid etching the surface of the fiber posts with hydrofluoric acid and sand blasting through SEM analysis that presence of microretentive morphological changes, which certainly increase post-retentive properties without decreasing their flexural properties.

- Monticelli F has shown the adverse effects of using Hydrofluoric acid for etching the fiber posts as it can cause the extensive damage to the fiber posts by giving rise to the micro-cracks and longitudinal fractures of the fiber layers.

- In order to enhance retention, it is advised that before the cementation of a post, the canal space should be cleaned by application of a chelating agent to remove the smear layer. When smear layer is removed, it allows the cement to enter the dentinal tubules and provide micromechanical retention.

- Commonly used agents for post space irrigation include EDTA or 5-5.25% NaOCl that denatures protein and removes collagen, and Acids (such as 50% citric acid and 37% phosphoric acid) that remove the smear layer and demineralise dentin as stated by Keles A et al.

6. LUTING AGENT

- Any of the current luting cements can be successfully used with a post if the proper principles are followed.
- The most commonly used luting agents are: zinc phosphate, resin cement, glass-ionomer and resin-modified glass ionomer.
- However, Resin-modified glass ionomer cements should be avoided as they expand on water absorption and may cause root fracture.
- Generally, in the past, zinc phosphate was the cement of choice, but, recent trend has been toward resin cements because they:
  - – Increase retention.
  - – Tend to leak less than other cements.

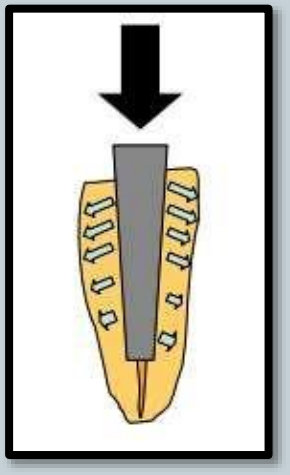
7. NUMBER OF POSTS

- It is possible to place more than one post in teeth with multiple roots.
- Additional posts may be used, where feasible, to increase retention and retain core material, especially in severely broken down teeth

III. RESISTANCE FORM

- Resistance is defined as the ability of the post and tooth to withstand lateral and rotational forces.
- One of the functions of a post and core restoration is to improve resistance to laterally directed forces by distributing them over as large an area as possible.
- However, excessive preparation of the root weakens it and increases the probability of failure.
- The post design should distribute stresses as evenly as possible.

- The influence of post design on stress distribution has been tested using.
  - ☐Photo elastic materials.
  - ☐Strain gauges and
  - ☐Finite elements analysis



- The greatest stress concentrations are found at the shoulder, particularly interproximally, and at the apex.
- Dentin should be conserved in these areas

- Stress is reduced as post length increases. But excessive length reduces the thickness of dentin at the apical area and hence the fracture resistance decreases.
- Parallel-sided posts distribute stresses more evenly than tapered posts, which can have a wedging effect. However, parallel posts generate high stresses at the apex.
- Sharp angles should be avoided as they produce high stresses during loading.

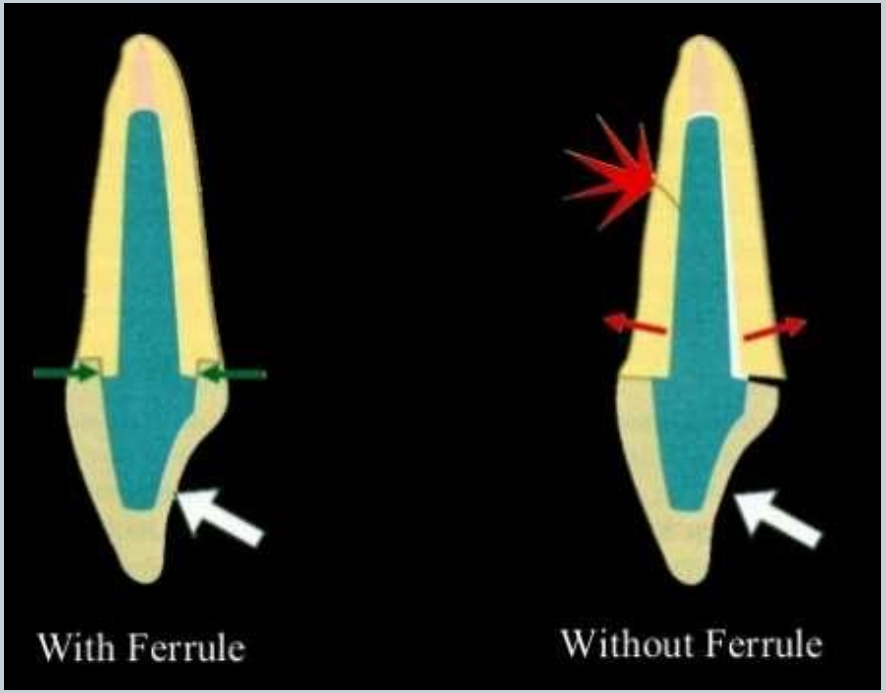
- High stress can be generated during insertions of smooth parallel-sided posts that have no vent for escape of cements. Therefore, in these posts, longitudinal grooves (vents) running along the length of the post should be provided to allow escape of cement thus reducing the hydrostatic pressure and generation of stress.
- Tapered posts are self-venting and generally do not require vents.
- Threaded posts can produce high stresses during insertion and loading, but they have been shown to distribute stress evenly if the posts are backed off a half-turn.

Rotational Resistance

- In molars it's commonly achieved by the square shape of the tooth; however premolars and anterior teeth are commonly more round.
- It is important that a post with a circular cross section not rotate during function.
- Where sufficient coronal tooth structure remains, this should not present a problem because the axial wall then prevents rotation.
- When coronal dentin has been completely lost, a small groove placed in the canal can serve as an anti-rotational element.
- The groove is normally placed where the root is bulkiest, usually on the lingual aspect.

- Many cast posts resist rotational forces because they are oblong in cross section. However, the cast post for round canals, such as the maxillary incisor requires locking notches or keyways incorporated into the canal to resist rotational movement (Gutmann JL et al; 1977, and Dewhirst RB et al; 1969).

- Ferrule is an important feature in the resistance form



1.

With Pulpless Teeth, Do Posts Improve Long-Term Clinical Prognosis or Enhance Strength?

- Both laboratory and clinical data fail to provide definitive support for the concept that posts strengthen endodontically treated teeth. Therefore, the purpose of a post is to provide retention for a core.

2.

What Is the Clinical Failure Rate of Posts and Cores?

- Posts and cores had an average clinical failure rate of 9% (7 to 14% range) when the data from 10 studies were combined (average study length of 8 years).

3.

What Are the Most Common Types of Post and Core Failures?

- Loss of retention and tooth fracture are the two most common causes of post and core failure.

4.

Which Post Design Produces the Greatest Retention?

- Tapered posts are the least retentive and threaded posts the most retentive in laboratory studies
- Most of the clinical data support the laboratory findings.

5.

Is There a Relationship Between Post Form and the Potential for Root Fracture?

- When evaluating the combined data from multiple clinical studies, threaded posts generally produced the highest root fracture incidence (7%) compared with tapered cemented posts (2%) and parallel cemented posts (1%).

6.

What Is the Proper Length for a Post?

- Make the post approximately two-third of the length of the root when treating long-rooted teeth.
- When average root length is encountered, post length is dictated by retaining 5 mm of apical gutta-percha and extending the post to the gutta-percha
- Whenever possible,posts should extend atleast 4mm apical to the bone crest to decrease dentin stress.
- Molar posts should not be extended more than 7 mm into the root canal apical to the base of the pulp chamber

7.

How Much Gutta-Percha Should Be Retained to Preserve the Apical Seal?

- Since there is greater leakage when only 2 to 3 mm of gutta-percha is present, 4 to 5 mm should be retained apically to ensure an adequate seal.

8.

Does Post Diameter Affect Retention and the Potential for Tooth Fracture?

- Laboratory studies relating retention to post diameter have produced mixed results, whereas a more definitive relationship has been established between root fracture and large-diameter posts

9.

What Is the Relationship Between Post Diameter and the Potential for Root Perforations?

- Safe instrument diameters to use are 0.6 to 0.7 mm for small teeth such as mandibular incisors and 1 to 1.2 mm for large-diameter roots such as the max- illary central incisors. Molar posts longer than 7 mm have an increased chance of perforations and there- fore should be avoided even when using instruments of an appropriate diameter.

10.

Can Gutta-Percha Be Removed Immediately after Endodontic Treatment and a Post Space Prepared?

- Adequately condensed gutta-percha can be safely removed immediately after endodontic treatment.

11.

What Instruments Remove Gutta-Percha Without Disturbing the Apical Seal?

- Both rotary instruments and hot hand instruments can be safely used to remove adequately condensed gutta-percha when 5 mm is retained apically.

12.

How Soon should the Definitive Restoration Be Placed After Post Space Preparation?

- Following endodontic treatment, post space preparation should be performed and a post definitively cemented as soon as possible: the same day for a prefabricated post, and as soon as possible for a custom-fabricated post and core. The prepared tooth should then be restored with a well-fitting provisional restoration (good marginal seal and occlusion) followed by cementation of the definitive crown in as short a time as possible.

13.

Does the Use of a Cervical Ferrule that Engages Tooth Structure Help Prevent Tooth Fracture?

- Differences of opinion exist regarding the effectiveness of ferrules in preventing tooth fracture. Ferrules have been tested when they are part of the core and also when the ferrule is created by the overlying crown engaging tooth structure. Most of the data indicate that a ferrule created by the crown encompassing tooth structure is more effective than a ferrule that is part of the post and core

POST SPACE PREPARATION

1. . SELECTIONOFROOT
2. REMOVAL OF GUTTA PERCHA
3. ENLARGEMENT OF THE CANAL
4. IMPRESSION:
    1. DIRECT TECHNIQUE
    2. INDIRECT TECHNIQUE
5. INVESTMENT AND CASTING
6. CEMENTATION

1. ROOT SELECTION IN CASE OF MULTIROOTED TEETH

PREMOLARS

- When posts and cores are needed in premolars, posts are best placed in the palatal root of the maxillary premolar and the straightest root of the mandibular premolar. The buccal root could be prepared to a depth of 1 to 2 mm and to serve as an antirotational lock, if needed.

MOLARS

- When posts and cores are needed in molars, posts are best placed in roots that have the greatest dentin thickness and the smallest developmental root depressions.
- Maxillary molars : palatal roots
- Mandibular molars :distal roots
- The facial roots of maxillary molars and the mesial root of mandibular molars should be avoided if at all possible. If these roots must be used, then the post length should be short (3 to 4 mm) and a small-diameter instrument should be used (no larger than a No. 2 Peeso instrument that is 1.0 mm in diameter).

2. GUTTA PERCHA REMOVAL

Three methods have been advocated for the removal of gutta-percha during preparation of a post space:

1. Chemical (oil of eucalyptus, oil of turpentine, and chloroform),
2. Thermal (electrical or heated instruments), and
3. Mechanical (Gates Glidden drills, Peeso reamers, etc.).

- The chemical removal of gutta-percha for post space preparation is not utilized for specific reasons (microleakage, inability to control removal)

- However, thermal and mechanical techniques or a combination of both are routinely used.

- Dentists often use mechanical preparation techniques for post spaces because it is faster. The thermal method of removing gutta-percha using heat pluggers is safer but more time-consuming.

- When mechanical preparation is preferred, it has been established that Gates-Glidden drills and Peeso reamers used on low speed are the safest instruments.

- The provision of a longer post that preserves maximum root dentine and 4-5 mm of gutta percha apical seal, combined with extra-coronal support offers the best prognosis.

- A post length of 7.0-8.0 mm is frequently stated as a typical guideline.

Removal with a heated endodontic condenser

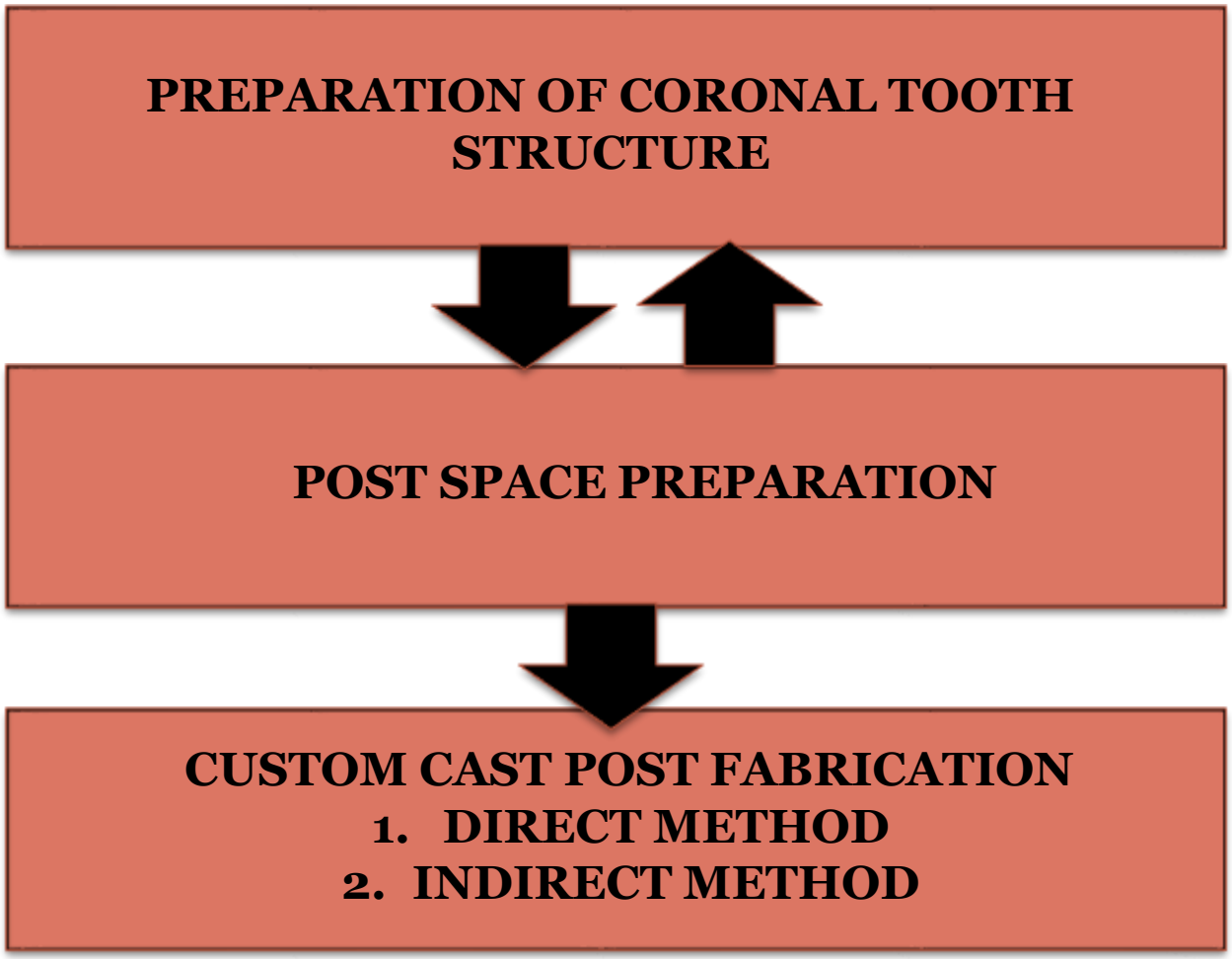
- In this method a heated endodontic plugger or an electronic device is used to remove the gutta-percha.
- This method is commonly used when gutta- percha is to be removed right after obturation as there are minimal chances of disturbing the apical seal.

TECHNIQUE:

- Apply rubber dam to prevent aspiration of instrument.
- Select an endodontic condenser large enough to hold heat well but not so large that it binds against the canal walls.
- The instrument is heated till it is red hot, inserted into the gutta-percha and is quickly withdrawn.
- This sears off the gutta-percha.

Removal with Rotary Instruments

- GG drills and Peeso Remaers are most often used.

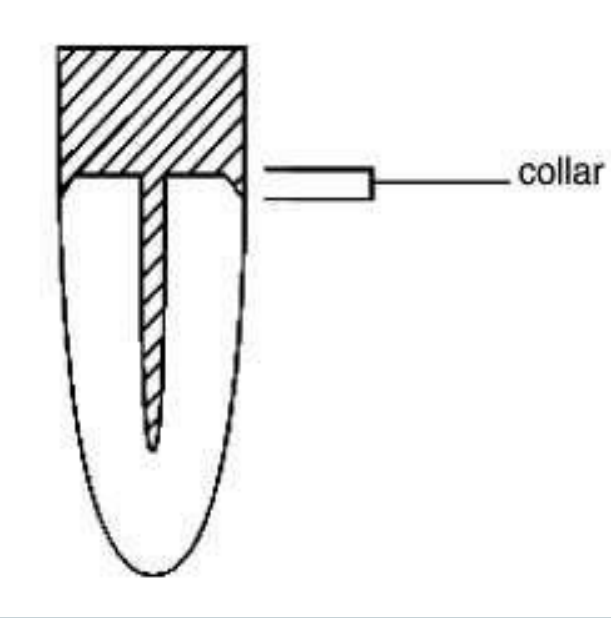

PREPARATION OF CORONAL TOOTH STRUCTURE
POST SPACE PREPARATION
CUSTOM CAST POST FABRICATION
1. DIRECT METHOD
2. INDIRECT METHOD

Preparation of Coronal Tooth Structure

- Ignore any missing tooth structure and prepare the remaining tooth as though it was undamaged.
- The facial surface (in anteriors) should be adequately reduced for good esthetics.
- Remove all undercuts that will prevent removal of pattern.
- Preserve as much tooth structure as possible.
- Prepare the finish line at least 2mm gingival to the core. This establishes the ferrule.


Armamentarium For Coronal Tooth Structure Preparation

- For custom-made post and core restorations, place a contra bevel with a flame-shaped diamond at the junction of the core and tooth structure.
- The bevel provides a metal collar around the occlusal circumference of the preparation (in addition to the ferrule) in bracing the tooth against fracture.
- It also provides a vertical stop to prevent over-seating and wedging effect of the post.
- Complete the preparations by eliminating sharp angles and establishing a smooth finish line.



POST FABRICATION

DIRECT TECHNIQUE

- Trim a 14-gauge solid plastic sprue so that it slides easily into the canal to the apical end of the post preparation without binding.
- Cut a small notch on the facial portion to aid in orientation during subsequent steps.
- Mix acrylic resin monomer and polymer to a runny consistency.
- Lubricate canal with petroleum or any other lubricating agent, on cotton wrapped on a Peeso reamer.
- Fill the orifice of the canal as full as possible with acrylic resin applied with a plastic filling instrument.
  - Alternatively: – In the doughy stage, roll the resin into a thin cylinder, introduce it in the canal and push it to place with the monomer-softened sprue.

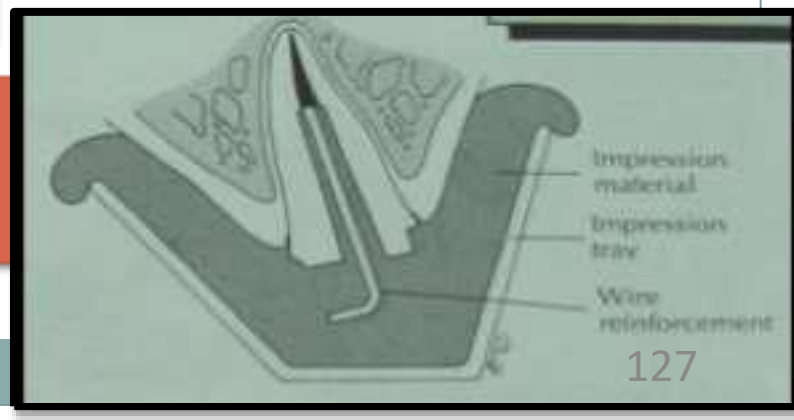
- Seat the monomer coated sprue completely into the canal.
- Make sure the external bevel is completely covered with resin at this time. Trying to cover it later may disturb the fit of the post. When acrylic resin becomes tough and doughy, pump the pattern in and out to insure that it will not lock into undercuts.

- As the resin polymerizes, remove post from canal and make sure it extends till the apical end.
- If required, additional resin can be placed at the apical end and the post is reseated and removed. Any voids can be filled with soft dead wax e.g. utilizing wax Reinsert and remove to ensure smooth withdrawal.
- Slightly overbuild the core and allow it to fully polymerize.
- Shape the core with carbide finishing burs.
- Correct any small defects with wax

- A direct pattern can also be made using inlay wax in a similar manner.
- Add more resin or wax to form the core.
- Shape it in the form of the final preparation.

INDIRECT PROCEDURE

- Orthodontic wire is bent to form a J-shape
- It is inserted into the canal and the fit is verified
- Coat is wired with adhesive and the canal is lubricated
- Canal, with the seated wire, is injected with elastomeric impression material
- Some of the impression material is syringed around the teeth and impression is taken



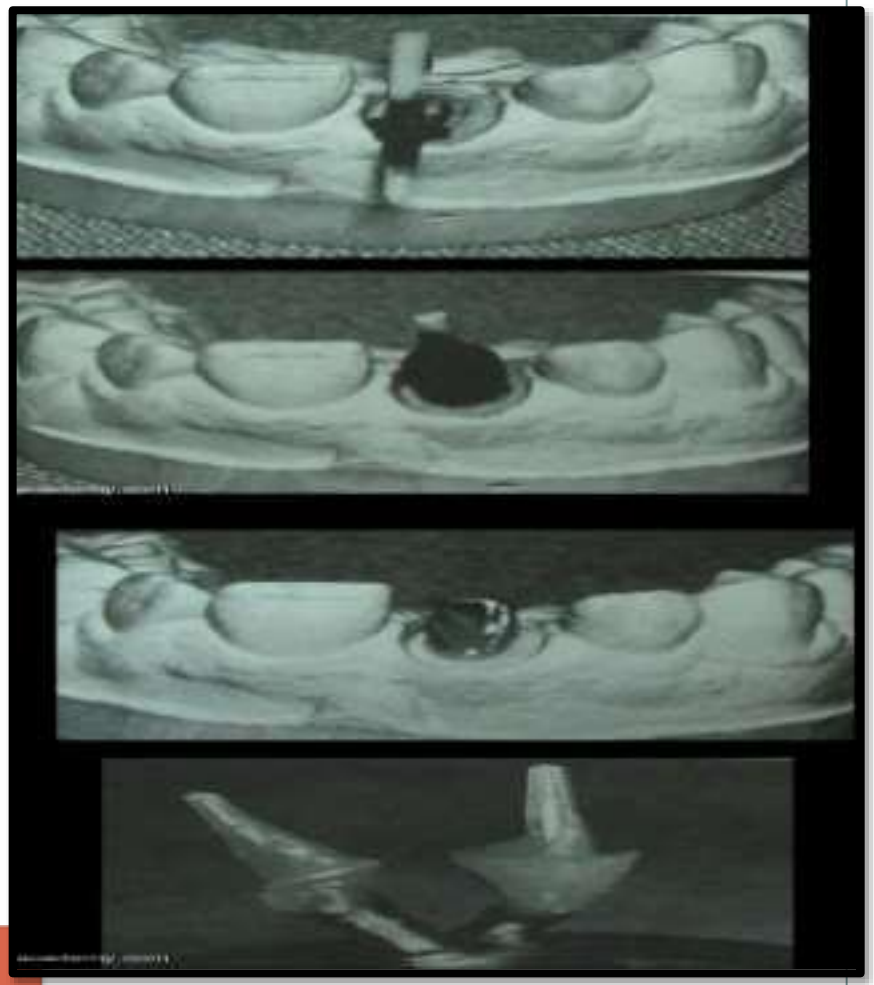
Cast is poured

In the lab a plastic post is selected and it is extended to the full depth using impression as a guide

Stine cast is lubricated, and inlay wax is added in increments on post

Post pattern is fabricated followed by core fabrication and shaping

Casting of the pattern is done



INVESTING AND CASTING

- The post-core pattern is sprued on the incisal or occlusal end.
- 1.0 to 2.0cc of extra water is added to the investment and a liner is omitted to increase the casting shrinkage.
- This results in a slightly smaller post that does not bind in the canal, and it also provides space for the cement.
- A tight fit may cause root fracture.
- When resin is used, the pattern should remain for 30 minutes longer in the burnout oven to ensure complete elimination of the resin.
- The final post, core and crown should be fabricated as soon as possible, because microleakage can contaminate the post space and endodontic fill.

TRY IN

- Check the fit of the post-core in the tooth by seating it with light pressure.
- If it binds in canal or will not seat completely, air abrade the post and reinsert it in the canal.
- The core portion of the casting should be polished.
- If required, a vertical groove, from apical end to contrabevel, can be cut in the post to provide an escape vent for the cement.
- The canal should be cleaned with a cavity cleaner to remove lubricant / temporary cement which may inhibit set of resin cements and decrease retention.

CEMENTATION

- Cements are best introduced into the canal with a lentulo-spiral and the post also coated with cement. The most commonly used dental cements—
  - zinc phosphate,
  - polycarboxylate,
  - glass ionomer cement,
  - resin-based composite
  - hybrid of resin and ionomer cements
- zinc phosphate has had the longest history of success.
  - In the case of an endodontic failure, a metal post that is cemented in the canal space with zinc phosphate is easier to remove and has a lower risk of root fracture compared with a metal post that is bonded strongly with a resin-based composite cement in the root canal space.
- Resin-based composite, on the other hand, is becoming increasingly popular because of its potential to bond to dentin

Any residual gutta-percha and root canal sealer must be removed from the dentinal walls to ensure proper bonding of resin to dentin

Removal of the demineralized collagen layer using a specific proteolytic agent such as sodium hypochlorite has been shown in an SEM study to improve the bonding of resin to the root canal wall owing to the penetration of resin tags into dentinal tubules along the wall.

A lentulo spiral can be used to carry acid etchant into the post space, while a fine-tipped microapplicator can be used to coat the canal walls with bonding agent..

PRINCIPLES OF CORE BUILD UP

- CORE REFERS TO A BUILD U P RESTORATION, USUALLY AMALGAM/COMPOSITE PLACED IN A BADLY BROKEN DOWN TOOTH TO RESTORE THE BULK OF THE CORONAL P ORTION OF THE TOOTH TO FACILITATE SUBSEQUENT RESTORATION BY MEANS OF AN INDIRECT EXTRACORONAL RESTORATION.
- IT MAY SERVE AS EITHER FINAL RESTORATION OR AS A FOUNDATION FOR A CROWN.

Morgano and brackett described some of the desirable features of a core material. They include:

- Adequate compressive strength to resist intraoral forces
- Sufficient flexural strength
- Biocompatibility
- Resistance to leakage of oral fluids at the core-to tooth interface
- Ease of manipulation
- Ability to bond to remaining tooth structure
- Thermal coefficient of expansion and contraction similar to tooth structure
- Dimensional stability
- Minimal potential for water absorption
- Inhibition of dental caries.

According to Weine

- Stability in wet environment
- Ease of manipulation
- Rapid, hard set for immediate crown preparation
- Natural tooth color
- High compressive strength
- High tensile strength
- High fracture toughness
- Low plastic deformation
- Inert (no corrosion)
- Cariostatic properties
- Biocompatibility
- Inexpensiveness.

CORE MATERIALS

- Cast core
- Amalgam
- Composite
- Glass ionomer cement
- Resin modified glass ionomer cement

Cast Core

- Core is an integral part of the post and it does not need mechanical means for retention to the post
- Prevents dislodgment of core and crown from post
- Sometimes, more structure is removed for space preparation to create path of withdrawal
- Placing cast gold post and core, however, is an indirect procedure requiring two visits.

Amalgam

- Widely used for the longest time.
- Placing an amalgam core requires a prolonged setting time, making it difficult to prepare immediately after placement if a crown is the final restoration.
- Requires additional pins to provide retention and resistance to rotation
- The presence of mercury in amalgam, was also of concern
- Esthetic problems with ceramic crowns and make gingiva look dark
- No natural adhesive properties and needs adhesive system

Glass Ionomer Cements

- Lack adequate strength and fracture toughness
- Not to be used in teeth with extensive loss of structure
- Soluble and sensitive to moisture

Composite

- Resin-based composite offers an esthetically pleasing material especially in the anterior section under an all-porcelain restoration.
- Most widely accepted and used
- Advantages:
  - Good bonding for retention
  - High tensile strength
  - Tooth can be prepared right after polymerization
  - Esthetic
  - Fracture resistance comparable to amalgam
  - It has good strength characteristics and low solubility.

- Disadvantages:
  - Polymerization shrinkage causing gaps in areas where adhesion is the weakest
  - Adhesion to dentin on pulpal floor is not as strong
  - Strict isolation

- One in vitro study comparing resin-based composite, amalgam and cast gold as core material under a crown in ET teeth found no significant difference in fracture and failure characteristics among these materials

Robbins WJ. Restoration of the endodontically treated tooth. Dent Clin N Am 2002;46:367–384.

THE FINAL RESTORATION

- Castings such as gold onlay, gold crowns, metal-ceramic crowns, and all-porcelain restorations with cuspal coverage are used routinely as standard and acceptable methods to restore posterior ET teeth.

FAILURE

- Vire classified failure of endodontically treated teeth are:
  - Prosthetic failures.
  - Periodontic failures.
  - Endodontic failures.
- Of these, prosthetic failures occurred 59.4% of the times, thus emphasizing the need to properly restore endodontically treated teeth to increase their longevity.

- For post and core restorations, failure rates between 7% and 15% have been reported in the literature (Torbjorner).
- The main factors that make endodontically treated teeth more disposed to technical failure are:
  - Root fracture: Thin-walled weakened roots unable to withstand high stress.
  - Dislodgement of post: Reduced retentive surfaces resulting in high stress levels in the cement.
  - Fracture of post.
  - Caries
  - Periodontal disease.
- Careful, case selection, adherence to biomechanical principles of post and core restoration, appropriate post selection and meticulous maintenance of oral hygiene on the part of the patient can prevent this.

CONCLUSION: PRACTICAL CONSIDERATIONS

- Posts should be placed along the long axis of the tooth and should be in the center of the root or canal, as this is considered as a neutral area with regard to force concentration.
- The length of the post has a significant effect on retention and resistance.
- The narrowest possible post diameter should be chosen.
- The post selected should be parallel sided, serrated, vented, and passive. It must be well adapted to the canal wall.
- Active posts are to be considered in case there is a need for increased retention, but care must be taken to avoid insertion stresses.
- Of the post materials, titanium is the most biocompatible. But lately, nonmetallic posts, like carbon fiber-reinforced epoxy resin posts and zirconia posts, are available.

- Ideally, dissimilar metals should not be used in the post, core, and crown.
- In case of flared canals or extensively damages tooth CAST POST and core is indicated.
- In CAST POST and CORE FERRULE is one very important feature that should be incorporated.
- Of the various cements available, zinc phosphate cement is a time tested one. Resin cement has been demonstrated to provide greater retention and resistance, but should be chosen only in conditions where excess retention is required.
- One of the factors that will affect the success of resin cement is the eugenol from the endodontic sealer. In this condition, it is recommended that the post space be cleaned by EDTA, followed by rinsing with sodium hypochlorite and water in succession. The distribution of cement in the post space has to be done with the help of a lentulospiral.

- When a prefabricated post is used, the core material should be either amalgam or composite resin. This core material should be used with a bonding agent.
- The clinician should retain as much coronal dentin as possible. In case the exposed dentin is not sufficient, surgical crown lengthening and/or orthodontic extrusion can be considered to give an adequate ferrule of 1.5 to 2 mm for the final crown.
- In endodontically treated posterior teeth, complete coverage is mandatory.
- Tooth function must be considered when determining the need for a post and core

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