

Furcation diagnosis and management in multirooted teeth



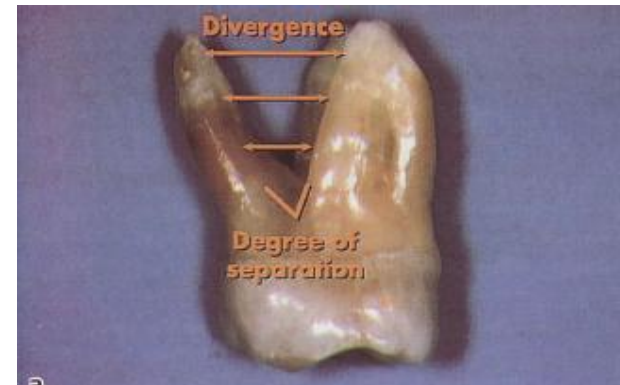
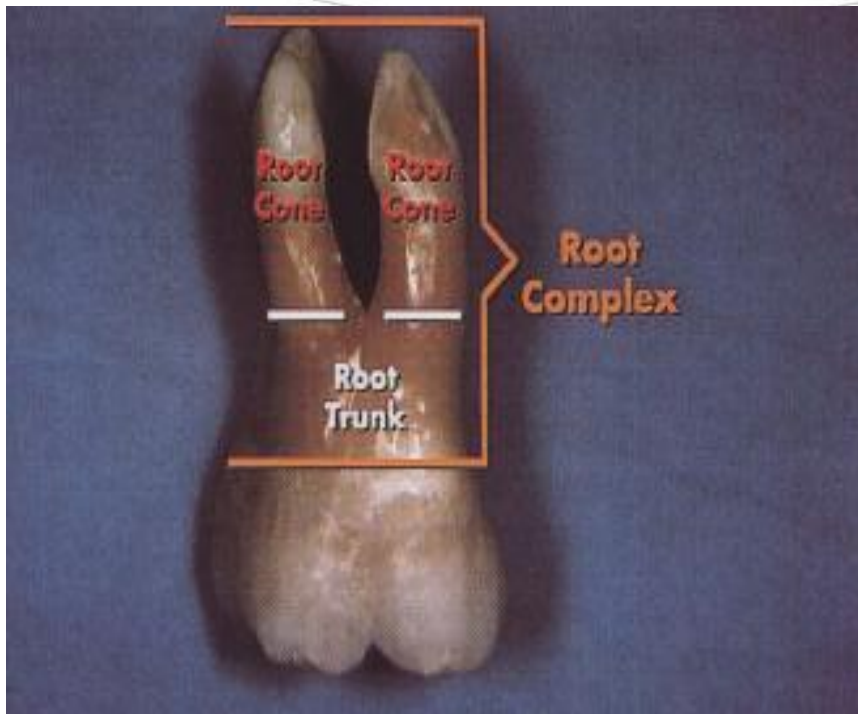
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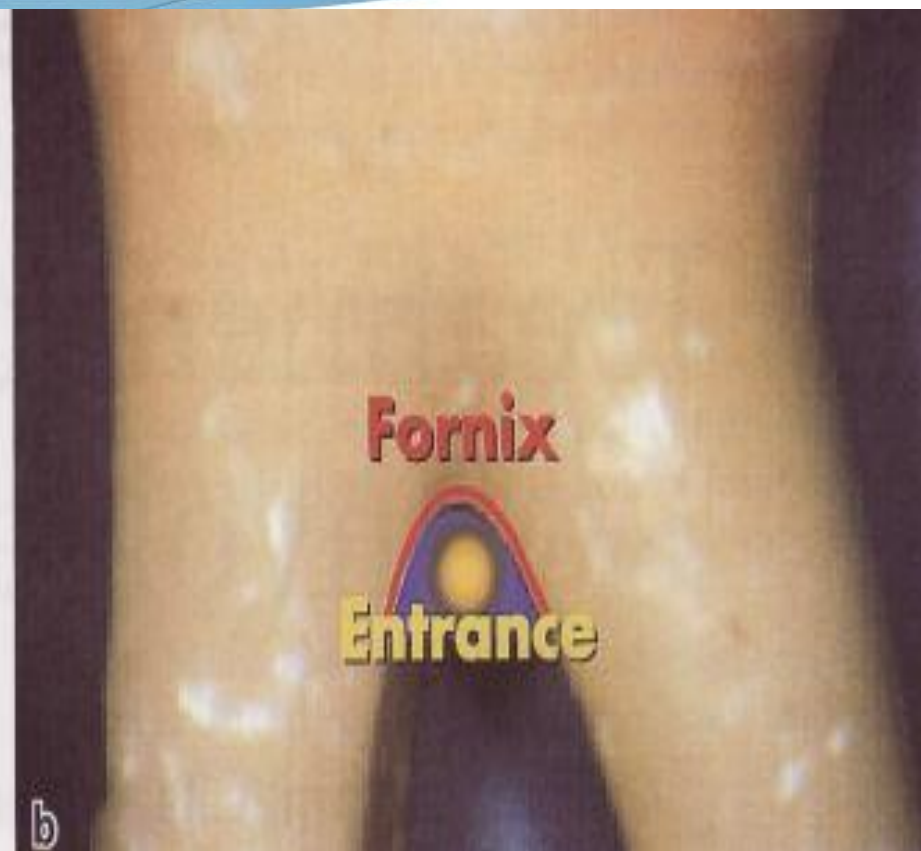
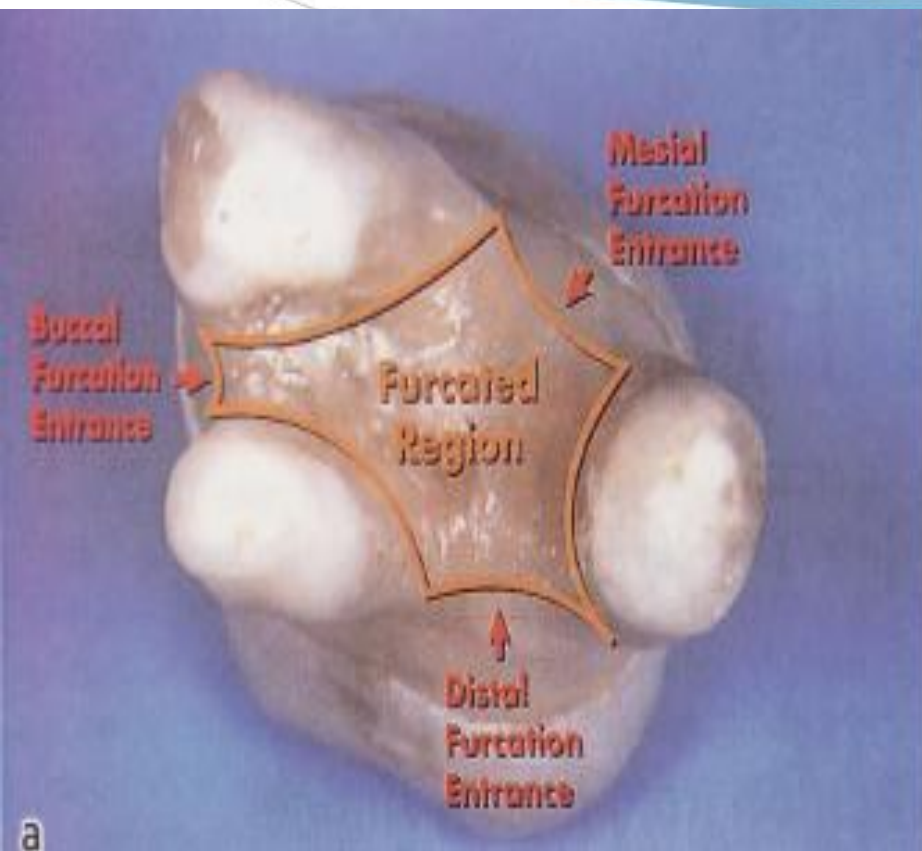
The significance of furcation involvement in multirooted teeth

- ◆ Furcation involvement is a significant risk factor for tooth loss.
- ◆ Risk of tooth loss increases with increasing bone loss in the furcation area.
- ◆ Diagnosis of furcation involvement is challenging.
- ◆ Hence thorough examination and early diagnosis is essential
- ◆ Multirooted teeth have a significant role in our dentition and have unique anatomical features.
- ◆ Due to their posterior position, access is challenging for professional and self performed cleaning

Terminology & Anatomy



Anatomy





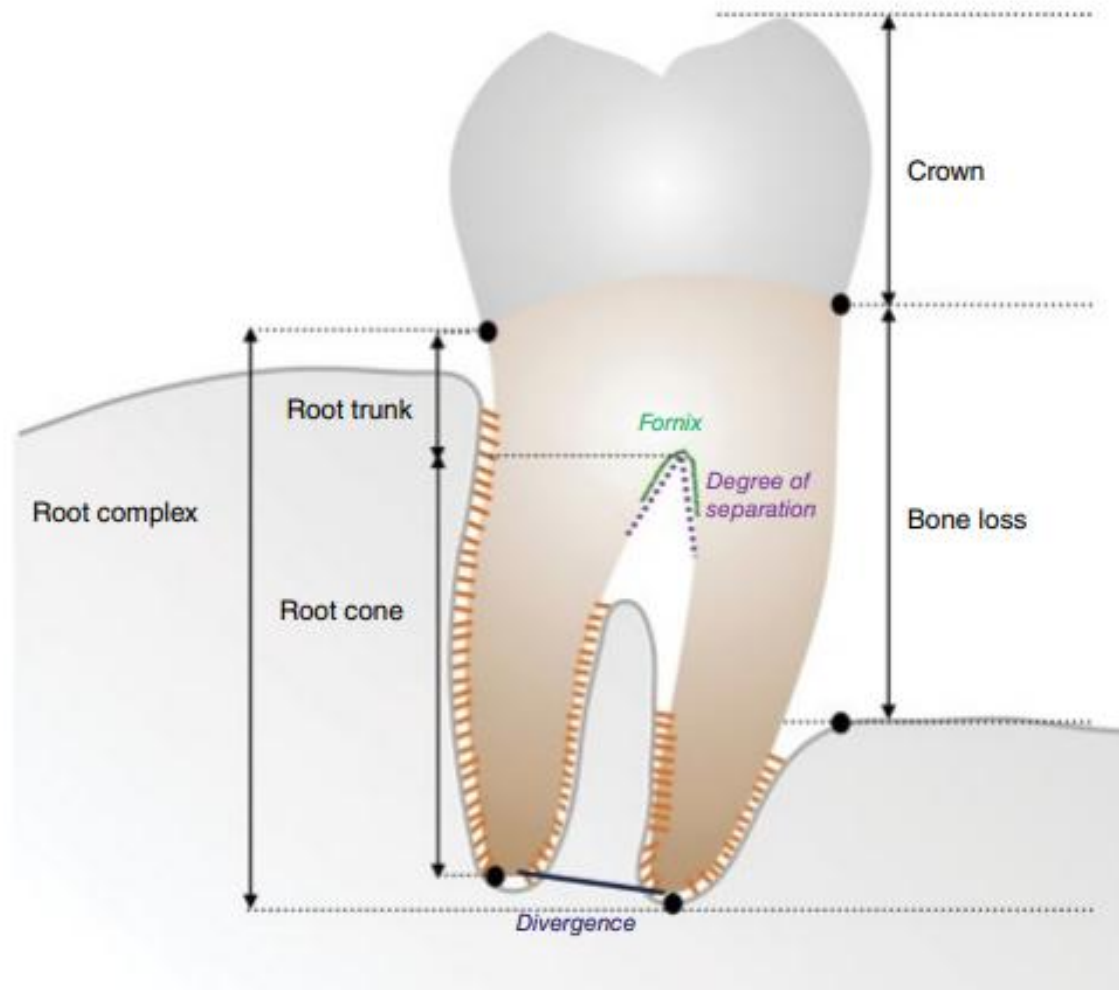


Figure 1.1 Drawing of mandibular molar with furcation involvement, showing the main anatomical features, including root trunk (part of the root from the cemento-enamel junction [CEJ] to the furcation entrance) and root cones, and pointing at root divergence and degree of separation between roots. The 'bone loss' is schematically indicated as the distance between the CEJ and the most apical part of the bone. *Source:* Courtesy of Dr Aliye Akcali.

Anatomy





Maxillary first PREMOLARS

40 % of maxillary premolars have 2 roots and furcation @ 8mm from CEJ

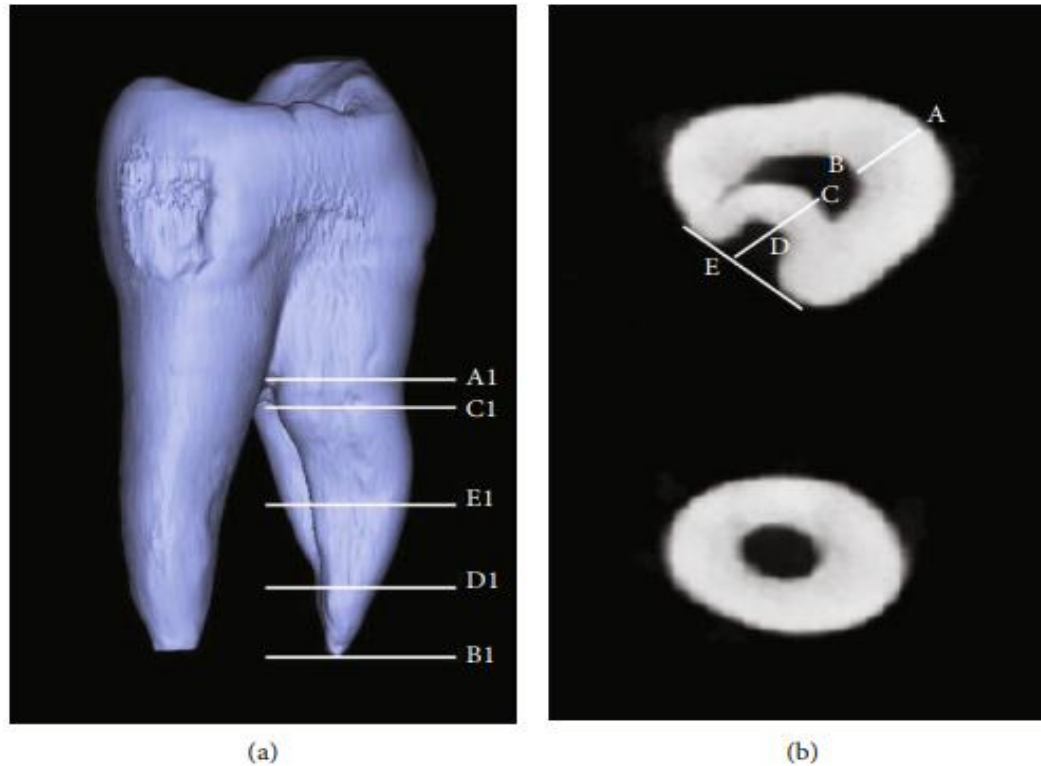


FIGURE 2: Measurement of the buccal root with furcation grooves in maxillary first premolars using micro-CT. (a) Vertical measurement. (b) Horizontal measurement. A1: root furcation position; B1: apical position; C1: the start point of furcation groove; D1: the end point of furcation groove; E1: the middle point of CD connection. A1B1: buccal root length; C1D1: furcation groove length; A1C1: length from root bifurcation to the beginning of furcation groove; B1D1: length from apical position to the end point of furcation groove. AB: buccal root canal wall thickness; CD: palatal root canal wall thickness; DE: furcation groove depth (depth of root invagination).

ANATOMY OF MOLARS

- ◆ Root surface area and shape
- ◆ Bifurcation ridges
- ◆ Enamel projections/pearls-connective tissue does NOT adhere to enamel
- ◆ Horizontal component of furcations = **4.6-6.9 mm wide**
- ◆ Accessory canals
- ◆ Iatrogenic- overhangs, caries, fractures

ANATOMY OF MOLARS and Premolars

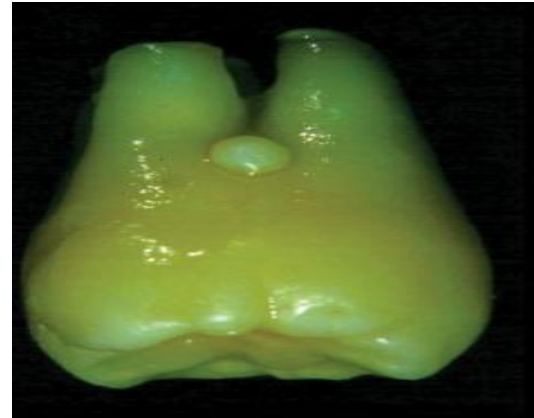
- ◆ FURCATION ENTRANCE WIDTH
- ◆ Almost all less than 1mm
- ◆ 50% less than 0.75mm
- ◆ Average curette width is 1mm , thin US tip 0.5mm



Furcation entrance distances from CEJ (Root trunk length)

- ◆ MAXILLARY MOLARS Buccal-4.3 +/- 1mm
- ◆ Distal- 4.8 +/- 0.8mm MP 3.6 +/- 0.8mm
- ◆ MANDIBULAR MOLARS
- ◆ Buccal – average 4.15mm
- ◆ Lingual- average 3.4 mm
- ◆ HENCE AT 6MM FROM CEJ-ALL FURCATION ENTRANCES INVOLVED

Enamel projecting to furcation



- ◆ Projections/ enamel pearls
- ◆ Risk factor for furcation involvement

Diagnosis

- ◆ History and examination-clinical and radiographic.
- ◆ Colour coded Nabers probe, Perio probe
- ◆ Radiographs- parallel periapicals/ vertical bitewings but limitations of overlapping roots etc , esp upper molars and premolars
- ◆ Consider CBCT if tooth is strategic in treatment planning

Grade, Class , Degree

Diagnosis & Classification of furcation involvement

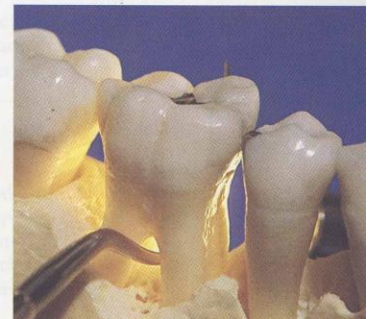
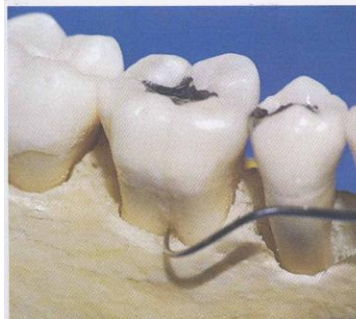
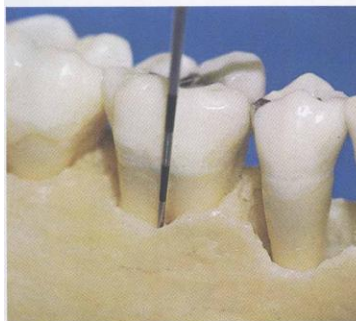
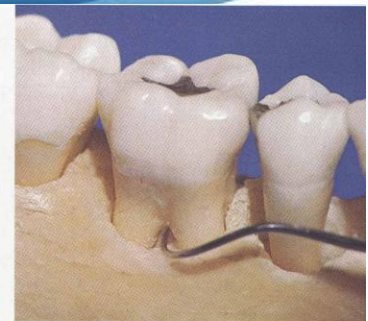
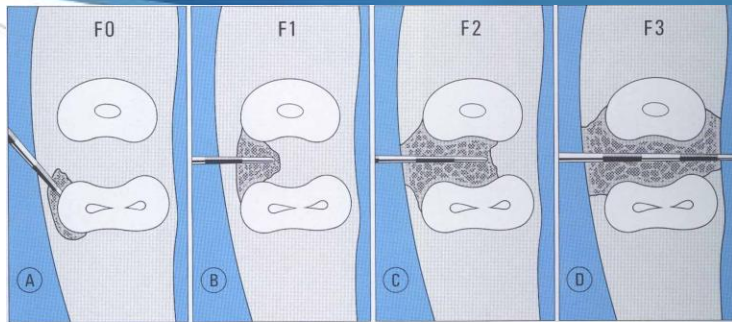
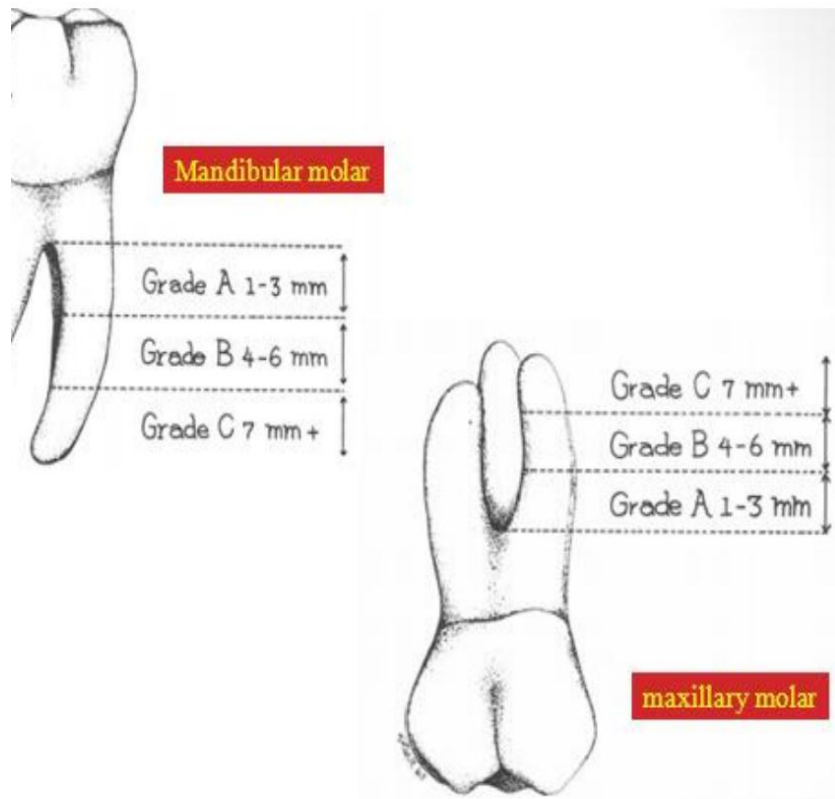


Table 2.4 Recommended classification of furcation involvement.

Degree 0	No furcation involvement.
Degree I	Horizontal loss of periodontal tissue support up to 3 mm (Eickholz and Staehle 1994).
Degree II	Horizontal loss of support exceeding 3 mm, but not encompassing the total width of the furcation area (Hamp et al. 1975).
Degree III	Horizontal 'through-and-through' destruction of the periodontal tissue in the furcation. In early degree III involvement, the opening may be filled with soft tissue and may not be visible. The clinician may not even be able to pass a periodontal probe completely through the furcation because of interference with the bifurcational ridges or facial/lingual bony margins. However, if the clinician adds the buccal and lingual probing dimensions and obtains a cumulative probing measurement that is equal to or greater than the buccal/lingual dimension of the tooth at the furcation orifice, the clinician must conclude that a degree III furcation exists (Ammons and Harrington 2006).

Sources: Hamp et al. (1975); Eickholz and Staehle (1994); Ammons and Harrington (2006).

Vertical component-subclasses affecting prognosis



Thus, a subclassification was proposed that measures the probeable vertical depth from the roof of the furcation apically: (1) subclass A indicates a probeable vertical depth of 1-3 mm, (2) subclass B of 4-6 mm, and (3) subclass C of ≥ 7 mm. Furcations would thus be classified as IA, IB, IC, IIA, IIB, IIC and IIIA, IIIB, IIIC (Tarnow & Fletcher 1984).

Clinical exam: Nabers Probe



Premolar furcation entrance-M and D



Accuracy of diagnosis

- ◆ Clinical assessment alone detects 3% of maxillary molars and 9% of mandibular molars
- ◆ 2 D radiographs and clinical assessment combined-65% of maxillary molars and 23% of mandibular molars
- ◆ WHY?

Angulation of radiographs, superimposition of roots, high mandibular bone density.....

Important diagnostic considerations

- ◆ Horizontal/ vertical bone loss in furcation area
- ◆ Length of root trunk
- ◆ Length/divergence/shape of roots
- ◆ Fusion of roots
- ◆ Residual bone support
- ◆ Endodontic/restorative/caries status

Radiographs: Furcation “Arrows”



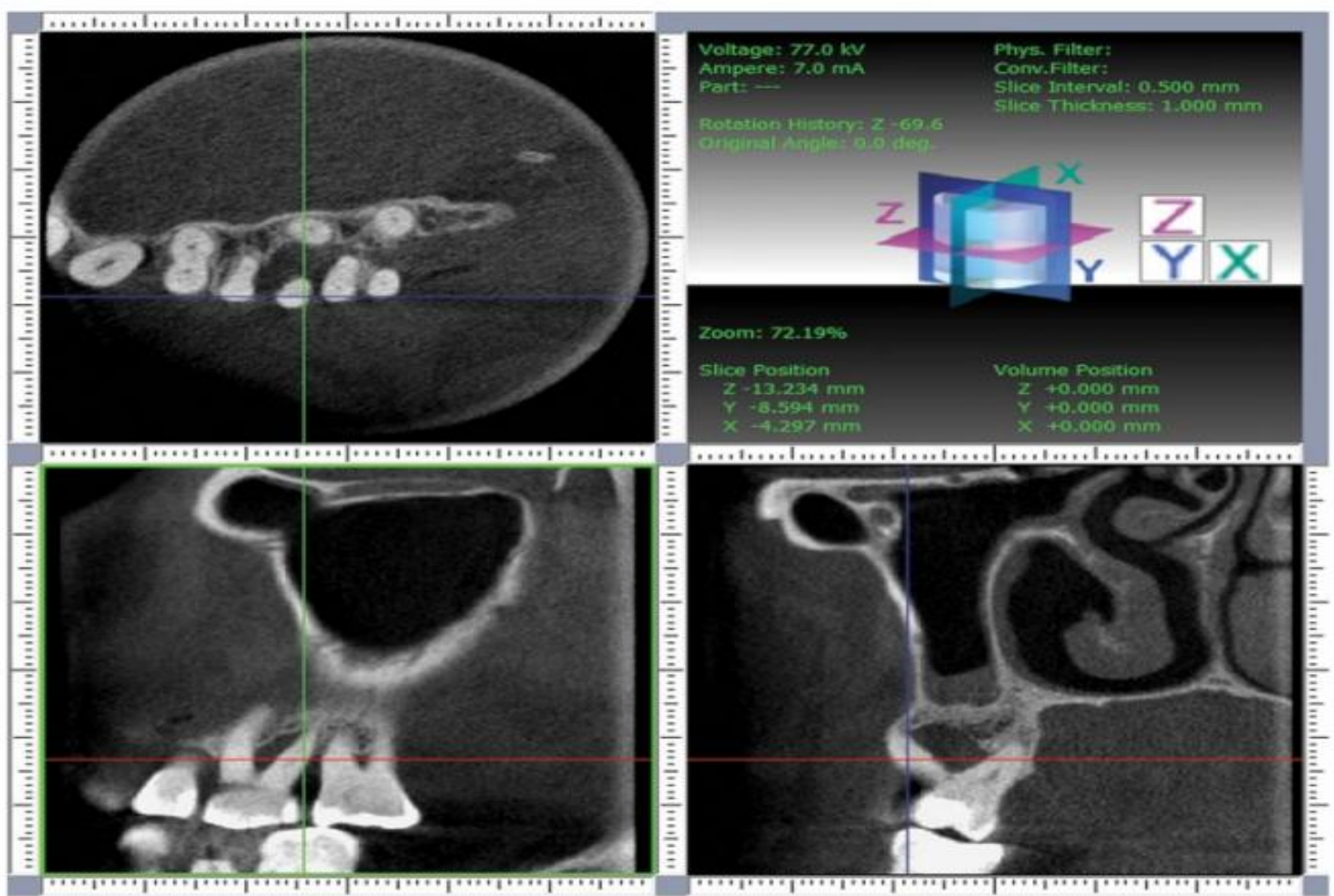


Figure 2.8 Diagnosis and treatment planning using cone-beam computed tomography (CBCT). CBCT images with horizontal, sagittal, and transversal sections of first and second left maxillary molars. According to the bone loss around the disto-buccal root and the remaining periodontal attachment around the mesio-buccal and palatal root, it was decided to extract the distobuccal root. *Source:* Walter et al. (2010).

Prevalence of furcation involvement in perio patients

Table 1. Frequency of furcation involvement in patients referred for periodontal treatment. Adapted from original data

Authors	Numbers (%) of molars with furcation involvement				Diagnostic method
	Maxillary		Mandibular		
Hirschfeld & Wassermann (32)	858/2217	38.7%	597/2054	29.0%	Clinical
McFall (57)	95/378	25.1%	60/377	15.9%	Clinical
Goldman et al. (24)	454/870	52.2%	169/865	19.5%	Radiographic
Wood (102)	87/205	42.4%	77/220	35.0%	Radiographic/clinical



Fig. 38.24 Periodontal abscess associated with a furcation-involved mandibular molar.



Fig. 39.24 Early furcation involvement suggested by fuzziness in the furcation of the mandibular first molar, particularly when associated with bone loss on the roots.



Fig. 39.25 Furcation involvement of mandibular first and second molars indicated by thickening of the periodontal space in the furcation area. The furcation of the third molar is also involved, but the thickening of the periodontal space is partially obscured by the external oblique line.



Fig. 39.26 Furcation involvement of the first molar partially obscured by the radiopaque lingual root. The horizontal line across the distobuccal root demarcates the apical portion (*arrow*), which is covered by bone, from the remainder of the root, where the bone has been destroyed.

DIFFERENTIAL DIAGNOSIS

- 🔹 Endodontic infection
- 🔹 Trauma from occlusion
- 🔹 Iatrogenic damage



Endodontic infection-may take up to 5 years of radiographic healing



Figure 4.7 Primary endodontic lesion with inter-radicular and apical involvement on 4.6 (LR6). No furcation probing after three months and partial healing after one-year follow-up.

Endodontic considerations for FI teeth

- ◆ Pulp changes can be induced by periodontal disease- can be reparative or degenerative changes. Pulp necrosis can occur if apical NV bundle involved .
- ◆ Endodontic infections eg through accessory canals can mimic FI Class III- pulp testing important .
- ◆ If both periodontal disease and necrotic pulp present- medicate canals first.

Endodontic considerations for FI teeth

- ◆ A vital pulp appears to hinder bacterial migration from the pocket to the pulp chamber- immune cells and fluid flow in tubules
- ◆ If tooth is vital and root resection is performed- RCT must be done within 2 weeks of resection.
- ◆ Preventative RCT not recommended for surgical and regenerative therapy unless pulp necrosis /infection is present

Management of furcation involved teeth

Essentially 3 objectives:

- (I) eliminate microbial plaque from the exposed surfaces of the root complex
- (II) establish an anatomy of the affected surfaces that facilitates proper self performed plaque control eg tunnelling
- (III) Eliminate the furcation (resection or regeneration)

Terminology

- ◆ Odontoplasty –reshaping of the tooth to aid cleansability
- ◆ Osteoplasty – reshaping of the bone to aid cleansability
- ◆ Flap procedures -OFD (open flap debridement) +-reshaping, resection or repositioning the soft tissues
- ◆ Regeneration- aims to restore the original architecture (and close the furcation) with new bone , cementum and PDL

Management: Non-surgical

Non-surgical treatment:

- Standard Curette width 0.8-1.06mm
- Standard Ultrasonic tip 0.88mm measured 1mm from the tip and 1.06mm measured 2mm from the tip
- Furcation opening < 1 mm
- Difficult to access furcation
- Standard Ultrasonic slightly better than standard curettes in narrow furcation areas
- Gr I furcation relatively stable with SRP
- Gr II and III furcation relapse or deteriorated over 2 years



How good are we at cleaning furcations- Success rates of calculus removal from furcations

- Experienced vs
inexperience

- Less experienced /closed
approach only 8 % of surfaces
were calculus free

- Closed vs open
access-

- Experienced periodontists
open approach-68% calculus
free furcation surfaces
achieved

- Experienced 44% calculus
free with a closed approach

PL1=0.5, PS=0.6, PL5 & 6=0.8

How Good are We at Cleaning Furcations? 47

Figure 3.4 EMS Piezon® Master ultrasonic scaler and tips: (a) PL1 tip with a diameter of 0.5 mm for debridement of hard-to-reach interproximal areas; (b) PL5 tip with a ball end of diameter 0.8 mm for debridement of furcations and concavities; (c) PS universal tip with a diameter of 0.6 mm for debridement of deep pockets.



Many different US tips

- ◆ Straight and thin eg PS1
- ◆ Curved and thin eg PL1/PL2
- ◆ Ball ended- for furcation roof and grooves PL5/PL4
- ◆ Diamond coated – very fast and efficient but removes cementum and dentine too
- ◆ Some systems eg Kavo- inbuild light (LED) to improve visibility

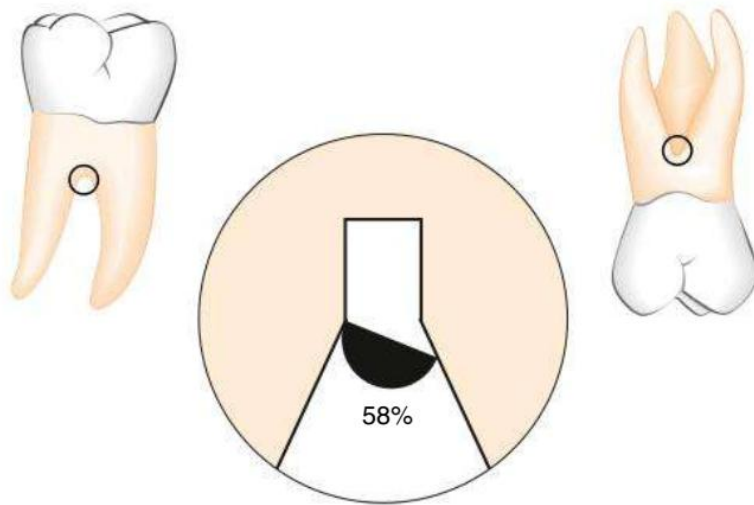


Fig. 41.8 The furcation entrance is narrower than a standard curette in 58% of first molars. (Redrawn from Bower RC. *Furcation morphology relative to periodontal treatment. Furcation root surface anatomy.* J Periodontol. 1979;50:366.)



Fig. 51.27 Micro Mini Five Gracey curettes. Left to right, #1-2, #7-8, #11-12, #13-14. (Copyright A. Pattison.)



Fig. 51.28 Comparison of Gracey curette designs. Left to right, Standard #1-2, After Five #1-2, Mini Five #1-2, Micro Mini Five #1-2. (Courtesy Hu-Friedy, Chicago, IL.)

Mini 5 (0.76mm)/Micro Mini 5 (0.6mm) Gracey curettes

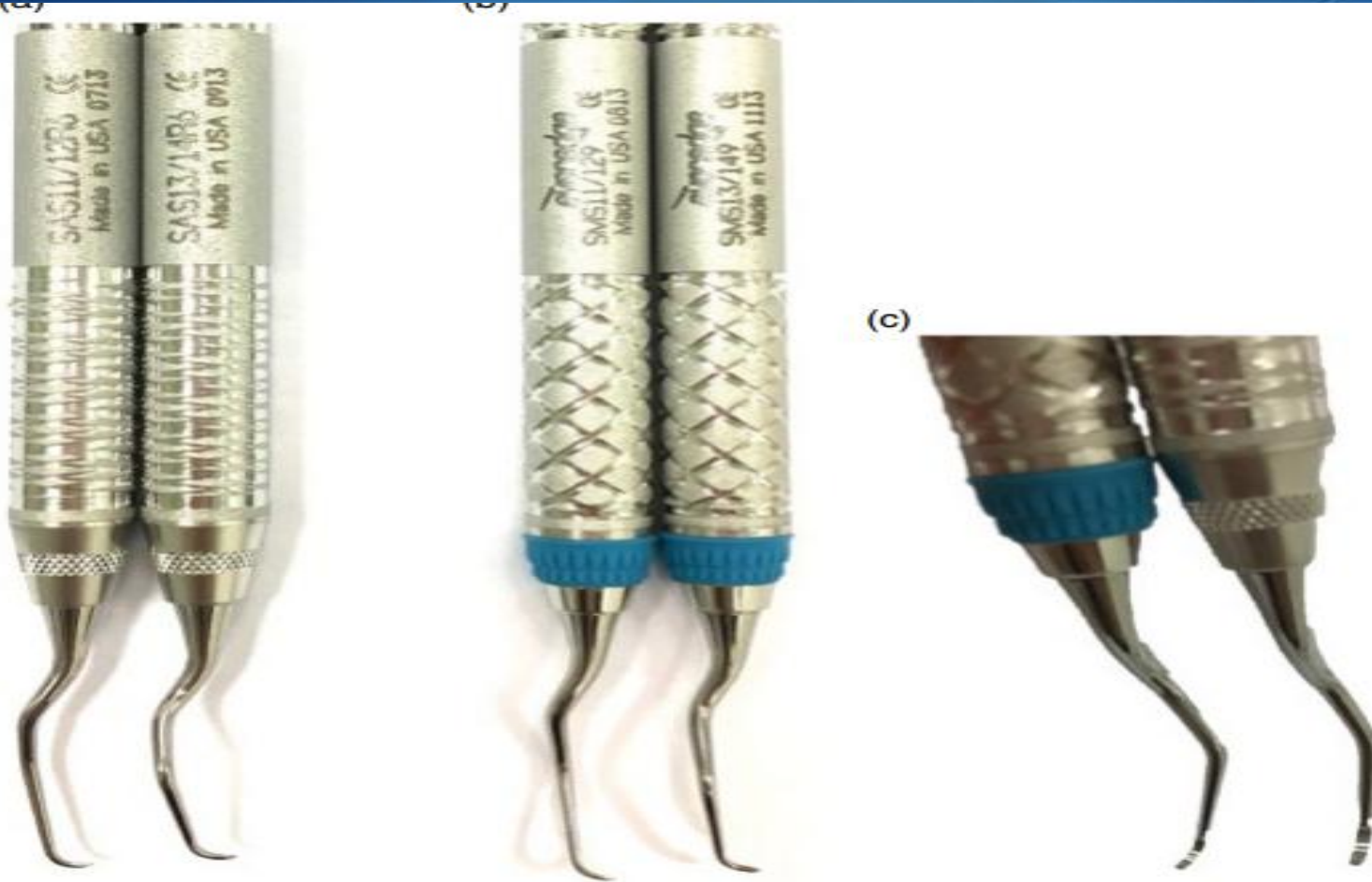


Figure 3.2 (a) Mini Five® Gracey curettes #11/12 and #13/14 with blade width of 0.76 mm; (b) Micro Mini Five® Gracey curettes #11/12 and #13/14 with blade width of 0.6 mm; (c) difference in the blade widths of the Micro Mini Five Gracey curette #11/12 (left) and Mini Five Gracey curette #11/12 (right).

Self performed biofilm control for management of furcations

CURRENT EVIDENCE SUGGESTS

- 💧 Oscillating rotating electric toothbrush
- 💧 End or compact tufted brush
- 💧 Cylindrical interdental brushes
- 💧 WaterPik?



TEPE COMPACT TUFT TOOTHBRUSH

\$4.00

This special toothbrush has a small, dome-shaped tuft and short, extra soft filaments. The stable handle and dense, firm tuft make this brush ideal for precision cleaning of difficult to reach areas.

The toothbrush is suitable for cleaning around fixed orthodontic appliances, attachments for overdentures or along the gum line. It is also ideal for brushing children's erupting molars.

Colours may vary.

1

Add to cart

ROOT RESECTION

- 💧 The surgical removal of all or a portion of the root.
- 💧 Can eliminate an involved furcation



ROOT RESECTION

The 'ideal' candidate:

- 💧 **Class II or III furcation involved molar**
- 💧 Severe bone loss around just 1 root ideally or occasionally 2 roots
- 💧 If there is a localised root fracture, perforation or resorption
- 💧 **Remaining roots should have adequate bony support - favourable crown-root ratio**
- 💧 Sound endodontic & restorative prognosis
- 💧 Tooth has minimal mobility (Gr 1 mobile or nil)
- 💧 Good oral hygiene

ROOT RESECTION

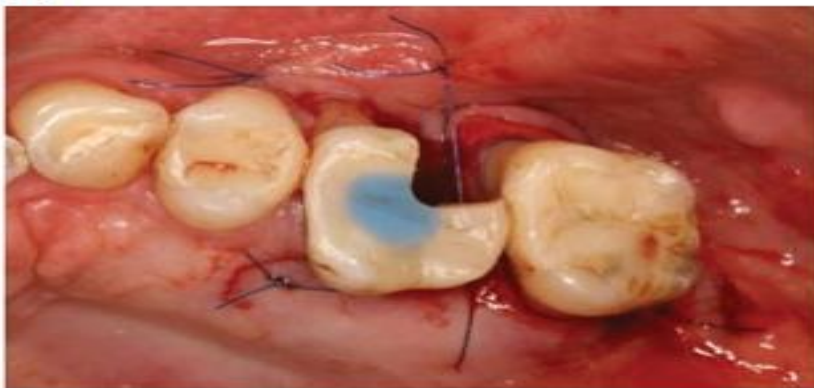
Contraindications:

- ◆ Teeth with a poor crown-root ratio on remaining roots
- ◆ Inadequate bone support on roots to be retained
- ◆ Long root trunks
- ◆ **Fused roots**
- ◆ Teeth where endodontic & restorative treatment not feasible on remaining roots
- ◆ Poor surgical access & inability to perform oral hygiene procedures



(c)

(d)



(e)



Figure 2.9 Root resection in a maxillary first molar: (a) pre-surgical view; (b) tri-section of the distobuccal root; (c) the flap is fixed with monofilament synthetic sutures 5 x 0; (d) four months post-operation, the wound healing was uneventful; (e) a crown with an extended metal margin is placed and the patient is introduced to meticulous oral hygiene.

Are these cases suitable for ROOT RESECTION?



Success of Root Resection

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CASE SERIES

Outcomes of root resection therapy up to 16.8 years: A retrospective study in an academic setting

Madi Alassadi | Musa Qazi | Andrea Ravidà | Rafael Siqueira |
Carlos Garaicoa-Pazmiño  | Hom-Lay Wang 

Methods: Patient-related demographic data, medical history information, and relevant data pertaining to the root-resected teeth performed from **January 1990 to September 2017** were reviewed through electronic and paper chart.

Conclusions: Root resection therapy **remains a treatment solution for molars** with furcation defects. In an academic setting, >50% of teeth remained functional after 9 years of root resection therapy

TABLE 2 Cumulative survival rate of root resection therapy at different intervals

Follow-up	Sample size	Failures	Percentage of failure per interval	Cumulative survival rate
<12 months	85	1	1.2%	98%
12 to 24 months	81 ^a	15	18.5%	79.6%
>24 to 36 months	61	7	11.5%	69.7%
>36 to 48 months	46	8	16.7%	56.8%
>48 to 96 months	31	2	6.5%	52.9%
>96 to 144 months	19	3	15.8%	42.1%
>144 months	8	2	25%	18.4%

^aValues adjusted per observation period.

Root Separation

- ◆ All roots retained
- ◆ Indications- eg caries /perforations of root trunk, deep Class II or III, usually mandibular molars where it is termed premolarization
- ◆ Rarely , can be used on maxillary molars +/- root resection as well



Figure 8.1 Root separation (rizotomy: sectioning of the multi-rooted tooth with the maintenance of all the roots) of a mandibular first molar affected by degree III furcation involvement (a–d), followed by an apical positioned flap (e) and final restoration (f), allowing self-performed oral hygiene.



Figure 8.3 Root separation of all three roots of a maxillary upper second molar and extraction (rizectomy) of the disto-buccal root.

TUNNELING PROCEDURES

- 💧 Treatment of teeth with Degree II or III furcation involvement
- 💧 The furcation is opened more widely to improve access for plaque control by an interproximal brush.
- 💧 Furcation area - vulnerable to root caries and plaque accumulation- **high Fluoride toothpaste recommended**
- 💧 **Tunneling - limited to mandibular molars but may be combined with root amputation in maxillary molars**

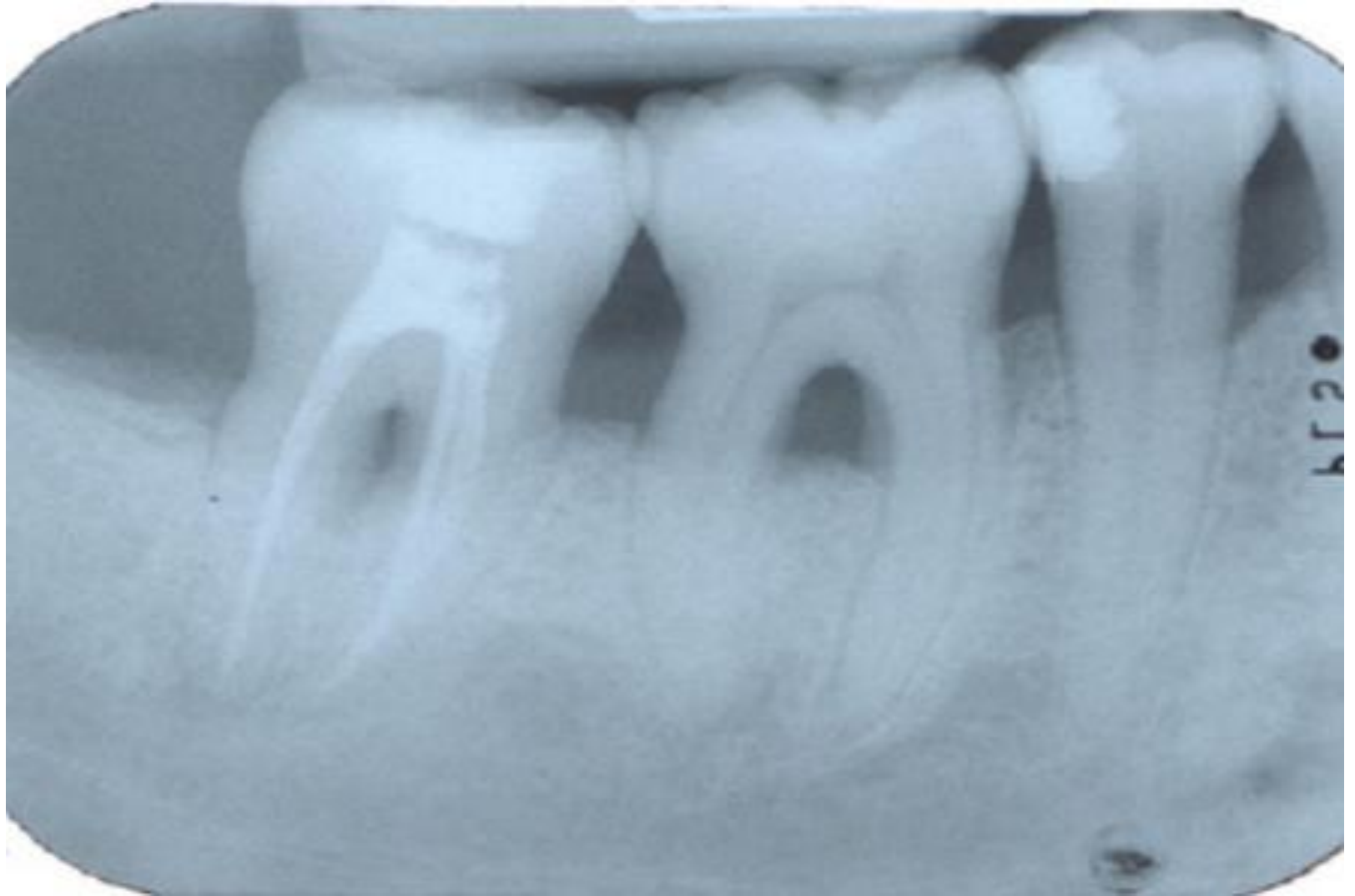




Fig. 39-20 Tunnel preparation of a degree III-involved mandibular molar. Radiograph (a) and photograph (b) showing a wide inter-radicular space where self-performed plaque control can be obtained by the use of an interproximal brush.

TUNNELING PROCEDURES

💧 **Beware – caries risk & tooth sensitivity**

- 💧 **Hamp** et al - 7 molars with degree III furcation defects undergone tunnel preparation. After 5 years, caries in 4 teeth (57%).
- 💧 **Little** et al over 5 years - 18 class II or III molar furcations that underwent tunneling procedures. Crestal bone levels and attachment levels in the furcations were maintained for this time period. During follow-up, 3 of the 18 teeth experienced root caries (17%).
- 💧 **Hellden** et al - 149 teeth received tunnel preparation, over avg 3 years. 24% of the teeth - caries. Of the 17 teeth that had to be extracted or further treated by root resection, root caries in 70%.

Management: Surgery

Surgical treatment:

- ◆ Open Flap debridement

Regenerative treatment:

- ◆ GTR (Guided Tissue Regeneration) +/- bone grafts
- ◆ And/ or EMD (Enamel Matrix Derivative)
- ◆ Not for class III furcations
- ◆ Most suited for lower molars class II buccal (and lingual) & upper buccal furcation class II but complete closure NOT PREDICTABLE

Important factors for success of regeneration

- ◆ Controlled systemic factors
- ◆ good OH
- ◆ thicker phenotype/wide band of keratinized tissue/ no recession
- ◆ good interproximal bone height
- ◆ good access
- ◆ complete coverage of defect and membrane- more important than defect size.

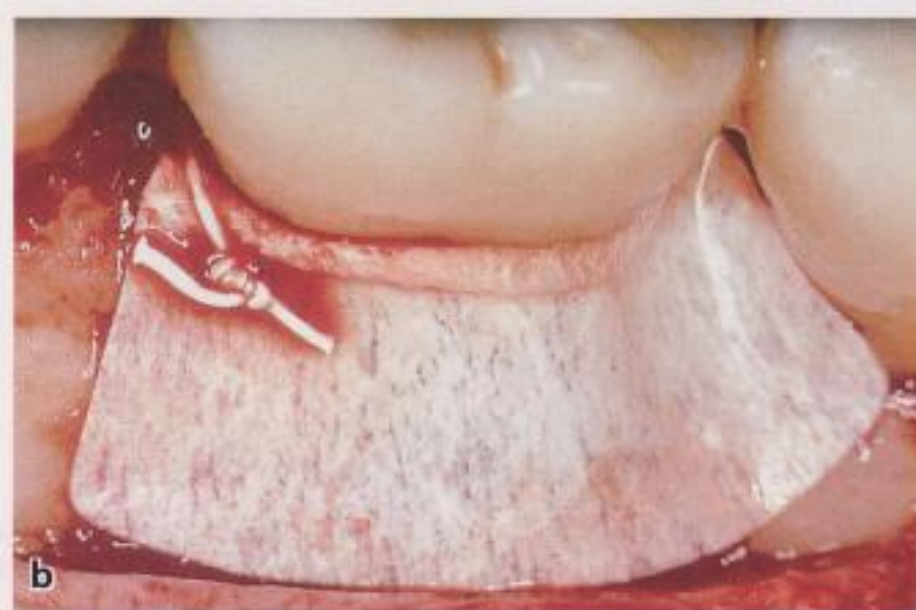
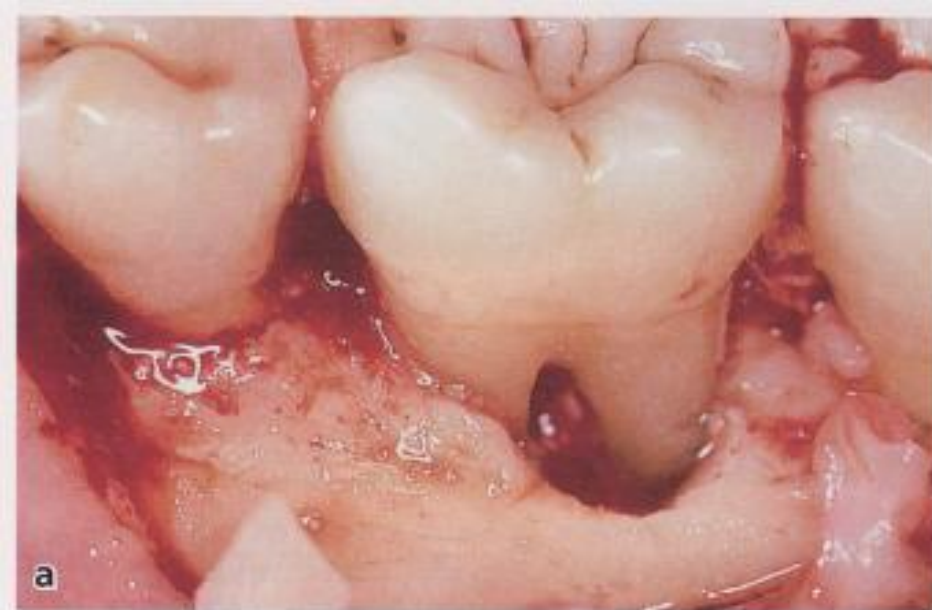


Fig. 39-43 Aspect of a lingual degree II furcation involvement in a mandibular first molar. (a) Note the infrabony component of the defect and the level of the approximal supporting bone in relation to the furcation fornix. (b) The Teflon membrane sutured in position and supported by the interproximal alveolar bone. (c) The flap positioned and sutured over the membrane. (d) At re-entry, after 6 months of healing, the previously exposed furcation defect was closed and filled with bone tissue.

Which treatment is best?

- ◆ Depend on tooth-related factors- degree of furcation involvement, root length & amount of bony support, access, phenotype
- ◆ Patient-related factors- smoking, level of diabetic control, other systemic factors, caries risk

Tooth-related factors

Degree of furcation involvement
Amount of remaining periodontal support
Probing depth
Tooth mobility
Endodontic conditions and root/root-canal anatomy
Available sound tooth substance
Tooth position and occlusal antagonisms

Patient-related factors

Strategic value of the tooth in relation to the overall plan
Patient's functional and esthetic demands
Patient's age and health conditions
Oral hygiene capacity

Which treatment is best?

Degree of furcation involvement:

- Class I – NST, odontoplasty
- Class II – NST, odontoplasty, OFD, osteoplasty, regeneration eg GTR /EMD, Tunnel Preparation, root resection
- Class III – SRD, OFD, Tunnel Preparation, Root resection, extraction
- Non-surgical treatment depends on patient compliance to attend regular maintenance visits
- Maintenance is important
- Less furcation-involved molars were lost in well maintained group (difference >10%) across all studies



The importance of Maintenance

- ◆ Perio treatment and maintenance reduced tooth loss rate of FI molars in all studies vs no treatment (not many studies on no treatment !)
- ◆ Tooth loss rate is approx. double for FI molars (Class II) vs non- FI molars over a 15 year period.
- ◆ Degree of FI involvement influences tooth loss- x3 risk of tooth loss for Class III.

Management: Treatment Options

Degree of furcation involvement:

- ◆ Class I – NST , odontoplasty
- ◆ Class II – NST, odontoplasty, OFD, regeneration, Tunnel Preparation
- ◆ Class III – SRD, OFD, Tunnel Preparation, Root resection, extraction

- ◆ Treatment options depends on patient compliance to attend regular maintenance visits

Tooth-related factors

Degree of furcation involvement
Amount of remaining periodontal support
Probing depth
Tooth mobility
Endodontic conditions and root/root-canal anatomy
Available sound tooth substance
Tooth position and occlusal antagonisms

Patient-related factors

Strategic value of the tooth in relation to the overall plan
Patient's functional and esthetic demands
Patient's age and health conditions
Oral hygiene capacity

Important issues to be discussed-cost , time ,consent

- ◆ Extraction
- ◆ Implant
- ◆ Long term maintenance and unpredictability of treating periimplantitis
- ◆ OFD
- ◆ Emdogain
- ◆ GTR +Bone
- ◆ Root resection/ tunnelling
- ◆ +/-RCT
- ◆ +/-Crown
- ◆ long term maintenance

Summary of Evidence

- ◆ **Teeth with FI can be retained in the longterm but at higher cost then teeth without FI**
- ◆ The higher degrees of FI, bone loss and mobility, higher cost of maintaining the tooth
- ◆ However removing and replacing teeth with implant supported crowns does not seem to cost less in the long term

Conclusions

- Furcations can be very difficult to manage
- Class I – non-surgical approach with ultrasonics/ mini curettes
- Class II and III – more effective debridement with a surgical approach
- Regenerative approach more successful with mandibular Class II buccal & lingual furcations; maxillary Class II buccal molars
- GTR is more effective than OFD in managing furcation defects, but results can be variable due to operator skill, patient & tooth selection
- Tunnel procedures & Root resection both effective & successful treatment modalities long-term for Gr II +III furcation involvements
- Regular maintenance is crucial to success of treatment (only 30% of degree III FI lost after 15years of regular maintenance Nibali et al, 2019)

2018 Reference book

Diagnosis and Treatment of Furcation-Involved Teeth

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Review > [J Periodontol](#). 2015 Feb;86(2 Suppl):S108-30. doi: 10.1902/jop.2015.130677.

Periodontal regeneration – furcation defects: a systematic review from the AAP Regeneration Workshop

Gustavo Avila-Ortiz ¹, Juan G De Buitrago, Michael S Reddy

Conclusions: On the basis of the reviewed evidence, the following conclusions can be drawn. 1) Periodontal regeneration has been demonstrated histologically and clinically for the treatment of maxillary facial or interproximal and mandibular facial or lingual Class II furcation defects. 2) Although periodontal regeneration has been demonstrated histologically for the treatment of mandibular Class III defects, the evidence is limited to one case report. 3) Evidence supporting regenerative therapy in maxillary Class III furcation defects in maxillary molars is limited to clinical case reports. 4) In Class I furcation defects, regenerative therapy may be beneficial in certain clinical scenarios, although most Class I furcation defects may be successfully treated with non-regenerative therapy. 5) Future research efforts should be primarily directed toward the conduction of clinical trials to test novel regenerative approaches that place emphasis primarily on patient-reported outcomes and also on histologic demonstration of periodontal regeneration. Investigators should also focus on understanding the influence that local, systemic, and technical factors may have on the outcomes of regenerative therapy in furcation defects.

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Review > [J Clin Periodontol. 2009 Feb;36\(2\):164-76. doi: 10.1111/j.1600-051X.2008.01358.x.](#)

The effect of periodontal therapy on the survival rate and incidence of complications of multirooted teeth with furcation involvement after an observation period of at least 5 years: a systematic review

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Conclusions: Good long-term survival rates (up to 100%) of multirooted teeth with furcation involvement were obtained following various therapeutic approaches. Initial furcation involvement (Degree I) could be successfully managed by non-surgical mechanical debridement. Vertical root fractures and endodontic failures were the most frequent complications observed following resective procedures.

Long-term prognosis of teeth with class III furcation involvement

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Objective: Evaluation of survival of teeth with class III furcation involvement (FI) ≥ 5 years after active periodontal treatment (APT) and identification of prognostic factors

Conclusions: Subgingival instrumentation with adjunctive systemic antibiotics favours retention of class III furcation-involved teeth. Baseline RBL and PPD at T1 deteriorate long-term prognosis.

References

Lindhe (7th Ed):

Chapter 33

Clinical Periodontology and Implant Dentistry

Fifth Edition



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Editors


Blackwell
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