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Restoring the Endodontically Treated Tooth:Post and Core Design and Material
根管治療後牙齒的修復：Post and Core 的設計與材料

前言

牙齒經過根管治療之後，由於失去血液的供應，較容易脆裂，故常須要 Post-core 以強化牙齒並增加 Retension，專科醫師建議，根管治療之後若所剩的牙齒構造仍足夠，" No post is the best post " 只須要build up core，反之，當牙齒構造不足時，則須 Build up Post & Core 以強化牙齒及支撐未來的牙冠，本文將建議 Build up Post & Core 所須要的原則。

理想的根管治療，牙齒將會符合以下的情況

1. Good prognosis
2. Resume full function
3. Serve satisfactorily as an abutment for a fixed or removable partial denture

Definition

Dowel:

a post, usually made of metal that is fitted into a prepared root canal of a tooth that has had endodontic therapy

Core:

the coronal aspect of the post foundation

Restorative Challenge

1. Insufficient sound coronal tooth structure due to:
   - Caries
   - Endodontic treatment
   - Previous restorations
2. Consequences of insufficient coronal tooth structure
   - Retention of subsequent restorations are more problematic
   - Increases likelihood of fracture during functional loading

Choice of Restorative Technique

Factors

- Type of Tooth (Anterior V.S. Posterior)
- Amount of Remaining Coronal tooth structure

Topics of Discussion

- Diagnosis and Treatment Planning
- Considerations and Guidelines for Anterior Teeth
- Considerations and Guidelines for Posterior Teeth
- Preparation:
  - ~ Root Canal
  - ~ Coronal Tissue
- Classification of Prefabricated Posts
- Dowel/Post Materials
- Core Materials
- Amalgam Coronal Post-Core
- Indications for Custom Cast Post and Cores
- Custom Post Core Direct Technique
- Custom Post Core Indirect Techniques
- Provisionalization Investing and Casting
- Try-In
- Cementation
- Root Perforations
- Common Causes of Failures

Diagnosis and Treatment Planning

Prognosis of tooth

Q1. Is the tooth worth saving?

- Extent of caries
- Periodontal status

Q2. Will loss of tooth significantly jeopardize the patient's occlusal function or total treatment plan, particularly if dental implants are not an option?

Endodontic Considerations

1. Good apical seal
2. No sensitivity to pressure
3. No exudate
4. No fistula
5. No apical sensitivity
6. No active inflammation
7. Retreatment should occur if there are signs or symptoms indicating failure

Periodontal Considerations

1. Ultimate prognosis for a given tooth depends on periodontal status
2. Treatment of periodontal disease is paramount prior to placement of definitive restoration
3. Extensive coronal destruction may require Crown Lengthening:
   a. Re-establish biologic width
   b. Provide coronal tooth structure to incorporate ferrule into cast restoration.

Prosthetic Considerations

1. Extent of coronal destruction
2. Other factors to evaluate
   a. Tooth type (anterior vs. posterior)
   b. Position in arch
   c. Morphology
   d. Occlusal and prosthetic forces applied to tooth
   e. Periodontal support
3. Each case is unique and requires an individualized approach to treatment planning
4. Evaluation of Tooth Type
5. Morphology: Circumference of tooth

structure at the CEJ

6. Occlusal forces
   - ~ Anterior teeth, forces are directed more laterally
   - ~ Posterior teeth, forces are directed more axially
   - ~ For teeth acting as abutments for FPD/ RPD, there is an increase in occlusal forces

Considerations for Anterior Teeth

1. Intact Marginal Ridges - Place base over GP material and seal lingual access with an acid etch composite resin
2. Discoloration in absence of significant tooth loss – Bleaching
3. Presence of mesial and distal restorations – post and core prior to placement of a crown
4. Extensive loss of tooth structure - complete crown coverage is mandatory
5. Tooth will be serving as FPD/RPD abutment - complete crown is mandatory

Considerations for Posterior Teeth

1. Subjected to greater loading than anterior teeth
2. Morphology – cusps that can be wedged apart- increases susceptibility to fracture
3. Cuspal coverage to prevent biting forces from wedging cusps apart

   Exception : Mandibular premolars and first molars with intact marginal ridges and conservative access cavities
4. Complete coverage especially for maxillary premolars which have high fracture rate
5. Restorative Material include:
   a. Metal-ceramic restoration
   b. Significant coronal tooth loss: Cast post and core or an amalgam foundation restoration

Principles of Tooth Preparation: Conservation of Tooth Structure

Preparation of the Canal

1. RULE : Remove only the minimal tooth structure
2. Excessive enlargement results in:
   a. Perforation or weakening of root
   b. Splitting during cementation of post or in function
3. Make post fit into the tooth and not the tooth fit into the post!

Preparation of Coronal Tissue

1. Conserve as much of tooth structure as possible
2. Amount of remaining tooth structure is probably the single most important predictor of clinical success
3. More than 2mm – post design plays little role in the fracture resistance of the restored tooth
4. Less than 2mm – crown lengthening is indicated

The Ferrule Effect

Definition:

1. Fer-rule/ˈ fer-el/ n: a circumferential band of metal that engages the cervical tooth structure as part of the post and core preparation
2. Cervical Ferrule helps encompass tooth structure and prevent fracture

3. Increases retention
4. Increase resistance to root fracture
5. Resist lateral forces
6. Reinforces tooth at its external surface
7. Helps dissipate occlusal forces
8. Lack of sufficient ferrule forces the post and core to accept high functional forces

Barkhordar et al JPD 61:676-678,1990(Fig.1)

Creating a Ferrule

Extension of the axial wall of the crown apical to the missing tooth structure by:

Surgical Crown Lengthening

- Reduces root length
- Increase crown length
- Less favorable crown-to-root ratio
- Increased leverage on root during function

Orthodontic Extrusion

- Reduces root length
- Crown length remains unchanged
- More favorable crown-to-root ratio
- May be preferred to surgical crown lengthening

. Gegauff AG: J Dent Res 78:223, 1999(Abstract)

Post Materials

- Stainless Steel
- Titanium
- Titanium Alloy
- Gold-Plated brass
- Carbon
- Ceramic

Core Materials

- Amalgam
- Composite
- Glass

Ionomer Amalgam > Composite > Glass Ionomer

Procedure

1. Removal of the root canal filling material to the appropriate depth (Removal of Gutta-Percha)

Two common methods:

- Warmed endodontic plugger - prefered because it eliminates the possibility of damaging the dentin
- Rotary Instruments (Pesso-Reamers and Gates Glidden drills) - used if GP is old

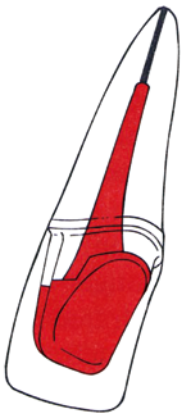

Fig.1:
Dowel: a post, usually made of metal that is fitted into a prepared root canal of a tooth that has had endodontic therapy Core: the coronal aspect of the post foundation

and has lost it' s thermoplasticity

a. Calculate appropriate Length of Post

Guidelines:

- Post Length = height of anatomic crown or 2/3 the length of root
- Leave 5mm of apical gutta-percha
- However in short teeth an absolute minimum of 3mm but not less is acceptable

b. Apply Rubber Dam

c. Select endodontic plugger that is large enough to hold heat well but not too large that it binds against the canal walls

d. Mark it at the appropriate length = (WL-5mm) and place into canal to soften the gutta-percha

Guidelines for using Rotary Instruments:

- Choose an instrument that is slightly narrower than canal
- Follow GP and do NOT engage dentin
- Only remove part of the GP with instrument and remainder remove with heated condenser
- NB: Rotary instruments are not to be used immediately after obturation because it may disturb apical seal

2. Enlargement of the canal

- Shape Canal as needed using low-speed drill or hand instruments
  - ~ Removes undercuts
  - ~ Prepares canal to receive an appropriate sized post
- Take a radiograph to verify post space
- Enlarge the canal 1 or 2 sizes with the drill, endodontic file or Peeso-Reamer that matches the configuration of post
- Alternate between Peeso-Reamer and twist drill that correspond in size
- Be careful not to remove more dentin at the apical extent of the post space than is necessary

Fig.2

3. Preparation of the coronal tooth structure

- Coronal tooth structure reduced for extracoronal restoration
- Ignore any missing tooth structure and prepare remaining tooth structure
- Be sure that the facial surface of the tooth is adequately reduced for good esthetics
- Remove all undercuts that would prevent

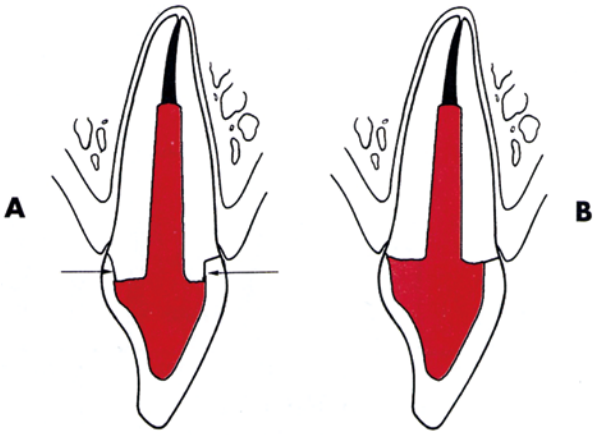

Fig.2：
A. prepared with a ferrule (arrow)
B. Prepared without ferrule

withdrawal of the pattern

- Remove any unsupported tooth structure but careful to preserve as much of the crown as possible
- Be sure part of the crown is prepared perpendicular to post (shoulder) to allow seating
- Eliminate sharp angles and establish smooth finish line

Post Selection:an Introduction

- *Prefabricated Posts*

  ~Preformed metal post cemented into prepared post space

  ~Core material

- *Custom-made Posts*

  ~Post and Core are cast as single unit

Guidelines in Post Selection:

- Rule of Thumb: Post should be no more than 1/3 the diameter of the root, with the root and walls at least 1mm thick.
- Other Factors: Knowledge of…
  - ~ Average root dimensions
  - ~ Root canal cross-section configurations

Post Selection: Factors to Consider

- *Post Size :* Increase Post Diameter → Decrease Dentin Thickness → Increase Stress on Tooth → INCREASE FAILURE
- *Number of Posts :*
  - ~ For Multi-rooted teeth at least 1-2 posts
  - ~ Max Molars – usually palatal canal
  - ~ Increase number of posts → Increase retention → Decrease tooth strength

Fig.3

- *Post Length:*
  - ~ Increase in Post Length → Increase chances of Perforation → Increase FAILURE (Compromise apical seal)
  - ~ Decrease post length → Increase risk of root fracture

Fig.4

- *Post surface texture :*
  - ~ Serrated post more retentive than smooth post
  - ~ NB: Post length is most important retentive factor and Post Diameter is a secondary factor

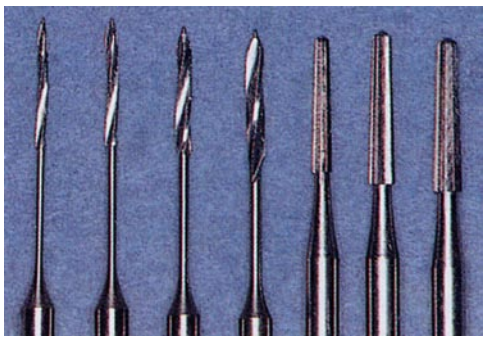

Fig.3 :
Alternate between Peeso-Reamer and twist drill that correspond in size

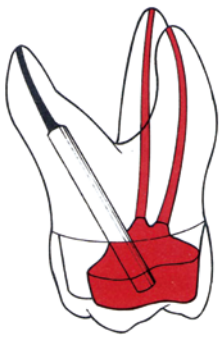

Fig.4 :
For Multi-rooted teeth at least 1-2 posts- Max Molars – usually palatal canal

Fig.5

Prefabricated Posts

Classification

1. Tapered Post

a. A. Non-Threaded/Smooth

b. B. Serrated

c. C. Threaded

2. Parallel-Sided Posts

a. D. Non-Threaded/Smooth

b. E. Serrated

c. F. Threaded

Fig.6

Tapered Post

Advantages of Tapered Posts

Conservative of tooth structure

High strength and stiffness

Disadvantages of Tapered Posts

Low retention

Longitudinal splitting of remaining root (Kantor MK, Pines MS, JPD 38:405.1977)

Recommended Use of Tapered Posts:

Small circular canals or

Very tapered canals

Precautions of Tapered Posts

Not recommended for excessively flared canals

Prefabricated Post: Parallel-Sided Posts, Non-Threaded/Smooth

Advantages:

Excellent clinical retention

Minimal stress production within root

Ease of placement

Superior rating

Disadvantages:

Precious material post expensive

Corrosion of stainless-steel

Less conservative of tooth structure

Recommended Use:

Small circular canals

Precaution:

Care during preparation

Prefabricated post: Threaded Posts

Advantages:

High retention

Disadvantages:

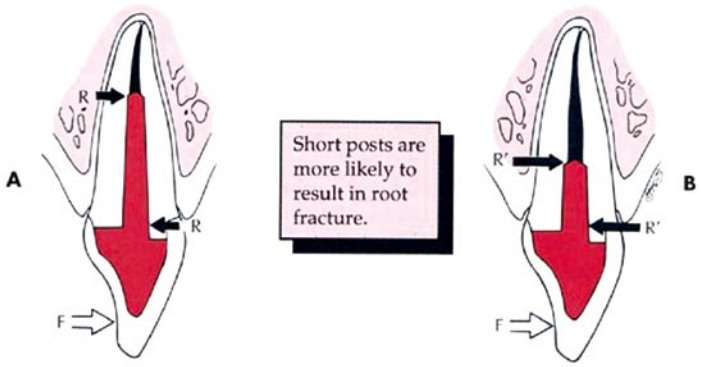

Fig.5：
Decrease post length, Increase risk of root fracture

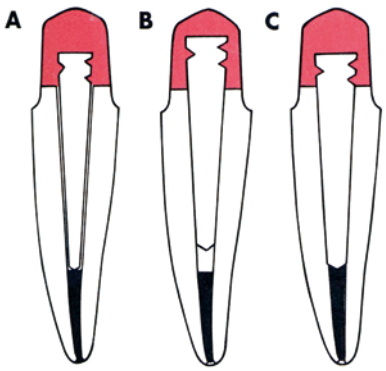

Fig.6：
Post length is most important retentive factor and Post Diameter is a secondary Factor

Stresses generated in canal may lead to fracture

Not conservative of coronal and radicular tooth structure

Recommended Use:

Only when maximum retention is essential

Precaution:

Care to avoid fracture during seating

Prefabricated Posts: Carbon Fiber posts

Advantages:

Dentin bonding

Easy removal

Disadvantages:

Low strength

Microleakage

Carbon color presents an esthetic problem

Recommended Use:

Minimal missing tooth structure

Uncertain endodontic prognosis of tooth

Precautions:

Not recommended for teeth under lateral load

Prefabricated Post: Zirconia Ceramic Posts

Advantages:

Esthetics

High stiffness

Disadvantages:

Uncertain clinical performances

Recommended Use:

High esthetic demands

Prefabricated Post: Woven fiber Posts

Advantages:

Esthetics

Dentin bonding

Disadvantages

Low strength

Uncertain clinical performances

Recommended Use

High esthetic demands

Precautions:

Not recommended for teeth under lateral load

Custom Cast Post and Core

Advantages:

Preservation of maximum tooth structure, the post is fabricated to fit the radicular space

Provision of anti-rotational properties

Core retention, since core is an inherent part of the post

Less chances of vertical fractures during preparation

High strength

Disadvantages:

Less stiff than wrought

Time consuming, complex procedure

Recommended use:

Elliptical canals

Flared canals

Precautions:

Care to remove nodule before try-in

During preparation care should be taken to avoid root perforation in Danger zones of Molars

Post Selection: The Dilemma

When should a custom cast post and core be made vs. a prefabricated post and core?

When there is extensive loss of tooth structure

When there will be heavy occlusal forces applied to the final restoration

If the tooth will act as an abutment to a FPD or RPD

Custom Cast Post and Core

Can be cast from :

Direct Technique

Fabricated in patient’ s mouth

Utilizes autopolymerizing or light-polymerized resin

For Single canals

Indirect Technique

Fabricated in dental laboratory

For multiple canals

Custom Made Post: Direct Technique

Fig.7

Custom Made Posts: Direct Technique (-pretend the model is patient's mouth-)

- Lightly lubricate canal and make sure plastic dowel “speedy post” extends to full depth of post space
- Use the bead brush technique and add GC resin to canal space, the add “speedy post” inside the canal and seat completely
- Do NOT allow resin to set completely. Loosen and reset it several times while it is still rubbery
- Once resin has polymerized, remove the pattern
- Inspect for any undercuts in pattern and trim away
- Measure and verify pattern post is same as prepared post length
- Check that pattern goes in and out of canal without binding
- Additional resin is added for the core

Custom Made Posts : Indirect Technique

Any elastomeric material will make anaccurate impression of the root canal if a wire reinforcement is placed to prevent distortion

- Cut ortho wire to length and shape of letter J (Figure A)
- Verify the fit of the wire in the canal (should fit loosely and extend to full depth of post space)
- Coat the segment with tray adhesive
- Lubricate canal to facilitate removal of

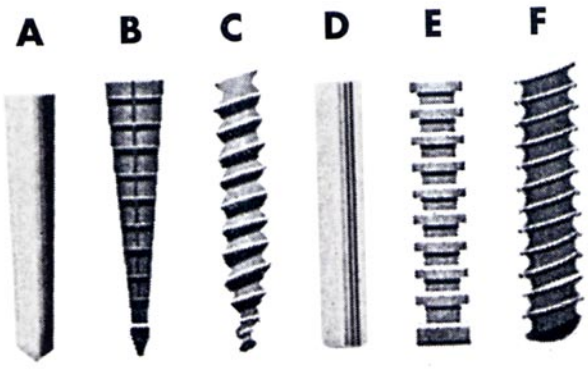

Fig. 7 :
Prefabricated Posts Classification Tapered Post
A. Non-Threaded/Smooth
B. Serrated
C. Threaded Parallel-Sided Posts
D. Non-Threaded/Smooth
E. Serrated
F. Threaded

impression material and place retraction cord if subgingival margins

- Using a lentulo, fill canals with elastomeric impression material
- Seat the wire reinforcement to the full depth of each prepared teeth and insert the impression tray
- Remove the impression and evaluate it (Figure C)
- Pour the working cast (figure D)
- Roughen a loose fitting plastic post
- Make sure it extends to depth of the canal
- Apply a thin coat of sticky wax to the plastic post and add soft inlay wax in increments
- Wax the core

Fig.8

Core Fabrication

- Core of the post-and-core restoration replaces carious, fractured or missing tooth structure
- It also retains the final crown
- Material used: Amalgam, Composite, Glass

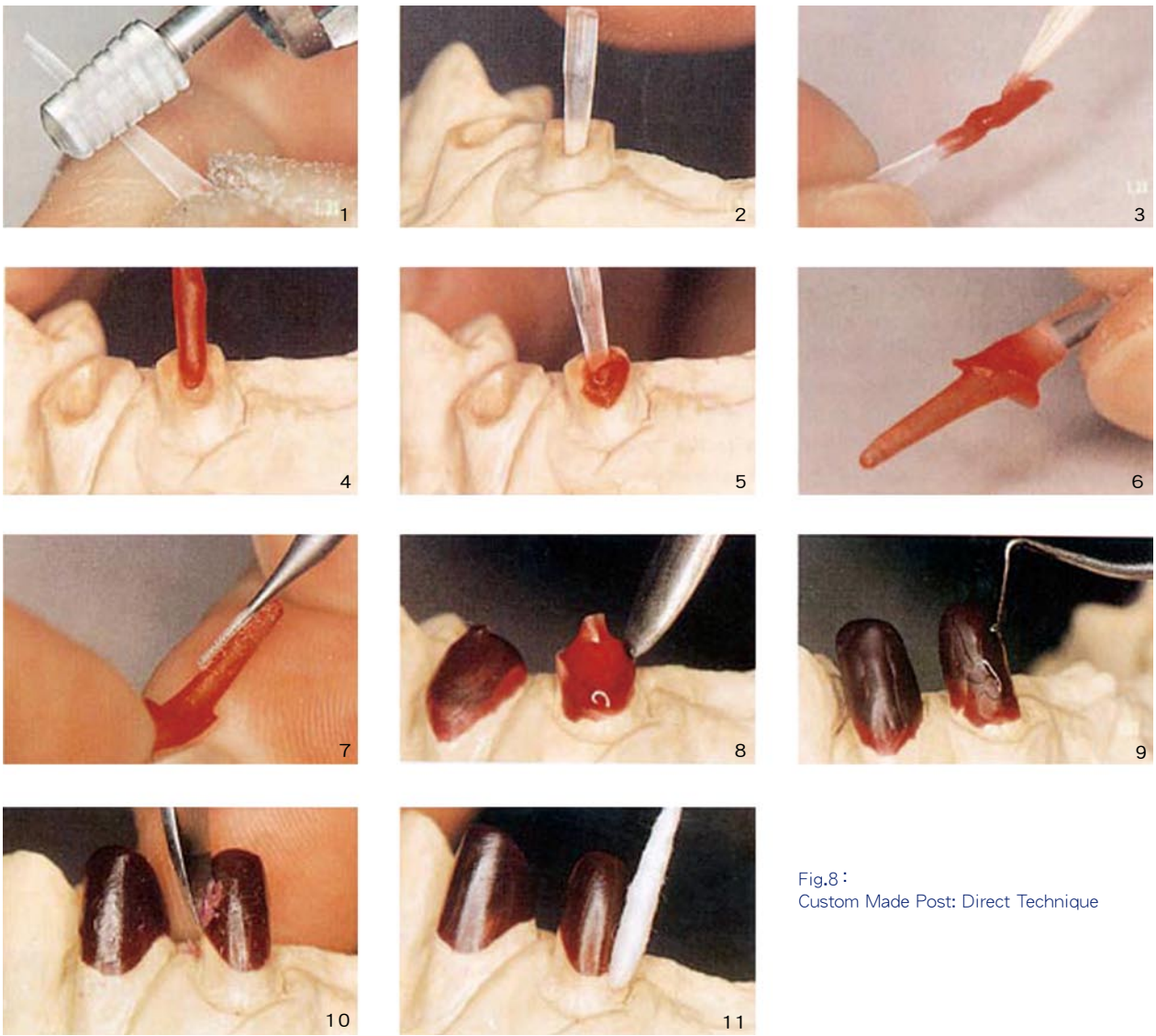

Fig.8：
Custom Made Post: Direct Technique

Ionomer

Core Build Up with Composite resin and prefabricated post

Fig.9

Composite Resin Core

Advantages:

- Good compressive strength
- Easy to manipulate
- Rapid polymerization
- Dentin bonding

Disadvantages:

- Polymerization shrinkage
- Poor dimensional stability

Recommended Use

- Teeth with minimum tooth structure missing

Precautions:

- Not for teeth under lateral load (anteriors)

Core Build Up with Amalgam

Fig.10

Amalgam Core

Advantages:

- Reduced marginal leakage

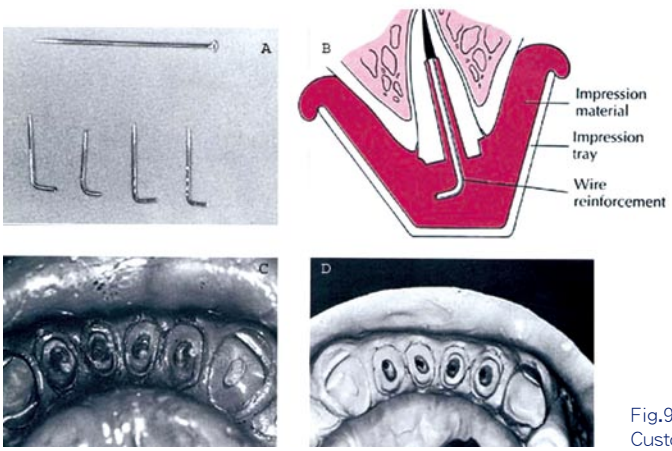

Fig.9：
Custom Made Posts: Indirect Technique

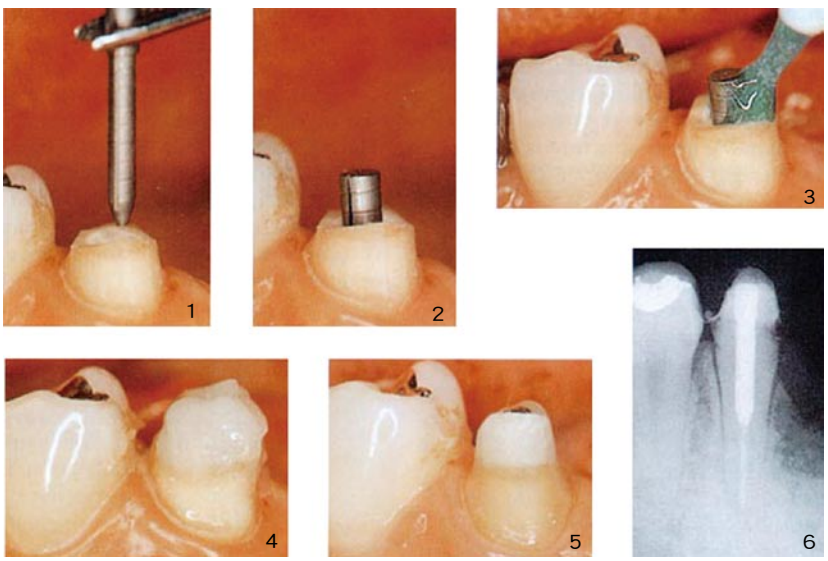

Fig.10：
Core Build Up with Composite resin and prefabricated post

- Better dimensional stability
- Better compressive strength
- Better modulus of elasticity

Disadvantages:

- Mercury sensitivity
- Low tensile strength
- Corrosion with base metal

Recommended Use:

- Molars with adequate coronal tooth structure

Precautions:

- Not for teeth under lateral forces (Anteriors)

Glass Ionomer Resin

Advantages:

- Anticariogenic?
- Adhesive
- Easy to manipulate

Disadvantages:

- Low resistance to fracture
- Low retention to preformed post
- Sensitive to moisture

Recommended Use:

- Teeth with minimum tooth structure

Precaution

- Not for use in teeth under lateral load

Follow Up after Post-Core Selection

- Place provisional
- Invest and cast
- Try in
- Cementation

Fig.11, 12

Most common types of post-core failure

- Post loosening
- Apical lesion and caries
- Post dislodgment

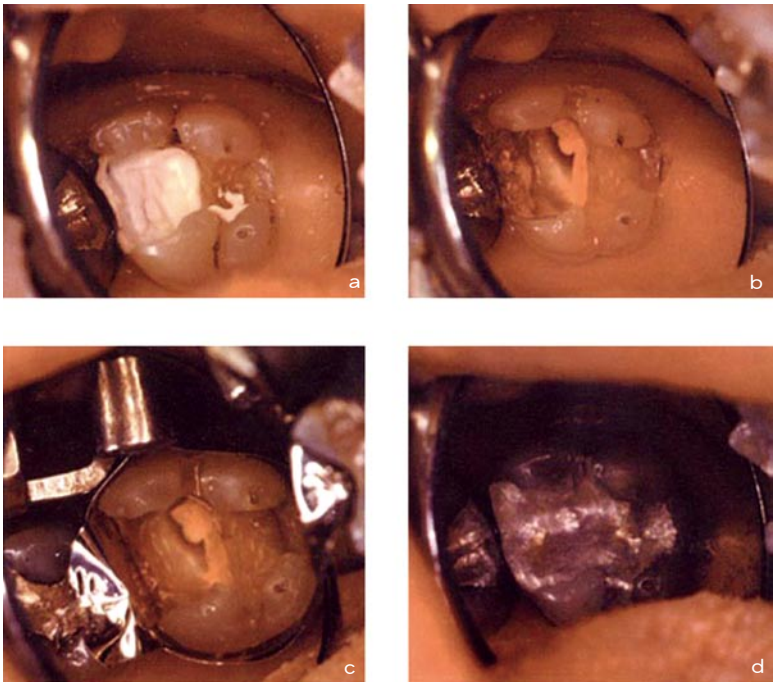

Fig.11:
Core Build Up with Amalgam

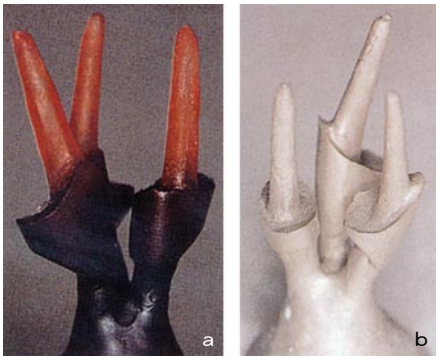

Fig.12: Investment and cast
a. Wax patternc before casting.
b. Cast patterns

- Tooth fractures
- Root perforation

How to Avoid Root Perforation

- Post should not extend more than 7mm apical to the canal orifice in a molar
- Peeso Rotary instruments should be avoided especially # 5 & 6 (1.3-1.5 diameter)
- GG bur #6 should be avoided (1.4mm diameter)
- Recommended: Heated instruments and GG burs

Reference

1. Rosentiel SF, Land MF, Fujimoto J. Contemporary Fixed Prosthodontics. 3rd ed. Mosby Inc. 2001. 272-312
2. Fukushima S, Suzuki S. Core Buildups Practical Preparation for Abutment Teeth. Ishiyaki EuroAmerica Inc. 1995
3. Gegauff AG. Change in strength from creating a ferrule via crown lengthening. J Dent Res 78:223. 1999(abstract)
4. Gegauff AG et al. A comparative study of post preparation diameters and deviations using parapost and Gates-Glidden drills. J Endodont 14:377. 1988
5. Sorenson JA, Martinoff JT: Clinically significant factors in dowels design: J Prosthet Dent 73:439. 1995
6. Title Four post-and-core combinations as abutments for fixed single crowns: a Source The International journal of prosthodontics 2003:16:3: 249
7. Comparative study of the physical properties of core materials. Source The International journal of periodontics & restorative dentistry 2002:22:4: 355

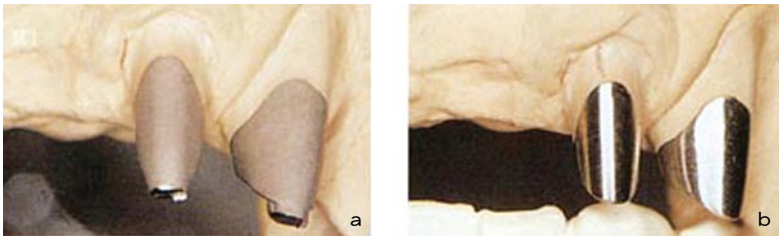

Fig.13：Try in& polishing
a. Try-in and polishing.
b. After polishing.