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A Review

Furcation In Dentistry - A Review

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Abstract
Advances in dentistry, as well as the increased desire of patients to maintain their dentition, have led to treatment of teeth that once would have been removed. Furcally-involved teeth present unique challenges to the success of periodontal therapy. The treatment, management and long-term retention of molar teeth exhibiting furcation invasions, always have been a challenge to the discerning general dentist or dental specialist. Anatomic and morphological complicating factors dictate modifications in treatment approaches used for managing these areas.This review evaluates the different aspects of furcation in terms of etiology, classification, diagnosis and various treatment possibilities.

Key Words
Furcation, Furcation involvement,Periodontal disease, Plaque.

Introduction:
Periodontal disease may be defined as "Inflammation of the supporting tissues of the teeth. Usually a progressively destructive change leads to loss of bone and periodontal ligament. An extension of inflammation from gingiva into the adjacent bone and ligament" [1] which is affected by age, gender, ethnicity, income, social class and educational status. The degree to which a lesion progresses is affected by several factors: inflammatory response, type of bacteria present, organic conditions and local factors. In the posterior segments of dentition; the progress of inflammatory periodontal disease, if unabated, ultimately results in attachment loss sufficient enough to affect the bifurcation or trifurcation of multi-rooted teeth & this is one of the most serious sequels of periodontitis.[2] Furcation is defined as the anatomic area of a multi rooted tooth where the roots diverge.[3] It has a complex anatomic morphology that may be difficult or impossible to debride by routine periodontal instrumentation. Routine home care methods may not keep the furcation area free of plaque. [4] "Furcation involvement may be defined as the invasion of the bifurcation and trifurcation of multirooted teeth by periodontal disease". [5] Involvement of the furcae in multi-rooted teeth by chronic periodontitis is a common event resulting from loss of bone adjacent to and within the furcae.
Some authors recommended extraction of the teeth with furcation invasions rather than trying to retain them.[6] Long-term studies on treated periodontal patients have reported that molar teeth with prior furcation involvement were the most frequently lost teeth, probably because of their complex anatomy. Nevertheless these same studies showed that in the majority of patients who responded well to treatment, many molar teeth with furcation involvement were retained for periods as long as 40-50years. [5]

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Furcation involvement therefore presents both diagnostic and therapeutic dilemmas.[2] Nevertheless, conservation of natural dentition has been the aim of periodontics since time immemorial.

Etiology:
The etiology of furcation involvement can be classified into three major groups, among which the most common etiologic factor is bacterial plaque. [6]

1. Primary factor
2. Predisposing factors
3. Contributing factors

The primary factor includes bacterial plaque. The various predisposing factors include location relative to CEJ, root trunk length, root length, root form, interradicular dimension, furcation shape, location of entrance, furcation entrance diameter, facial and lingual radicular bone, enamel projections, enamel pearls, bifurcation ridges, root concavities and carious lesions. The contributing factors include plaque-associated inflammation, trauma from occlusion, pulpal pathology, vertical root fractures and iatrogenic factors. [4-13]

Classification:
Several systems have been devised to classify the severity of furcation involvement based either on the extent of horizontal probing depth into the furcation defect or on the vertical extent of the loss of alveolar bone within the defect. Out of the various classifications listed in **Table 1**; Glickman's classification **[Figure 1]** is most frequently used by the dentists in day-today practice.

Diagnosis:
The presence of furcation-involved teeth in a periodontal patient will influence the treatment plan. [14] The selection of procedures to be used in the treatment of periodontal disease at multirooted teeth can first be made when the presence and depth of furcation lesions have been assessed. A thorough clinical examination is the key to diagnosis and treatment planning. [2]

1. **Clinical Assessment –**
   - Probing: Buccal and lingual furcation can be easily

Figure 1: Glickman's Classification of Furcation Defects. (A) Grade I furcation defect , (B) Grade II furcation defect, (C) Grade III furcation defect and (D) Grade IV furcation defect.[2]

HORIZONTAL COMPONENT OF FURCATION INVOLVEMENT	VERTICAL COMPONENT OF FURCATION INVOLVEMENT
GLICKMAN (1953) [8]ESKOW & KAPLIN (1984) [9]	
GOLDMAN (1958) [9]TARNOW & FLETCHER (1984) [9]	
HAMPS, LINDHE, NYMAN (1975) [4]HOU & TSAI (1997) [11]	
RAMJFORD & ASH (1979) [9]HOU et al (1998) [12]	
RICCHETTI (1982) [9]	
FEDI (1985) [9]	
BASARABA (1990) [10]	

Table 1: Classification Of Furcation Involvement

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 anatagonisms
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

Table 2:Factors to consider in treatment of furcation-involved molars[14]

Glickman	I	II	---	III/IV
Lindhe	---	I	II	III
Tarnow	---	A, B/C	A, B/C	A, B/C
Treatment	Scaling & Root planing, Gingivectomy, Odontoplasty	Odontoplasty, Osteoplasty, Furcationplasty, Regenerative procedures	Root resection, Tunnel preparation Regenerative procedure, Extraction/ Implant placement	Root resection, Tunnel preparation, Regenerative procedure, Extraction/ Implant placement

Table 3: Treatment of furcation

Furcation involvement	Root resection	Root resection + separation of the remaining roots
BuccalMesiobuccal, Distobuccal		
MesialMesiobuccal, Palatal		
Distal Distobuccal, Palatal		
Buccal & DistalDistobuccal, Mesiobuccal & Palatal		Palatal
Buccal & MesialMesiobuccal, Distobuccal & Palatal		Palatal, Diatobuccal
Mesial & DistalPalatal, Mesial & Distobuccal		Distobuccal
Buccal, Distal & MesialDistobuccal & Palatal, Mesiobuccal		Palatal, Diatobuccal
& Palatal, Mesial & Distobuccal		

Table 4: Root respective treatment possibilities in molars with furcation involvement [14]

probed. Proximal furcations are difficult for probing particularly when broad contacts are present in adjacent teeth.[14] Nabers Probe and Columbia curette 4R / 4L are used for probing the furcation area.

- Bone Sounding or Transgingival probing: It may aid in the diagnosis of furcation defects more accurately determining the underlying bone contours.[10]

2. Radiographic Assessment –

Radiographs are helpful but show artifacts that make it possible for furcation involvement to be present without detectable radiographic changes. As a general rule, bone loss is always greater than it appears in the radiograph.

Radiographs must always be obtained to confirm findings made during probing of a furcation-involved tooth. The radiographic examination includes intraoral periapical radiographs and vertical "bitewing" radiographs for detection of furcation invasion. In the radiographs, the location of the interdental bone as well as the bone level within the root complex should be examined.[14] Additional radiographs with different angles of orientation of the central beam should be used to identify bone loss within the root complex. [10]

Other than radiographs; CT scan, CBCT, Ultrasound, Dental Endoscope etc. are also now-a-days being used for detection.

Diagnosing furcation invasion is therefore best accomplished using a combination of radiographs, periodontal probing with a curved explorer or Nabers probe and bone sounding. [15]

Differentialdiagnosis: [14]

- Endo - Perio lesions
- Trauma from occlusion

Management:

Treatment of a bony defect in the furcation region is intended to meet two objectives: [14]

- Elimination of the microbial plaque from the exposed surfaces of the root complex.
- Establishment of an anatomy of the affected surfaces that facilitates proper self-performed plaque control.

Factors to be considered for successful treatment of furcation involvement: [2,9] **[Table 2]**

1. Degree of Involvement
2. Crown: Root ratio
3. Length of roots
4. Root anatomy/morphology
5. Degree of root separation
6. Strategic value of the tooth
7. Residual tooth mobility
8. Need for endodontic treatment
9. Prosthetic requirements
10. Periodontal condition of adjacent teeth
11. Ability to maintain oral hygiene
12. Quality of bone/ ability to place implants
13. Financial considerations
14. Long term prognosis

The treatment of furcation involvement according to different classification is shown in **Table 3**.

Scaling & Root Planing:

Scaling and planing of the root surfaces in the furcation entrance of a degree I involvement in most situations result in the resolution of the inflammatory lesion in the gingiva [14]; and it is also the preliminary phase of oral rehabilitation before proceeding with surgical correction of periodontal abnormalities. [2] Healing will re-establish a normal gingival anatomy with the soft tissue properly adapted to the hard tissue walls of the furcation entrance.[14] These procedures results in elimination of pocket, resolution of inflammation and repair of the periodontal ligament and adjacent bone margins.

Root Resection & Hemisection:

Root resection is a technique for maintaining a portion of a diseased or injured molar by removal of one or more of its roots.[14] It may be achieved by hemisection, in which the splitting of a two-rooted tooth into two separate portions,[2] or by root amputation, in which only a root or two are amputed from the remainder of the tooth.Hemisection has been called bicuspidizationor separationas it changes the molar into two separate roots.[2] The furca is then turned into an interproximal

space where the tissue is more manageable by the patient.
Which root to remove [2]: **[Table 4]**

- Remove the root(s) that will eliminate the furcation and allow the production of a maintainable architecture on the remaining roots.
- Remove the root with the greatest amount of bone and attachment loss. Teeth with uniform advanced horizontal bone loss are not candidates for root resection.
- Remove the root that best contributes to the elimination of periodontal problems on adjacent teeth.
- Remove the root with the greatest number of anatomic problems.
- Remove the root that least complicates future periodontal maintenance.

Indications for tooth resection [16]

1. Periodontal Indications:
- Severe vertical bone loss involving only one root of multi-rooted teeth.
- Through and through furcation destruction.
- Unfavorable proximity of roots of adjacent teeth, preventing adequate hygiene maintenance in proximal areas.
- Severe root exposure due to dehiscence.

2. Endodontic and Restorative Indications:
- Prosthetic failure of abutments within a splint
- Endodontic failure
- Vertical fracture of one root
- Severe destructive process

3. Prosthodontics Indications:
- Severe root proximity inadequate for a proper embrasure closure.
- Root trunk fracture or decay with invasion of the biological width.

Contraindications to root resection and separation treatment [17]

1. General contraindications to periodontal surgery
- Systemic factors
- Poor oral hygiene

2. Factors associated with local anatomy
- Fused roots
- Unfavorable tissue architecture

3. Endodontic factors
- Retained root endodontically untreatable
- Excessive endodontic instrumentation of retained roots
- Excessive deepening of pulp chamber floor

4. Restorative factors
- Internal root decay
- Presence of a cemented post in the remaining root

5. Strategic considerations
- Consider adjacent teeth available for conventional prosthetic restoration
- Consider removable prosthesis
- Consider implants

Therapeutic Protocol: A complete medical and dental history, thorough clinical and radiographic evaluations including periapical radiographs, diagnostic casts and consultation with the dentist should be carried out.[18] The procedure of root resection is illustrated in **Figure 2**.

Furcationplasty [14]

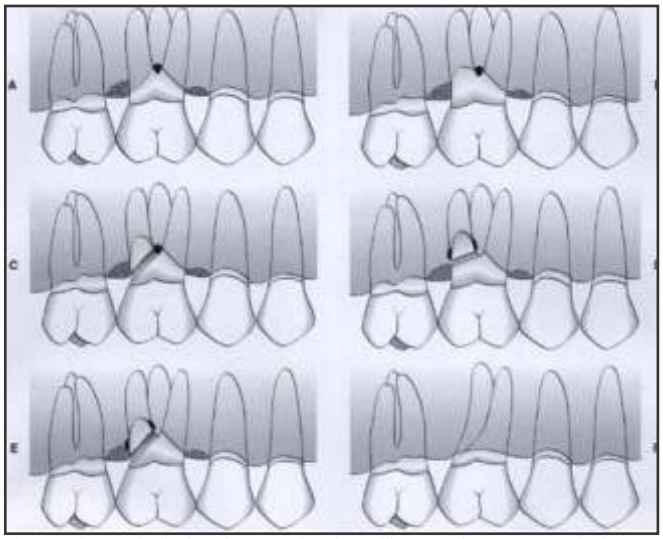

Figure 2: Diagram of a distobuccal root resection of a maxillary 1st molar. (A) Pre-operative bony contours with grade II buccal furcation and a creater between the first and second molar. (B) Removal of bone from the facial of the distobuccal root and exposure of the furcation for instrumentation. (C) Oblique section that separates the distal root from the mesial and palatal roots of the molar. (D) More horizontal section that may be used on a vital root amputation as it exposes less of the pulp of the tooth. (E) Areas of application of instruments to elevate the sectioned root. (F) Final contours of the resection.[2]

It is a resective treatment modality which should lead to the elimination of the interradicular defect. Tooth substance is removed (odontoplasty) and the alveolar bone crest is remodeled (osteoplasty) at the level of the furcation entrance. Furcationplasty is used mainly at buccal and lingual furcations. At approximal surfaces access is often too limited for this treatment. Care must be exercised when odontoplasty is performed on vital teeth. Excessive removal of tooth structure will enhance the risk for increased root sensitivity.

Tunneling [14]

Tunnel preparation is a technique used to treat deep furcation defects in mandibular molars. This type of resective therapy can be offered at mandibular molars which have a short root trunk, a wide separation angle and long divergence between the mesial and distal root. The procedure includes the surgical exposure and management of the entire furcation area of the affected molar.

The furcation area is widened by the removal of some of the interradicular bone. The flaps are apically positioned to the surgically established interradicular and interproximal bone level.During maintenance the exposed root surfaces should be treated by topical application of chlorhexidine digluconate and fluoride varnish. This surgical procedure should be used with caution, because there is a pronounced risk for root sensitivity and for carious lesions developing on the denuded root surfaces within artificially prepared tunnels. [4]

Open Flap Debridement & Root Conditioning

Non-surgical approach to therapy is very efficient but is also known to have therapeutic limitations. Factors that contribute to the decreased effectiveness of non-surgical therapy include; time constraints, difficulty in accessing the area to be treated, operator experience, individual responses to the therapy by the patient, and anatomical and microbiological influences. For these reasons it may be advantageous and indicated to have surgical access to the area in need of decontamination. The possibility to elevate a flap and visualize the roots surfaces allows for an accurate and complete elimination of local

etiologic factors.

Extraction

It is indicated when the destruction of the periodontium has progressed to such a level that no tooth can be preserved.Extraction may also be performed when the maintenance of the affected tooth will not improve the overall treatment or when treatment of the furcation involved tooth will not result in conditions which can be properly maintained by self-performed plaque control measure.

Restorative Management

In the prosthetic preparation of the roots; the preparation margins are supragingivally, which improves the precision of the definitive crown restoration. The framework of the restoration must be rigid to compensate for the compromised abutments (roots) with a compromised periodontal tissue support. The occlusion should be designed to minimize the infliction of lateral deflective forces.[14] Hemisected teeth should not be cantilevered unless supported by splinting.

Endodontic therapy should be conservative (minimal enlargement of the root canal) for root strength and condensation should not be excessive. Badly broken-down teeth may be built up with a post and core before final restoration is attempted.

Regeneration:

The possibility of regenerating and closing a furcation defect has been investigated. Following an early case report publication (Gottlow et al. 1986), where histologic documentation of new attachment formation in human furcation defects treated by "guided tissue regeneration" (GTR) therapy was provided; the results of several investigations on this form of treatment in furcation- involved teeth have been presented. [14]

Furcation defects with deep two-walled or significant three-walled components may however be candidates for regeneration procedures. These vertical bony deformities respond favorably to a variety of other surgical procedures such as debridement with or without membranes and bone grafts. [2]

Regeneration of new bone, cementum, and periodontal ligament is considered one of the primary objectives of periodontal therapy and has been demonstrated by numerous therapeutic grafting modalities for restoring periodontal osseous defects have been investigated.

Bone graft materials are generally evaluated based on their osteogenic, osteoinductive osteoconductive nature.

Autografts in the form of osseous coagulum, bone blend, and marrow have been most promising for bone induction and regeneration of lost tissues. Osseous coagulum and bone utilizing intraoral cancellous bone and marrow grafts exhibit some lack of predictability in restoring furcation lesions. Illiac autografts have yielded the best potential for osseous regeneration. Despite a promise of high predictability for success, the use of iliac autografts has been reserved, possibly because of the need for additional surgical intervention, expense of procurement, and a significant incidence of root resorption.

Recently,BMPs, Emdogain, Chorion Membrane, Amnion Membrane, Alloderm, PFRs etc are being used in the regenerative procedures. Stem cells have also been used for the treatment of furcation defects but little work has been done in this regard.

Conclusion:

Successful treatment, management and long-term retention of multi-rooted teeth with periodontal destruction of varying degrees into their furcations have long been a challenge to the discerning general dentist or dental specialist. Indeed, some earlier authors have reported that periodontal pockets that involve the domes of furcations of multi-rooted teeth present a hopeless or at best an unfavorable prognosis and should be extracted. However, long term studies of treated teeth with furcations have shown impressive on retention for period up to 50 years.

Complicated though it may sound, yet furcation involvement is a commonly encountered problem in day-today periodontal practice. The management of furcation involvement should include selection of appropriate treatment modality from the array of treatment options available. Preserving natural dentition, a functional natural dentition rather should be the goal of our practice.

The key to long term success appear to be“thorough diagnosis, selection of patient with good oral hygiene and careful surgical and restorative management”.

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