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PART

5

Treatment of Periodontal Diseases

- **Chapter 44 :** Furcation Involvement and Its Management
- **Chapter 45 :** Pulpoperiodontal Problems
- **Chapter 46 :** Splints in Periodontal Therapy
- **Chapter 47 :** Dental Implants: Periodontal Considerations
- **Chapter 48 :** Maintenance Phase (Supportive Periodontal Treatment)
- **Chapter 49 :** Occlusal Evaluation and Therapy in the Management of Periodontal Disease
- **Chapter 50 :** Role of Orthodontics as an Adjunct to Periodontal Therapy
- **Chapter 51 :** Periodontal–Restorative Interrelationship
- **Chapter 52 :** Drugs Used in Periodontal Therapy
- **Chapter 53 :** Sterilization and Disinfection
- **Chapter 54 :** Miscellaneous
- **Chapter 55 :** Genetics in Periodontal Disease
- **Chapter 56 :** Questionnaire for Clinical Case Discussion

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CHAPTER

44

Furcation Involvement and Its Management

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Chapter Outline

- Definition
- Furcation Anatomy
  - Terminology
- Etiology
  - Primary Etiologic Factor
- Classification
  - Glickman's Classification of Furcation Involvement (1953)
  - Based on Vertical Component (Tarnow and Fletcher in 1984)
  - Based on Horizontal Component (Hamp and Coworkers in 1975)
  - Other Classifications
- Clinical Features
  - Clinically
  - Microscopically
- Diagnosis
- Prognosis
- Treatment
  - Traditional Treatment Procedures
  - Reconstructive and Regenerative Treatment Procedures
- Indications and Contraindications for Root Resection and Separation
  - Indications
  - Contraindications

"Learning Objectives"

At the end of the chapter, the reader shall be able to:

- Define furcation involvement and identify the primary bacterial etiologic factor responsible for the pathologic resorption of interradicular bone.
- Define the anatomical components of the root complex, including the root trunk, root cones, furcation fornix, and coefficient of separation.
- Classify cervical enamel projections (CEPs) into Grades I, II, and III using the Masters and Hoskins system and explain their clinical significance.
- Differentiate Glickman's four grades of furcation involvement based on clinical probe penetration, tissue position, and radiographic features.
- Compare the horizontal classification system by Hamp with the vertical system by Tarnow and Fletcher to precisely map out architectural bone defects.
- Distinguish between root resection, hemisection, and bicuspidization based on their surgical protocols, anatomical targets, and clinical indications.

DEFINITION

Furcation involvement refers to commonly occurring conditions in which the bifurcations and trifurcations of multirooted teeth are invaded by the disease process.

According to American Academy of Periodontology (2001), it is defined as pathologic resorption of bone within the furcation.

FURCATION ANATOMY

Terminology

- **Root complex:** It is the portion of a tooth that is located apical to the cementoenamel junction (CEJ).

  The root complex may be divided into two parts:

  1. The root trunk
  2. The root cones
- **Root trunk:** It represents the undivided region of the root, which is the distance between the CEJ and the separation line between the roots.

- **Root cone:** It is present within the divided region of the root complex. Two or more root cones makeup the furcation region.
- **Furcation:** It is the area located between individual root cones.
- **Furcation fornix:** It is the roof of the furcation.
- **Divergence:** It is the distance between two roots, which normally increases in apical direction.
- **Coefficient of separation:** The length of the root cones in relation to the length of the root complex.

ETIOLOGY

Primary Etiologic Factor

Primary etiologic factor is bacterial plaque and long-standing inflammation of periodontal tissues.

The extent of attachment loss in the furcation defect is related to the following:

Anatomic Considerations (Fig. 44.1)

- **Root trunk length:** It is the portion of the root between CEJ and the separation of the roots **(Fig. 44.2)**.

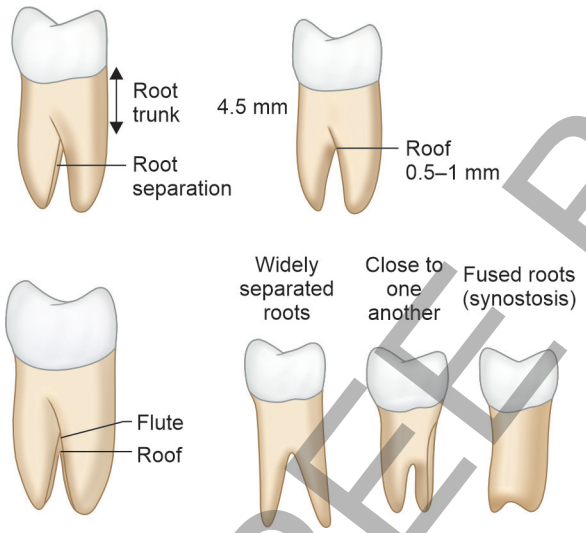

Fig. 44.1: Anatomic considerations.

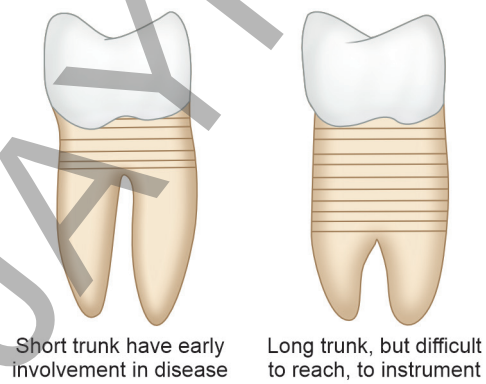

Fig. 44.2: Relationship between disease involvement and trunk length.

- **Root separation:** It is the portion of the tooth where adjacent roots forming the furcation are not in contact with each other and are separated by alveolar bone.
- The surface of the tooth just coronal to the root separation. This area is usually concave, grooved or fluted.
- The roof of furcation, which contains furcation ridges. These ridges run mesiodistally in lower and buccolingually in upper molars.

The roof of the furcation is concave in about 50% of maxillary first molars and is located 4.5 mm apical to the CEJ. The roof is 0.5–1 mm coronal to the root separation. Access to this area is extremely difficult for instrumentation of deep pockets.

Anatomic and clinical characteristics of tooth, bone and gingiva are of importance for the clinical management of furcation lesions.

Tooth

The following features should be considered:

- **Root trunk length:** When the root trunk is short, the furcation will become involved early in the disease process. When the root trunk is long, the furcation will be invaded later, but will be more difficult for instrumentation.
- **Concavity of the inner surface of exposed roots:** All the root surfaces facing the furcation exhibit some degree of concavity or depression in an occlusoapical direction. This may make instrumentation for plaque removal and root planing almost impossible. But these concavities increase the attachment area of a tooth and produce a root shape that is resistant to torque. It is common in mesiobuccal root of maxillary first molar and mesial root of mandibular first molar.
- **Degree of separation of roots/interradicular dimension:** Wide separation of roots improves access, thereby facilitating instrumentation.
- **Cervical enamel projections:** They occur approximately in 15% of molars. They favor plaque accumulation and must be removed to facilitate scaling and root planing.

  It was classified by Masters and Hoskins in 1964 as follows:

  Grade I: The enamel projection extends from the cementoenamel junction of the tooth toward the furcation entrance.

  Grade II: The enamel projection approaches the entrance to the furcation but does not enter the furcation and hence has no horizontal component.

  Grade III: The enamel projection extends horizontally into the furcation.
- **Anatomy of the furcation:** Presence of bifurcation ridges, presence of accessory canals can complicate the furcation treatment.
- **Presence of accessory pulpal canals:** It is believed that once the pulp is infected through the accessory canal, endo-perio communication may result, which in turn can cause either destruction of interradicular periodontium or interfere with the healing response of either periodontal or endodontic procedures.

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Bone

Bone shape in the exposed furcation area has a horizontal component that determines the grades (I, II and III) of the involvement and a vertical component that most often creates a depression in the center of the remaining bone similar to a crater in an interdental area. The vertical component can also appear as a vertical or angular loss toward one of the roots. The latter defect can have one, two or three osseous walls or can be funnel-shaped around one root.

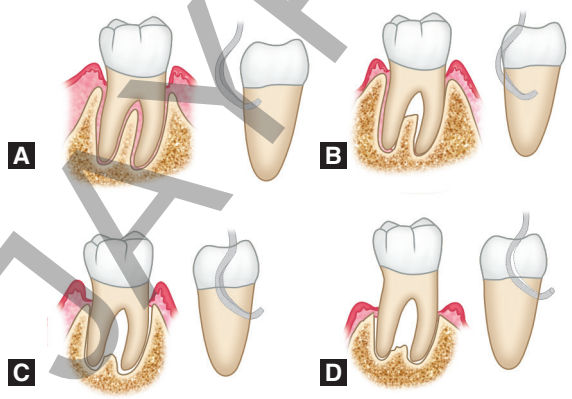
Gingiva

The presence of sufficient attached keratinized gingival tissue and adequate vestibular depth will facilitate the gingival management of the furcation area.

CLASSIFICATION

Glickman's Classification of Furcation Involvement (1953) (Figs. 44.3A to D)

- **Grade I:** It is the incipient or early lesion. The pocket is suprabony, involving soft tissue. There is slight bone loss in the furcation area. No radiographic changes.
- **Grade II:** In grade II cases, bone is destroyed on one or more aspects of the furcation, but a portion of alveolar bone and periodontal ligament remains intact, permitting only partial penetration of the probe into the furcation. The lesion is essentially a cul-de-sac. The radiograph may or may not reveal the grade II involvement.
- **Grade III:** In this type of furcation involvement, the interradicular bone is completely lost, but the facial or lingual surfaces are occluded by gingival tissues. Therefore, the furcation opening cannot be seen clinically, but it is essentially a through-and-through tunnel. If the radiographs are taken with proper angulation and the roots are divergent, the lesion will appear as a radiolucent area between the roots.
- **Grade IV:** As in grade III lesions, the interradicular bone is completely lost, but in grade IV involvement the gingival tissues recede apically so that the furcation opening is seen clinically. The radiographic changes are essentially the same as that of grade III lesion.



Figs. 44.3A to D: Glickman's classification of furcation involvement. (A) Grade I; (B) Grade II; (C) Grade III; (D) Grade IV.

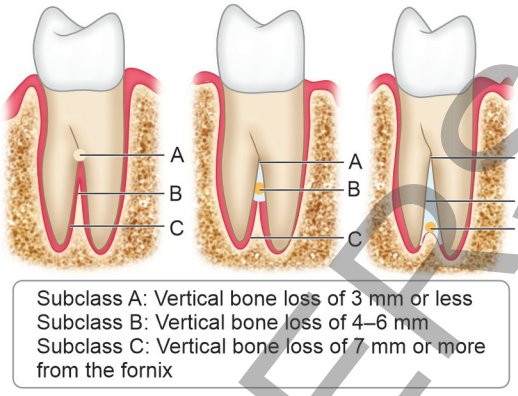


Fig. 44.4: Vertical classification of furcation involvement.

Based on Vertical Component (Tarnow and Fletcher in 1984) (Fig. 44.4)

Depending on distance from base of the defect to roof of the furcation, the furcations can be classified as follows:

- **Subgroup A:** Vertical destruction of bone up to one-third of the interradicular height (0–3 mm).
- **Subgroup B:** Vertical destruction of bone up to two-thirds of the interradicular height (4–7 mm).
- **Subgroup C:** Vertical destruction beyond the apical-third (7 mm or more).

Based on Horizontal Component (Hamp et al. 1975) (Fig. 44.5)

Furcations can be classified as follows:

- **Degree I:** Horizontal bone loss of less than 3 mm.
- **Degree II:** Horizontal bone loss of more than 3 mm.
- **Degree III:** Through-and-through horizontal lesion.

Furcation can be clinically detected by using Nabers probe along with a simultaneous blast of warm air to facilitate visualization and radiographs also help detect the furcation invasions.

Other Classifications

According to Goldman (1958)

- **Grade I:** Incipient
- **Grade II:** Cul-de-sac
- **Grade III:** Through-and-through

According to Ramfjord and Ash (1979)

- **Class I:** Beginning of involvement. Tissue destruction less than 2 mm (i.e., less than one-third tooth width).
- **Class II:** Cul-de-sac. Tissue destruction more than 2 mm (i.e., is more than one-third tooth width), but not through-and-through.
- **Class III:** Through-and-through involvement.

According to Fedi (1985)

It is a combination of Glickman's and Hamp's classification.

- **Grade I:** It is the incipient or early lesion. The pocket is suprabony, involving soft tissue. There is slight bone loss in the furcation area. No radiographic changes.

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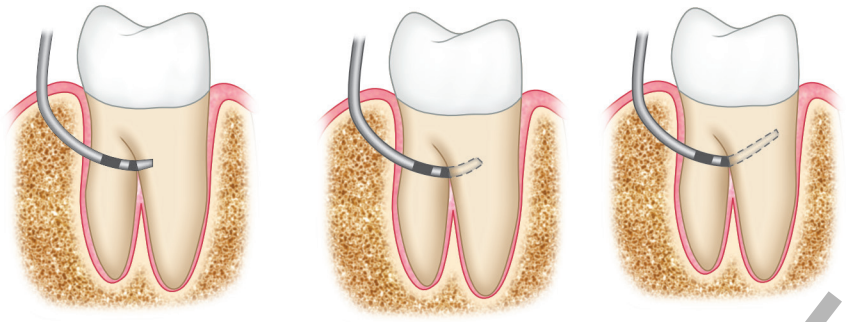

Fig. 44.5: Horizontal classification of furcation involvement. (*Source*: Hamp et al.)

- **Grade II:** In grade II cases, bone is destroyed on one or more aspects of the furcation, but a portion of alveolar bone and periodontal ligament remains intact, permitting only partial penetration of the probe into the furcation. The lesion is essentially a cul-de-sac. The radiograph may or may not reveal the grade II involvement. It can be further divided into the following:
  - *Degree I*: Interradicular bone loss less than 3 mm.
  - *Degree II*: Interradicular bone loss more than 3 mm.
- **Grade III and grade IV are same as Glickman's classifications.**

CLINICAL FEATURES

Clinically

- The mandibular first molars are the most common sites, and maxillary premolars are the least common.
- The denuded furcation may be visible clinically or covered by the wall of the pocket.
- Associated with suprabony and infrabony pockets.
- Periodontal abscess
- Root caries and tooth mobility are common.

Microscopically

Furcation involvement is simply a phase in the rootward extension of the periodontal pocket. In its early stages, there is a widening of the periodontal space with cellular and inflammatory fluid exudation, followed by epithelial proliferation into the furcation area from an adjoining periodontal pocket. Extension of the inflammation into the bone leads to resorption and reduction in bone height. The bone destructive pattern may produce horizontal loss, or there may be angular osseous defects associated with infrabony pockets. Plaque, calculus and bacterial debris occupy the denuded furcation space.

DIAGNOSIS

- **Probing:** Using a curved graduated periodontal probe (Nabers probe), an explorer or a small curette, furcations can be identified.
- **Maxillary molars:** Mesial furcation entrance is located closer to palatal than to the buccal surface, hence, the mesial furcation should be probed from the palatal aspect of the tooth. Whereas the distal furcation is in the midway between buccal and palatal surfaces, hence, this furcation can be probed either from the buccal or palatal surface. The distal maxillary furcation is most frequently involved.
- **Radiographs:** They can only be used to confirm the findings made during probing of a furcation in individual tooth.

PROGNOSIS

Maxillary first premolars and maxillary as well as mandibular molars are the teeth with multiple roots. Furcation involvement will be likely to occur in these multirooted teeth. Maxillary first premolar often shows fusion of the roots and the furcation area may be located very much apically and also the roots of the maxillary first premolars are placed buccally and palatally with furcation opening in a mesiodistal direction.

For these reasons, furcation involvement in maxillary first premolar has poor prognosis.

In the case of maxillary molars, furcations may open buccally, mesially and distally because of the presence of the three roots. Since access from proximal areas is difficult for plaque control, prognosis of furcation involvement in maxillary molars is not good.

Mandibular molars have two roots, placed mesially and distally and the furcation opens buccolingually. The roots are usually divergent especially in mandibular first molars.

As a result, prognosis of furcation involvement in mandibular molar (especially the first molar) is considered good.

Nuggets of Knowledge

- Furcation involvement refers to commonly occurring conditions in which the bifurcation and trifurcation of multirooted teeth are invaded by the disease process.

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- Primary etiologic factor is bacterial plaque, predisposing or anatomic factors include aberrant root morphology, cervical enamel projections or pearls and presence of accessory canals.
- Furcation involvement can be classified according to Glickman as grade I, grade II, grade III and grade IV.
- Depending on the distance from the base of the defect to the roof of the furcation (vertical component). Tarnow and Fletcher classified furcation involvement into—subgroup A, subgroup B, subgroup C.
- Furcation involvement can be diagnosed by Naber's probe and radiographs.

TREATMENT

Treatment is aimed to prevent further attachment loss and improve the maintenance of furcation area. Two treatment modalities have been proposed:

1. Traditional treatment procedures
2. Reconstructive or regenerative treatment

Factors to be considered when deciding on a mode of therapy are as follows:

- Degree of involvement
- Crown root ratio
- Length of roots
- Degree of root separation
- Strategic value of the tooth or teeth in question
- Root anatomy of the involved tooth
- Residual tooth mobility
- Endodontic therapy and complications
- Ability to eliminate the defect
- Periodontal condition of the adjacent teeth

Traditional Treatment Procedures

They are those which are directed to maintain the state of the health but do not attempt to regenerate the lost periodontium. The goal is to prevent the further progression of the disease and provide an environment, which will help in adequate plaque control.

The procedures are as follows:

- **Grade I:** They are usually associated with suprabony pockets, hence:
  - Initial preparation or scaling and root planing.
  - Curettage or gingivectomy to expose the furcation area.
  - Odontoplasty—to reshape the facial groove in order to prevent plaque accumulation.
- **Grade II:** In shallow grade II invasions:
  - Osteoplasty with limited ostectomy may be helpful.
  - Odontoplasty can be performed.

  In severe grades II to IV invasions elimination of furcation by:
  - *Root resection or amputation:* After periodontal flap reflection, surgical removal of the root portion of the affected tooth is most commonly performed in maxillary first molars.
  - *Hemisection or root separation:* It is the surgical removal of the root along with the crown. Most commonly done in mandibular molars.
  - *Bicuspidization/root separation:* Splitting of a two rooted tooth into two separate portions. Frequently performed in mandibular molars.
  - *Tunnel preparation:* It is by transforming the grade II lesion to grades III and IV for better access, but it is not performed anymore because of increased incidence of root caries.
- **Grade III and grade IV** can be treated with root resection and root separation.

Reconstructive and Regenerative Treatment Procedures (Figs. 44.6A to G)

- **Grade I:** Traditional treatment will do.
- **Grade II:** Various regenerative techniques include:
  - Autogenous bone grafting, e.g., osseous coagulum, bone blend
  - Allografts, e.g., freeze-dried bone allografts (FDBA), demineralized freeze-dried bone allografts (DFDBA)
  - Alloplasts—hydroxyapatite, tricalcium phosphate
  - Citric acid root conditioning with coronally positioned flap
  - Guided tissue regeneration and combination techniques (for details, *see* Chapter 42: Osseous Surgery)
- For grade III and grade IV furcation involvements the success rate is limited.

Definition of Root Resection, Hemisection and Root Separation (Figs. 44.7 and 44.8)

According to 1986 glossary of periodontal terms, following are the definitions:

- **Root resection:** It is the surgical removal of all or a portion of the root before or after endodontic treatment.
- **Hemisection:** It is the surgical removal of a root with the associated part of the crown. It is frequently used with reference to lower molars.
- **Root separation/bicuspidization:** It is the sectioning of the root complex and the maintenance of all roots.

Three Phases of Treatment Suggested for Root Separation and Resection

1. **Endodontic phase:** If possible, it should be performed prior to surgery. It offers the following advantages:
   - Better bone recontouring during surgery
   - Allows precise flap closure
   - Easy adaptation for temporary prosthesis
2. **Restorative phase:** Construction of a provisional restoration.
3. **Surgical phase:** Most commonly distobuccal root of the maxillary first molar is resected.

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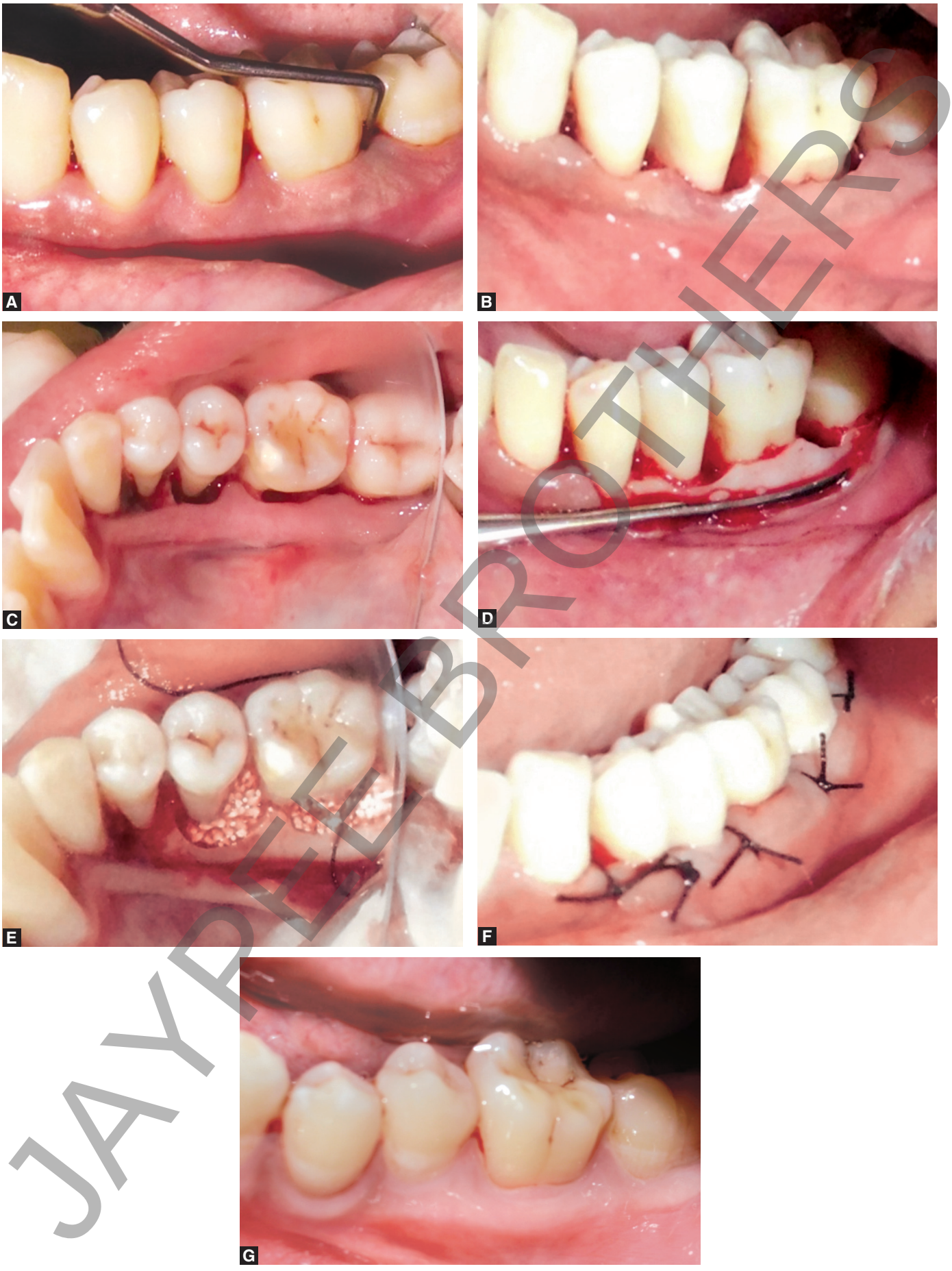

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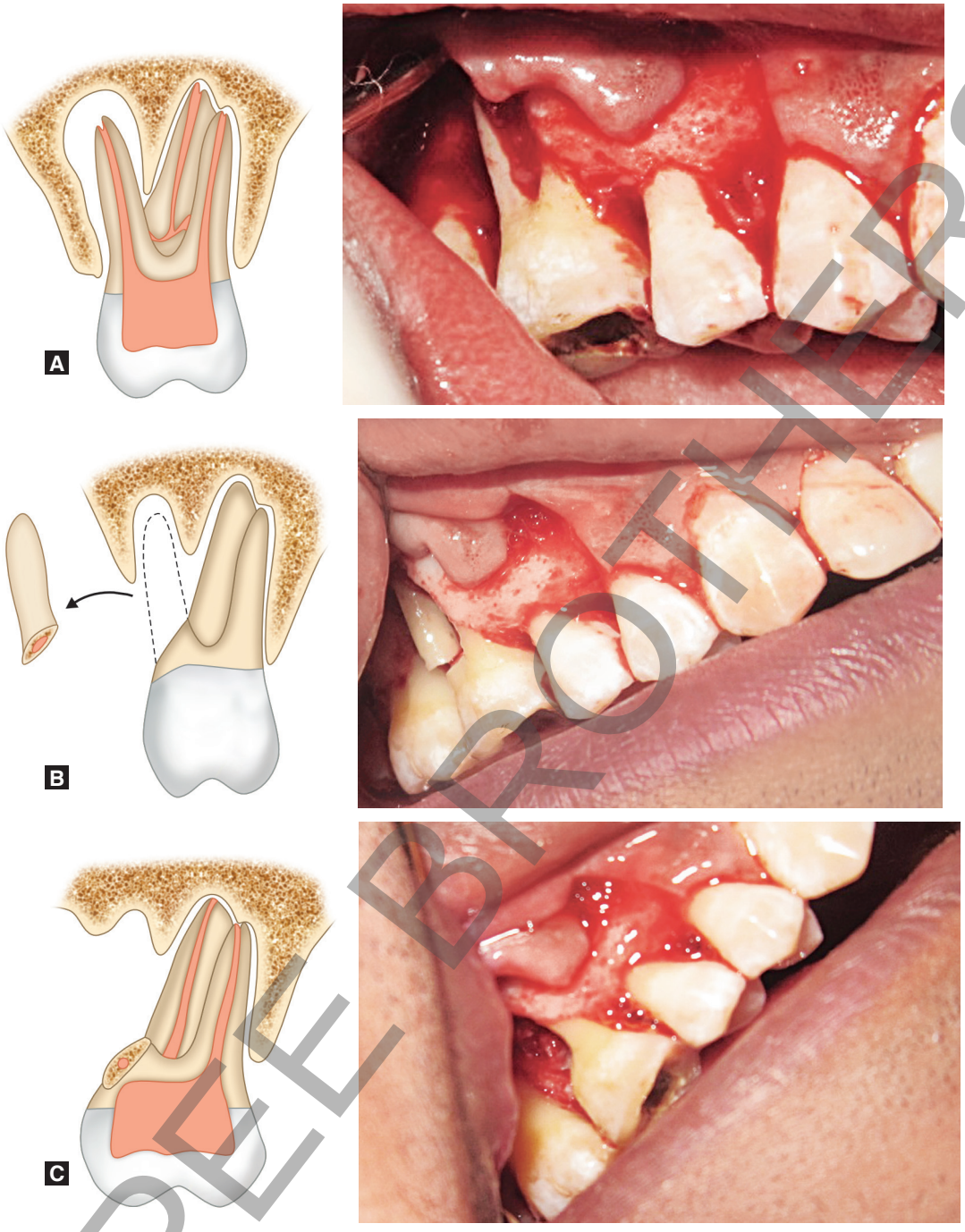
Figs. 44.6A to G: Furcation involvement. (A) Preoperative; (B) Buccal incision placement; (C) Lingual incision placement; (D) Reflection of flap; (E) Bone graft placement; (F) Suturing; (G) Facial view after healing.



Figs. 44.7A to C: Root separation/resection (diagrammatic representation and respective clinical pictures).

The procedure is as follows **(Figs. 44.7A to C)**:

- After appropriate local anesthesia a full thickness mucoperiosteal flap is raised.
- After debridement, resection of the root with advanced bone loss is carried out. First an oblique cut/incision is made directed from apical to the contact point through the tooth to the facial and distal orifices of the tooth.

  In case of vital resection, it is advised to perform a horizontal incision through the root because an oblique incision can expose a large surface area of the radicular pulp or pulp chamber, which in turn can lead to more postoperative pain.
- After sectioning, the root is elevated from its socket and is removed. If necessary, odontoplasty is performed to remove any furcation deformities. If any bony defects are present in the adjacent teeth, then resective or regenerative procedures are performed.
- The flaps are then approximated and sutured to maintain the position.

INDICATIONS AND CONTRAINDICATIONS FOR ROOT RESECTION AND SEPARATION

Indications

- Severe bone loss affecting one or more roots untreatable with regenerative procedures.

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- Class II or III furcation invasions or involvement.
- Severe recession or dehiscence of a root.

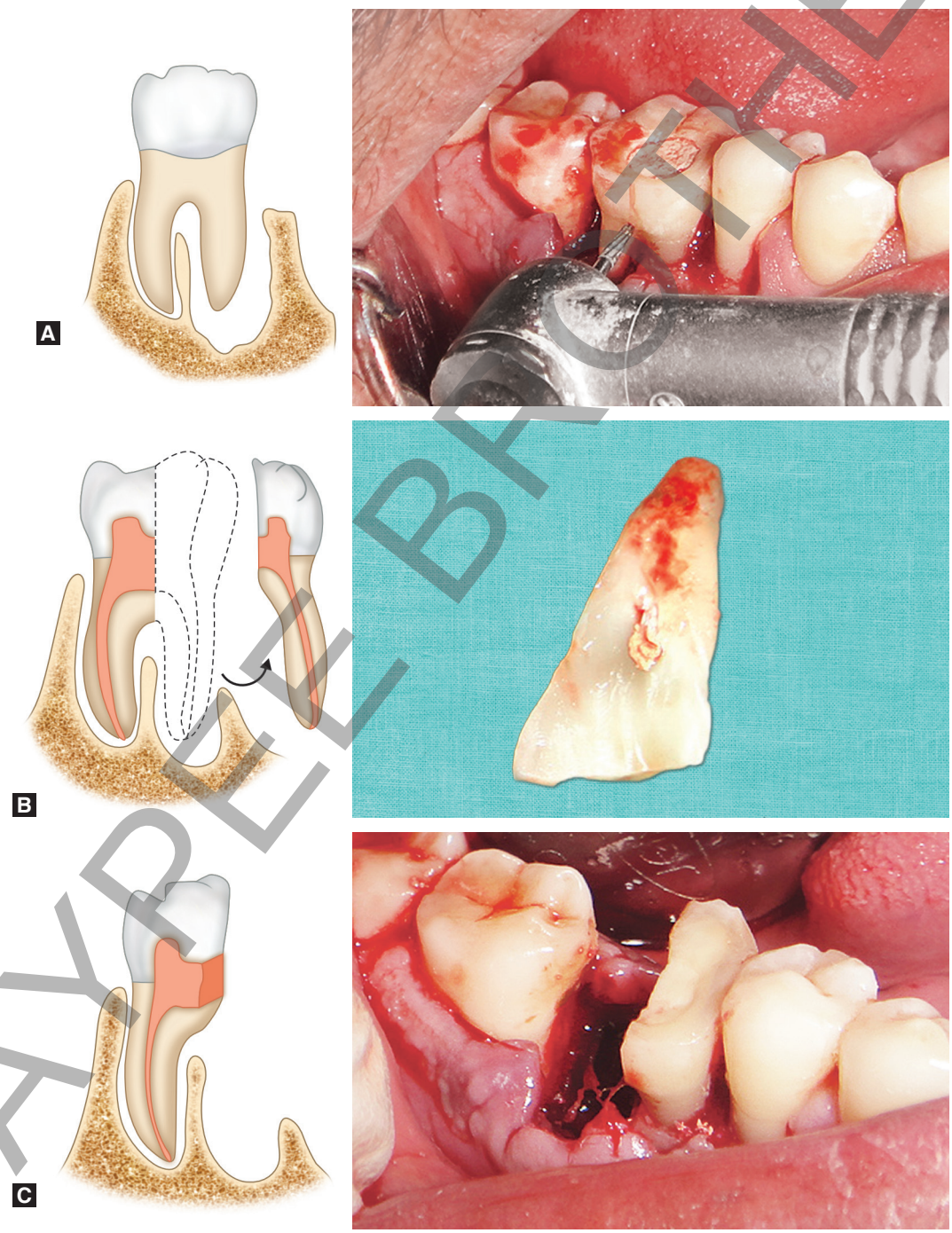
Contraindications

- General contraindications, such as systemic diseases and poor oral hygiene.
- Fused roots, unfavorable tissue architecture.
- Roots that are endodontically untreatable.

HEMISECTION

Removal of root with corresponding crown portion. **(Figs. 44.8A to C)**.

- Mostly done in mandibular molars with buccal and lingual class II and class III furcation involvement.
- Technique is similar to root resection except that the half of the crown is removed along with one of the affected roots



Figs. 44.8A to C: Hemisection (diagrammatic representation and respective clinical pictures).

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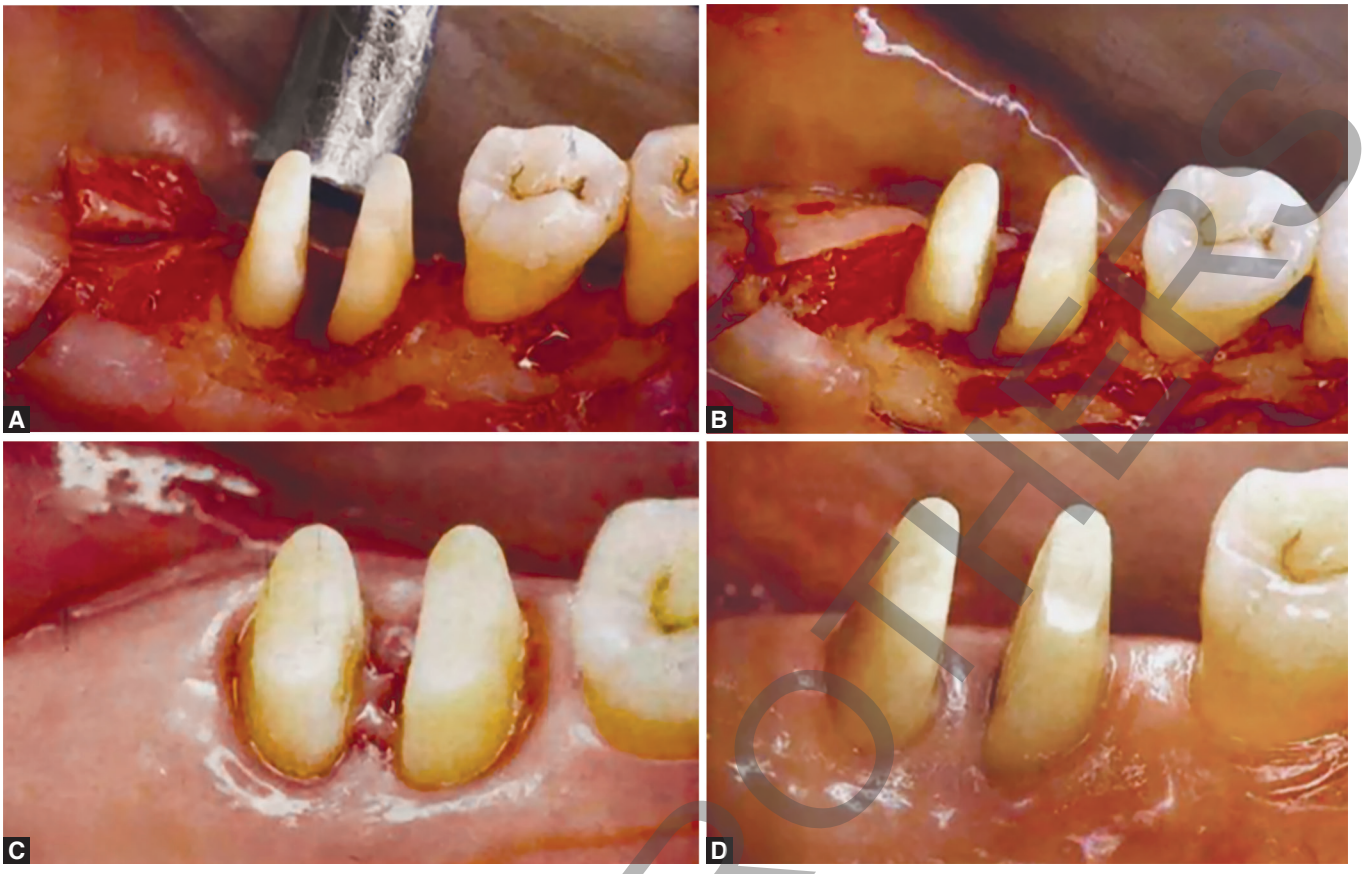

Figs. 44.9A to D: Bicuspidization. (A) Splitting of mandibular molar into two halves; (B) Debridement of the defect; (C) Healing after 1 week; (D) Healed after 1 month.

- Vertically oriented cut is made buccolingually through the pulp chamber and furcation.
- Retained mesial or distal half serves as a useful abutment.

BICUSPIDIZATION (FIGS. 44.9A TO D)

It is the splitting of mandibular molars and retaining both the fragments so as to shape the molar into two separate halves/units.

Indicated in mandibular molars with buccal and lingual class II and class III furcation involvement.

Nuggets of Knowledge

Treatment of furcation involvement is divided into:
- Traditional treatment procedures
- Reconstructive or regenerative treatment

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Furcation Involvement and Its Management

Definition

Furcation involvement refers to commonly occurring conditions in which the bifurcations and trifurcations of multirooted teeth are invaded by the disease process



Etiology

Primary etiology: Bacterial plaque and long-standing inflammation of periodontal tissues.

Predisposing/anatomic factors

- Root trunk length
- Root separation
- Concave root surfaces
- Cervical enamel projections
- Accessory pulpal canals

Clinical Features

- Mandibular first molars-most common sites
- Maxillary premolars are the least common
- The denuded furcation may be visible clinically
- Associated with suprabony and infrabony pockets
- Periodontal abscess
- Root caries and tooth mobility are common

Classification

Glickman's classification (1953)

- Grade 1: incipient or early lesion.
- Grade II: partial penetration, cul-de-sac.
- Grade III: through-and-through tunnel (not visible clinically)
- Grade IV: through-and-through tunnel (visible clinically)

Vertical Component (Tarnow and Fletcher in 1984)

- Subgroup A: vertical destruction of bone (0-3 mm)
- Subgroup B: vertical destruction of bone (4-7 mm)
- Subgroup C: vertical destruction of bone (>7 mm)

Horizontal Component (Hamp et al. 1975)

- Degree I: Horizontal bone loss of less than 3 mm
- Degree II: Horizontal bone loss of more than 3 mm
- Degree III: Through-and-through horizontal lesion

Treatment

Grade I

- Scaling and root planing, curettage
- Odontoplasty

Grade II

- Osteoplasty with limited ostectomy and odontoplasty
- Reconstructive/ Regenerative treatment techniques

Grade III and IV

- Root resection: surgical removal of all or a portion of the root surface
- Hemisection: surgical removal of a root with the associated part of the crown
- Bicuspidization: sectioning of the root complex
- Tunelling procedure

Diagnosis

- Probing (Nabers probe)
- Radiographs

Factors Affecting Prognosis

- Degree of involvement
- Crown-root ratio
- Length of roots
- Degree of root separation
- Root anatomy of the involved tooth
- Residual tooth mobility
- Endodontic therapy and complications
- Periodontal condition of the adjacent teeth

Reconstructive/Regenerative treatment

- Bone grafts
- Root surface biomodification
- Platelet concentrates
- Guided tissue regeneration and combination

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