Furcation Involvement Classification - A Literature Review

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Abstract: Furcation involvement is an extremely common clinical problem, resulted from progressive inflammatory periodontal pathology. Till date, a number of classifications have been proposed present limitations, because of varied anatomy of the furcation defects thatmake it almost impossible to correlate all possible clinical scenarios in a comprehensive and concise manner. This article reviews the current classifications for furcation involvements and clinical decision making for optimizing diagnosis and prognosis of interradicular defects. The classifications of Kolte and Pilloni(2018) are a more efficient guide to the clinician in proper diagnosis, treatment planning and provide a better understanding of furcation involvements. A more concise and less explanatory new classification system can be proposed.

Keywords: furcation involvement, classification, diagnosis, periodontal defect

1. Introduction

The furcation involvement (FI) is a result of periodontal inflammatory destruction of the iterradicular supportive bone, affecting the base of the root trunk of a multirooted tooth where two or more roots are separated-bifurcation or trifurcation.[1] The furcation zone has complex anatomic morphology, and because of that it is difficult for nonsurgicalperiodontal instrumentation, and difficult to personaloral care.Personal maintainproper plaque controlmethods may not keep the furcation area free of plaque.[2] A tooth with a furcation involvement always has a doubtfulprognosis. If left untreated in the initial stages, it leads to progressive destruction of the periodontal ligament, alveolar bone and root cementum.[3,4]Clinical diagnosesof furcation involvements are identical with the ones used for periodontal assessment. Furcation involvementis usually seen in the maxillary and mandibular first molars as they are the teeth which are exposed to plaque retention for a longer duration. [5]

The progression of periodontal destruction between the roots of multi-rooted teeth is considered to determine the prognosis of the involved teeth.[6]However, inherent limitations exist in determining accurate measurements, especially in the horizontal direction, due to interference from the furcation anatomy, the need for sound technical skills and compliance of the patient. Because of these factors, there is always searching for newer diagnostic tools and modern treatment modalities for accurate furcation diagnosis and treatment.[3]

Several classifications have been proposed in an attempt to describe the anatomy of the furcation more completely, describingthe morphology of the existing bone, the number of residual bonewalls, the relationship between root trunk and horizontal or vertical attachment loss.

The purpose of this review is to present the all proposed clinical classifications of furcation involvements in years, which could be important and decisive for prognosis and diagnosisof the involved teeth and to be more useful for the dental clinicians taking the right decisions in accurate treatment planning in the certain situation.

2. Literature Survey

Classifications of Furcation Involvements

It is important to appreciate that each furcationentrancemust be examined and each entrance must be classified according to the below criteria (Table 1).

Authors	Description
Glickman, I. (1953)	Grade I: Early lesion. The pocket is suprabony, involving the soft tissue. There is slight bone loss in the furcation area and no
	radiographic evidence of bone loss.
	Grade II: The bone is destroyed in one or more aspects of the furcation, but a portion of the alveolar bone and periodontal
	ligament remain intact, permitting only partial penetration of the probe. The radiograph may or may not reveal the grade II
	furcation involvement.
	Grade III: Destruction of the connective tissue and bone wall all the way through the furcation. It is clearly shown in the
	radiographs as a radiolucent area between the roots.
	Grade IV: Interdental bone is destroyed and the soft tissues recede apically. The furcation opening is visible.[7]
Goldman et al. (1958)	Grade I: Incipient lesion.
	Grade II: Cul-de-sac lesion.
	Grade III: Through-and-through lesion.[8]
Staffileno,	Class I: Furcation with a soft tissue lesion extending to furcal level but with minor degree of osseous destruction.
H.J.	Class II: Furcation with a soft tissue lesion and variable degree of osseous destruction but not a through-and-through
(1969)	communication through the furcation.

Table 1: Classifications of FI from different authors in the years

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	Class II F: Furcation with osseous destruction from facial aspect only.
	Class II L: Furcation with osseous destruction from lingual aspect only.
	Class II M: Furcation with osseous destruction from mesial aspect only.
	Class II D: Furcation with osseous destruction from distal aspect only.
	Class III: Furcation with osseous destruction with through-and-through communication.[9]
	Class I. Incipient involvement, entrance of the furcation detectable with no horizontal bone loss.
Easley and	Class II. Type 1. Horizontal bone loss, but no vertical component.
Drennan	Class II. Type 2. Horizontal and vertical bone loss.
(1969)	Class III. Type 1. Through-and-through loss of attachment into the furcation with no vertical component
. ,	Class III. Type 2. Through-and-through loss of attachment into the furcation with vertical component.[10]
TT /	Degree I: Horizontal attachment loss < 3 mm;
Hamp et	Degree II: Horizontal attachment $loss > 3$ mm not encompassing the width of the furcation area;
al.(1975)	Degree III: Horizontal through-and-through destruction of the periodontal tissue in the furcation area.[2]
	Horizontal
	Degree I. When the result of probing is not greater than 4 mm.
	Degree II. When probing shows a value greater than 4 mm (i.e., the bifurcation lesion has already passed the center of the
	trifurcation).
Rosenberg,	Degree III. Two or three furcations classified as degree II are found.
M.M. (1978)	Vertical
	Shallow: Slight lateral extension of an interradicular defect, from the center of the furcation in a horizontal direction, toward one
	or both adjacent furcations.
	Deep: Internal furcation involvement denotes the greater lateral extension of the internaliculardefect into but not penetrating the
	adjacent furcation.[11]
Ramfjord&	Class I. Beginning involvement. Tissue destruction <2 mm (1/3 of tooth width) into the furcation.
Ash	Class II. Cul-de-sac, tissue destruction >2 mm ($>1/3$ of tooth width), but not through-and-through.
(1979)	Class III. Through-and-through involvement.[12]
Goldman and	Degree I. Involves furcation entrance.
Cohen	Degree II. Involvement extends under the roof of furcation but not through-and-through.
(1980)	Degree III. Through-and-through involvement.[13]
	Class I. 1 mm of horizontal measurement, the root furrow.
Ricchetti.	Class Ia. $1-2$ mm of horizontal invasion, earliest damage.
P.A. (1982)	Class II. 2–4 mm of horizontal invasion.
	Class IIa. 4–6 mm of horizontal invasion.
	Class III. >6 mm of horizontal invasion.[14]
	The degree of severity of the furcation defects affecting each molar is assigned to one of four groups designated 1, 2, 3 and 4,
Tal and	referred to as furcation involvement index (FII) scores.
Lemmer	Furcal rating I. Depth of the furcation is 0 mm.
(1982)	Furcal rating 2. Depth of the furcation is 1 to 2 mm.
. ,	Furcai rating 3. Depin of the furcation is 3 mm.
	Furca rating 4. Depin of the furcation is 4 mm or more.[15]
Tarnow &	For each class of norizontal classification $(1-iii)$, a subclass based on the vertical bone resorption was added:
Fletcher	Subclass A: 0–5 mm.
(1984)	Subclass B: 4–0 mm.
	Subclass C. > / Infil.[10]
Eskow and	Funcation involvement is classified as grade 1 subclasses A, D, and C (vertical involvement): Subclass A: Vertical destruction $> 1/3$
Kapin	Subclass A: Vertical destruction of 7/3.
(1984)	Subclass C: Vertical destruction beyond the apical third of interradicular height [17]
	Combined Glickman and Hamp classifications:
Fedi PF	Grade II is subdivided into degrees L and II
(1985)	Degree I Vertical hone logs to 1 mm
(1960)	Degree II. Vertical bone loss > 3 mm, not communicate through-and-through.[18]
<i>a</i>	Class I: Involvement of the flute only:
Grant, D.A.	Class II: Involvement partially under the roof:
et al.(1988)	Class III: Through-and-through loss.[19]
	Class I. Initial/incipient furcation involvement.
Basaraba, N.	Class II. Partial furcation involvement.
(1990)	Class III. Communicating furcation involvement.[20]
Cornavala	Modified Hamp et al.(1975) classification:
G et al	Degree I: Horizontal attachment loss $< 1/3$
(1997)	Degree II: Horizontal attachment loss $> 1/3$.
(1))))	Degree III: Horizontal through-and-through destruction.[21]
Nevins and	Class I: Incipient or early loss of attachment.
Capetta	Class II: A deeper invasion and loss of attachment that does not extend to a complete invasion.
(1998)	Class III: Complete loss of periodontium extending from buccal to lingual surface. Diagnosed radiographically and clinically.[22]
Hou et	Classification based on root trunk length and horizontal and vertical bone loss.
al.(1998)	Types of root trunk:
· · · · /	Type A: Furcation involving cervical third of root length.

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	Type B: Furcation involving cervical third and cervical two-thirds of root length. Type C: Furcation involving cervical two thirds of root length.
	Classes of furcation:
	Class I: Horizontal loss of 3 mm.
	Class II: Horizontal loss > 3 mm.
	Class III: Horizontal "through-and-through" loss.
	Subclasses by radiographic assessment of the periapical view:
	Sub-class 'a'. Suprabony defect.
	Sub-class 'b'. Infrabony defect.
	Classification of furcation:
	AI, AII, AIII. Type A root trunks with class I, class II and class III furcations.
	BI, BII, BIII. Type B root trunks with class I, class II and class III furcations.
	Modified Clickmen's class II and class III furcations.[25]
Fedi et al. (2000)	Grade II degrae Leavists when furgal hone loss possesses a vertical component of >1 but <3mm
	Grade II degree II - exists when furcal bone loss possesses a vertical component of >3 mm but still does not communicate
	through and through [24]
Glossary of	Class I: Minimal but notable bone loss in furcation.
periodontal	Class II: Variable degree of bone destruction but not extending completely through furcation.
terms (2001)	Class III: Bone resorption extending completely through furcation.[25]
	Modification of the Hamp et al. classification.
Walter C at	Degree I: Horizontal attachment $loss < 1/3$ of the width of the tooth.
vallel, C. et al (2000)	Degree II: Horizontal loss of support > 3 mm, < 6 mm.
al.(2009)	Degree II–III: Horizontal loss of support > 6 mm, but not extending completely through furcation.
	Degree III: Horizontal through-and-through destruction.[26]
Carnevale,	Degree I: Horizontal attachment loss $< 1/3$;
G. et al.	Degree II: Horizontal attachment loss $> 1/3$;
(2012)	Degree III: Horizontal through-and-through destruction.[21]
	NE - non exposed; E - exposed.
	NEI. The furcation lesion is not clinically exposed. The horizontal attachment loss is 2 mm or more
Pilloni A	NEIII: The furcation lesion is not clinically exposed. The horizontal attachment loss is total, with through and through opening of
Rojas, M.A.	the furcation.
(2018)	EI: The furcation lesion is clinically exposed. The horizontal attachment loss is 2 mm or less.
	EII: The furcation lesion is clinically exposed. The horizontal attachment loss is 3 mm or more.
	EIII: The furcation lesion is clinically exposed. The horizontal attachment loss is total, with through and through opening of the
	furcation.[28]
	Grade I - This type of furcation involvement is an inchoate lesion which develops by mild to moderate and uniform periodontal
	destruction extending into the flute of the furcation, and manifesting itself with increased probing depth.
	Grade Ia: It comprises of all the features of Grade I FI, with the normal position of gingival margin which is slightly coronal to
	Ine CEJ.
	Grade Io: It comprises of all features of Grade I FI, with the position of gingival margin which is more than 3 mm apical to CEJ.
	and may lead to mucogingival margin which is more than 5 min apical to CES
	Grade II: This type of FI is a confined lesion which develops by moderate periodontal destruction of varying amount extending
	into the inter-radicular area, with an arched roof created by the furca and bordered by roots and bone.
	Grade II type1a- It comprises of all the features of Grade II Type 1 FI with the normal position of gingival margin which is
	slightly coronal to the CEJ.
	Grade II type1b - It comprises of all the features of Grade II Type 1 FI with the position of gingival margin which is 0-3 mm
	apical to the CEJ.
	Grade II type1c- It comprises of all the features of Grade II Type 1 FI with the position of gingival margin which is more than 3
Kolte, A P. et	mm apical to the CEJ and may lead to mucogingival problem.
al. (2018)	Grade II type2a- It comprises of all the features of Grade II Type 2 FI with the normal position of gingival margin which is
	slightly coronal to the CEJ.
	Grade II type20- It comprises of an the realities of Grade II Type 2 FI with the position of gingival margin which is 0-5 min
	$Grade II type 2c_{-}$ It comprises of all the features of Grade II Type 2 FI with the position of gingival margin which is more than 3
	mm apical to the CEJ and may lead to mucogingival problem.
	Grade III – This type of FI is a complete lesion which develops by moderate to severe periodontal destruction in the furcation
	area permitting the passage of a probe bucco-lingually on the mandibular molars and bucco-mesially and bucco-distally on the
	maxillary molars.
	Grade III type1a- It comprises of all the features of Grade III Type 1 FI with the normal position of gingival margin which is
	slightly coronal to the CEJ.
	Grade III type1b- It comprises of all the features of Grade III Type 1 FI with the position of gingival margin which is 0-3 mm
	apical to the CEJ.
	Crade III tunels. It comprises of all the features of Crede III Type 1 El with the section of similar section with the section of similar section with the section of similar section of the section of t
	Grade III type1c- It comprises of all the features of Grade III Type 1 FI with the position of gingival margin which is more than 3 mm anical to the CEL and may lead to mucoaingival problem
	Grade III type1c- It comprises of all the features of Grade III Type 1 FI with the position of gingival margin which is more than 3 mm apical to the CEJ and may lead to mucogingival problem. Grade III type2a- It comprises of all the features of Grade III Type 2 FI with the normal position of gingival margin which is

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slightly coronal to the CEJ.

Grade III type2b– It comprises of all the features of Grade III Type 2 FI with the position of gingival margin which is 0-3 mm apical to the CEJ.

Grade III type 2c– It comprises of all the features of Grade III type 2 FI with the position of gingival margin which is more than 3 mm apical to the CEJ and may lead to mucogingival problem.[29]

3. Discussion

A variety of classifications have been proposed to categorize FIs based on either the degree of horizontal probing depths, attachment level loss, morphology of bone defect, the radiographic vertical extent of alveolar bone loss or a combination of different criteria(Table 1).

Glickman was the first who suggested classification and it defines the main characteristics of furcation lesions based on horizontal attachment loss.[5] In 2000, Fedi, et al.modified Glickman's classification includes: Grade II degree I - when interradicularbone loss has a vertical component of >1 but <3mm andGrade II degree II - when interraducular bone loss has a vertical component of >3mm, but still does not communicate through-and-through.[24]

Glickman's classification has been often used in practice, but it has some limitations:

- It is based only on horizontal attachment loss –that fact creates difficulties in the classificationbetween grades I and II.
- Grades III and IV furcation involvements- the interradicular bone is absent. Creating two subgroups could represent the difference between them.
- In grade I and II furcation lesions the clinical exposition of the furcation is not considered.

In 1975, Hamp, together with Lindhe and Nyman, classified furcation defects according to the horizontalprobeable depth of the furcation zone.[2]Ramfjord and Ash proposed the same system but the value is 2 mm instead of 3 mm.[12] In 2009, Walter et al., proposed a modification of the Hamp's classification and they divided degree II into degrees II and II–III.[26]

A sub-classification referring to the vertical bone loss from the fornix furcation was later introduced to supplement the horizontal classification.[16]

Some of the classifications proposed in the years present limitations, because of varied anatomy of the furcation defects which makes it almost impossible to correlate all possible clinical scenarios in a comprehensive and concise manner.[28]

The optimal aim of periodontal therapy in furcation defects is to control the inflammatory process and cease the progression of periodontal destruction, to restore clinical attachment level loss and to maintain the health and function of the affected molar teeth.

The proposed classification by Kolte et al. (2018) is one of the first attempts to develop a system that relates the extent of alveolar bone damage horizontally as well as vertically in the furcation and gingival positions. This classification system is probably the only one which takes into account the hard and soft tissue conditions around molars in periodontal diseases and can provide meaningful guidelines into advising a complete therapeutic correction of the defects.[28]

Furcation lesions are classified into two main groups:by exposure and non-exposure, according to Pilloni A., Rojas, M.A., (2018) classification. When a molar presents a long root trunk and gingival recession, the furcation lesion may not be visible. It will be listed as a non-exposed group for this reason. The main criteria for this method of diagnosis are more the exposure of the furcation defect than the occurrence of gingival recession. It is important to use two periodontal probes to avoid errors in the diagnosis of nonexposed lesions. If the probes get in touch the diagnosis of a class III furcation defect will be confirmed.

4. Conclusion

The last two classifications (2018) are a more efficient guide to the clinician in proper diagnosis, treatment planning and provide a better understanding of furcation involvements. They are not only based on the destruction of the alveolar bone but also takes into account the soft tissue position which is nimportant key factor.

A more concise and less explanatory new classification system can be proposed. This would be of considerable aid for its widespread use.

5. Abbreviations

FI – furcation involvement CEJ – cemento-enamel junction NE - non-exposed group

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