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Research Article

Prevalence, Extension and Severity Associated Risk Factors Associated with Furcation Involvement in an Adult Population. An Epidemiological Study

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Abstract

Introduction: Severity of the periodontal disease and associated tooth loss are more prevalent in molar region. The reason behind more prevalence among molars is that furcation areas in molars have complex anatomy and they are difficult to approach for oral hygiene maintenance. Outcome of periodontal treatment is less favourable in furcation involved molars.

Aim: The aim of this study is to evaluate the prevalence, extension and severity associated risk factors of furcation involvement in patients referred for periodontal treatment.

Materials and Methods: An epidemiological study was planned for three years (2013 to 2016) in 551 patients who were referred to Department of Periodontics. In clinical examination assessments of furcation involvement, oral hygiene status, gingival condition and probing pocket depth were included. Full mouth intraoral periapical radiograph examination was performed. Associated risk factors such as smoking, education status were also assessed. Data analysis was done by SPSS software and Pearson's Chi square test was used for statistical analysis.

Result: The prevalence of furcation involvement was 8.2%. The results revealed that 5.08% patients presented with all 12 molars, while 4.72% had lost all molars. In 44.75% individuals had at least 8 molars were present. Prevalence of furcation involved molars was higher in the maxilla compared to mandible. Highest frequency of furcation involvement was found in distal furcation of the maxillary first molar (53%), and mesial furcation of maxillary second molar showed the lowest frequency (20%). Age of the patient ($p < 0.001$), dental plaque ($p < 0.001$), periodontal pocket ($p < 0.001$), gingival inflammation ($p < 0.005$) were significantly correlated with furcation involvement. Smoking ($p < 0.05$) and education ($p = 0.011$) status were also correlated with furcation.

Conclusion: It was concluded that tooth morphology may be an important factor that accounts for the prevalence of furcation involvement. Periodontal pockets, age, and smoking were risk indicators for furcation involvement.

Keywords: Bone Loss; Periodontitis; Attachment Loss; Tooth Loss

Introduction

Furcation involvement is an important clinical sign of advanced periodontitis. It is also a helpful clinical sign in determining the prognosis of the affected tooth [1]. Severity and extent of the periodontal disease and associated tooth loss are more prevalent in molar region [2-6]. The reason behind more prevalence among molars is that these teeth have complex anatomy and less approachable to nonsurgical periodontal therapy and oral hygiene methods [7,8]. Outcome of both nonsurgical and surgical periodontal treatment is less favourable in furcation involved molars and premolars compared to incisors and canines [9-12]. There are various risk factors associated with furcation involvement that includes anatomic factors (Cervical enamel projections, root trunk length, root divergence, root length, root concavities, narrow furcation entrance), pulp infection, trauma from occlusion, age, smoking, less favourable mechanical plaque control. Information on the prevalence of furcation involvement among periodontitis affected individuals is limited [13].

Aim of the Study

The aim of the present study is to evaluate the prevalence of furcation involvement in a patient sample referred for periodontal treatment.

Material and Methods

The present study is an epidemiological study conducted at Department of Periodontics and Implantology, Manubhai Patel Dental College and Hospital, Vadodara, Gujarat, India for the time duration of three years from May 2013 to July 2016. The sample subject was derived from the total of 624 patients who were referred for periodontal treatment to the department of periodontics and implantology. Out of 624 patients 551 fulfilled the inclusion criteria of the study and were willing to participate in the study.Written informed consent were received from all the participants.

All maxillary and mandibular molars of individuals aged between 19 to 75 years were included in the study

Molars with single/fused roots and retained residual root remnants were excluded. Patient with the previous history of any periodontal treatment were also excluded.

Degree of furcation involvement was determined according to the Hamp., *et al.* 1975 classification of furcation involvement [14]. Naber's probe was used to clinically detect the furcation involvement:

- **Degree I:** Horizontal loss of periodontal support not exceeding 1/3rd of the total width of the tooth.
- **Degree II:** Horizontal loss of periodontal support exceed -ing 1/3rd of the width of the tooth, but not encompas -sing the total width of the furcation area.
- **Degree III:** Horizontal "through and through" destruction of the periodontal tissue in the furcation area.

For radiographic examination full mouth set of intraoral periapical (IOPA) radiographs were analysed. Long cone paralleling technique was used to record intraoral periapical radiographs. All the patients were examined by single examiner.

The identification of furcation involvement was carried out according to the following rules:

A. The buccal furcation was considered healthy if the furcation fornix was filled with bone, or a slight widening of the periodontal ligament in the furcation area was confirmed, or if the alveolar bone crest was above or at the same level as the furcation fornix. The imaginary line between the mesial and distal alveolar bone crests was seen above or at the same level where furcation fornix is confirmed. The furcation was considered involved if a radiolucent area was identified at the furcation fornix.

B. The furcation in the proximal surfaces were considered healthy if the interdental alveolar bone crest was seen above or at the same level as furcation.

To ensure relationship between different clinical variables and the furcation involvement the following variables were used.

Oral Hygiene Status (Silness and Loe 1964) [15]: The presence of plaque was recorded for all teeth surfaces according to silness and loe 1964 indices.

Gingival Status: Gingival condition was assessed according to the criteria of the gingival index (Loe and Silness 1963) [16].

Probing Pocket Depth: Measured at the mesial, buccal, distal and lingual sites of all teeth with calibrated periodontal probe. (William/Ash probe tip diameter 0.5 mm).

Patient's Level of Education: Primary school, high school, high secondary school, graduate.

Ethical Consideration: The original study protocol was reviewed and approved by the research ethical committee of Manubhai Patel Dental College and Hospital, Vadodara, Gujarat, India.

Statistical analysis

The sample size was determined on the basis of pilot study conducted before starting the present study and with the help of nMaster 2.0 software. Frequencies, mean values and standard deviations were calculated for the various variables. Data processing was performed using SPSS version 22 (IBM Corporation, Armonk, NY). Correlation of various clinical variables with furcation involvement was calculated using Pearson's Chi square test as this test is used for the strength of association between two variables. Odds ratio was calculated for various clinical variables and furcation involvement association.

Results

A total of 551 patients (326 males and 225 females), fulfilled the inclusion criteria. The age of the patient varied between 19 to 73 years; mean age of 44.9 years (Table 1). Total of 3723 molars were included in the study. Description of patient's education level is described in table 2.

Age Group in Years	Number of Individuals	Percentage (%)
19 - 29	44	8
30 - 39	116	21
40 - 49	182	33
50 - 59	160	29
> 60	49	9
Total	551	100

Table 1: Distribution of the patient samples with respect to various age groups.

Level of Education	Total Number of Patients (n)	Percentage
Primary School	201	36.47%
High School	172	31.21%
High Secondary School	117	21.23%
Graduate	61	11.07%
Total	551	100%

Table 2: Patient's level of education.

Description of the periodontal examinations in the patient sample examined is present in table 3 to 5. The oral hygiene condition deteriorated slightly with increasing age; from a mean percentage of plaque carrying surfaces of 22.8% in the age below 30 years to 48.7% in the age group more than 60 years of age (Table 3). Independent of age, the molar tooth region showed the highest plaque scores. With respect to the condition of the gingiva, the differences between the various age groups were less pronounced (Table 3 and 4). In all age groups, the molar tooth regions showed higher prevalence of gingival index scores 2 - 3 compared to other teeth regions. Mean probing pocket depth was deeper at molars compared to other teeth regions (Table 5).

Age Group in Years	Incisors - premolars mean % (SD)	Molars Mean % (SD)	All Teeth Mean % (SD)
19 - 29	22.8 (17.8)	51.3 (28.9)	33.1 (20.7)
30 - 39	33.5 (22.1)	59.6 (21.6)	41.5 (20.9)
40 - 49	41.1 (24.2)	62.8 (22.2)	46.7 (21.3)
50 - 59	42.2 (24.6)	63.7 (26.4)	46.8 (23.3)
> 60	48.7 (25.4)	64.1 (29.8)	52.4 (23.9)
Total	37.6 (22.8)	60.3 (25.8)	44.3 (21.7)

Table 3: Mean % (SD) plaque harbouring tooth surfaces in the various age groups.

Age Group in Years	Incisors - premolars mean % (SD)	Molars Mean % (SD)	All Teeth Mean % (SD)
19 - 29	13.6 (13.3)	29.6 (22.4)	19.1 (15.4)
30 - 39	13.9 (15.7)	21.9 (22.1)	16.2 (16.5)
40 - 49	16.8 (18.7)	26.4 (22.3)	20.1 (17.4)
50 - 59	18.6 (19.3)	31.6 (26.4)	22.5 (19.8)
> 60	20.7 (20.1)	34.8 (27.2)	23.8 (20.1)
Total	16.7 (16.9)	28.9 (24.1)	20.3 (17.9)

Table 4: Mean % (SD) gingival index scores in the various age groups.

Age Group in Years	Incisors - premolars mean (SD)	Molars Mean (SD)	All Teeth Mean (SD)
19 - 29	2.21 (0.37)	3.56 (0.83)	2.45 (0.65)
30 - 39	2.67 (0.68)	4.24 (0.84)	3.56 (0.55)
40 - 49	3.80 (0.95)	5.18 (1.23)	3.78 (0.67)
50 - 59	3.34 (1.08)	4.67 (1.06)	3.89 (1.23)
> 60	2.74 (0.55)	4.94 (0.56)	3.45 (0.87)
Total	2.95 (0.72)	4.51 (0.90)	3.43 (0.75)

Table 5: Mean (SD) probing depth for remaining teeth in various age groups.

Table 6 describe the distribution of remaining molars with respect to age and tooth position. 5.08% (n = 28) of patients presented with all 12 molars, while 4.72% (n = 26) had lost all molars. 44.75% (n = 247) had at least 8 molars remaining. The mean number of remaining teeth in the youngest group (< 30 years) was 27, that was reduced to 17 teeth in greater than 60 years age group. Predominantly molars accounted for this decrease in mean number of remaining teeth by showing a 50% reduction.

Table 7 demonstrates association between clinical variables and furcation involvement at univariate and multivariate level. Individuals with a low level of education had a higher risk of having molars with furcation involvement. Plaque, age and presence of periodontal pockets were significantly correlated to furcation involved molars (p 0.0001). Gingivitis was significantly correlated to the presence of furcation involvement (p 0.005). Gender had no association to the outcome (p = 0.62).

Age Groups Years	Number of Molars												
	0	1	2	3	4	5	6	7	8	9	10	11	12
< 29	0	0	0	0	3	0	2	0	10	5	9	5	10
30 - 39	0	0	4	3	5	11	14	15	19	23	11	6	5
40 - 49	11	10	10	10	10	8	17	25	39	21	12	4	5
50 - 59	11	8	15	18	14	9	19	20	20	5	13	4	4
> 60	4	5	5	4	4	3	3	4	2	4	5	2	4
All individual frequency %	26 4.72	23 4.17	34 6.17	35 6.35	36 6.53	31 5.62	55 9.98	64 11.61	90 16.33	58 10.53	50 9.00	21 3.81	28 5.08

Table 6: Frequency of individuals with respect to number of remaining molars.

Variables	*P* value	Odds Ratio
Education Level	0.011	1.86
Periodontal Pockets	0.0001	6.12
Gingival Index	0.005	1.11
Plaque Index	0.0001	1.21
Age	0.0001	2.73
Smoking	0.004	2.68
Sex	0.62	1.34

Table 7: Correlation of various clinical variables with furcation involvement and measurement of odds ratio.

There was no difference between men and women in the prevalence of molars in ages below 50 years, while in the 2 oldest age groups men had fewer remaining molars than women.

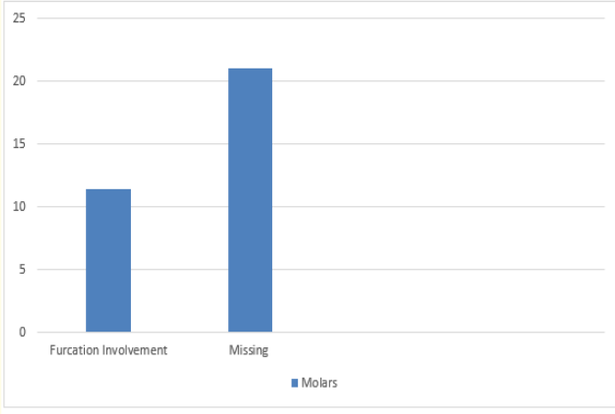

Figure 1: The prevalence of missing and furcation involvement at molar.

Comparison of furcation involvement and missing teeth between maxillary and mandibular molars is given in figure 2. Prevalence of furcation involvement was higher in maxillary molars compared to mandibular molars. Prevalence of furcation involvement in different molars is given in figure 3. Out of all maxillary teeth first molars shows highest furcation involvement followed by maxillary second molar, mandibular first molar, mandibular second molar. The third molar had a lower frequency of furcation involvement than first and second molars.

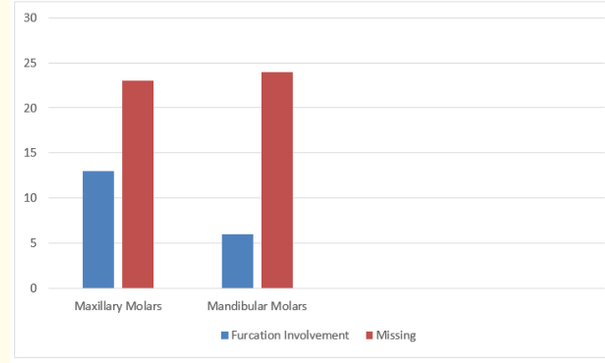

Figure 2: The prevalence of missing and furcation involvement at maxillary and mandibular molars.

Extension and severity of furcation involvement in molars was assessed through Hamp., et al. classification of furcation involvement. Figure 4 describes percentage distribution of furcation involvement in teeth with periodontitis according to degree of involvement (Hamp., et al. classification). 36.2% of molars were with Grade I furcation involvement, 41.8% were with Grade II furcation involvement, 18.8% were with Grade III furcation involvement.

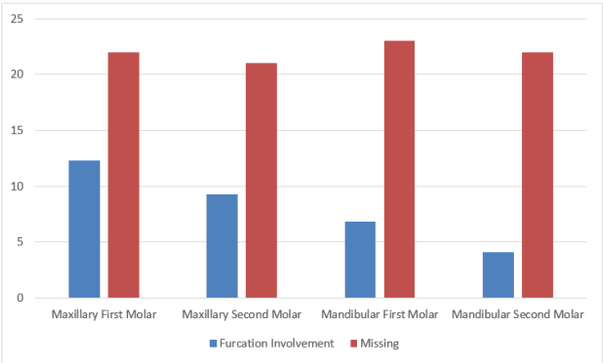

Figure 3: The prevalence of missing and furcation involvement at each molar in percentage (%).

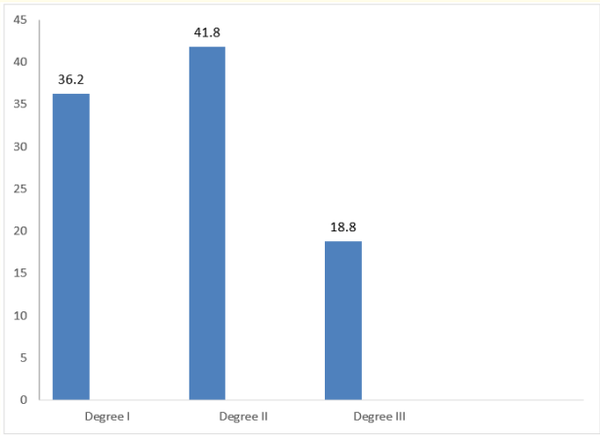

Figure 4: Percentage distribution of furcation involvement in teeth with periodontitis according to degree of involvement.

Total Number of molars examined = 3723	Maxilla = 1885 Mandible = 1838	
Prevalence of furcation involvement = 305	Maxillary = 190 Mandibular = 115	Maxillary 1st molar = 115 Maxillary 2nd molar = 75 Mandibular 1st molar = 71 Mandibular 2nd molar = 44
Missing molars = 617	Maxilla = 302 Mandible = 315	Maxillary 1st molar = 135 Maxillary 2nd molar = 129 Mandibular 1st molar = 141 Mandibular 2nd molar = 135

Table 8: Number of furcation involved and missing molars in maxilla and mandible.

Discussion

Patients who were referred for treatment of periodontal disease were selected in the present study. Prevalence of furcation was found more in maxillary teeth compared to mandibular teeth. The most commonly affected site was distal furcation of maxillary first molar. Maxillary first molar had prevalence of maximum furcation involvement among all the molars followed by maxillary second molar, mandibular first molar and mandibular second molar.

In the age group of 30 - 39 years about 35% of molars had deep involvements, and such lesions increased to more than 50% in age group above 40 years. This observation is in correspondence with the destruction previously reported [17,18].

An interesting observation made in the present sample was that the distal furcation site of the maxillary first molar had the highest prevalence of involvement, while the mesial site of the second molar had a comparatively low prevalence of furcation exposure. One explanation for the difference noted in furcation involvement may be morphological differences exist in the location of the actual furcation entrance. While the distal furcation of the first molar is located midway between the buccal and palatal prominences of the tooth, the mesial furcation area of the second molar is located at the palatal third of the tooth and, consequently, it may be more easily approachable for cleaning during regular tooth brushing. One explanation for this pattern may be that at maxillary molars two of the furcation entrances are located at proximal sites and, consequently, positioned in areas which usually show the highest frequency of plaque associated lesions [18,19]. The distal site of the molars had the highest frequency of furcation involvements, supports this hypothesis.

Furthermore, the furcation entrances in the second maxillary molar are commonly located more apically than furcation of the first molar. Thus, if exposed to plaque induced lesions of the same magnitude, more advanced periodontal destruction is required before the furcation of the second molar will be engaged in the disease process.

A difference in prevalence of advanced furcation involvement was also noticed when the mesial and distal furcation sites of the first maxillary molar were compared. Despite the fact that the mesial furcation entrance commonly is more coronally located than

the distal entrance [20-22], a higher prevalence of involvement was found at the distal surface. There may be several explanations to this apparent difference; (i) Mesial furcation site has a more palatal location on the proximal surface than the distal furcation. (ii) Neighbouring teeth, mesial and distal of the first molar, have different bucco palatal width. Thus, it is likely that these morphological differences may account for the difference noticed in prevalence of furcation involvements.

The interpretation that the accessibility for plaque control measures plays a decisive role in the development of furcation involvement, is also supported by the fact that the prevalence of furcation involvement was lowest for the buccal furcation despite its more coronal position [22].

The prevalence of advanced furcation involvements was similar in the mandibular first and second molars and at buccal and lingual sites. With the higher plaque scores found on lingual side compared to buccal side [19], it would be expected that the prevalence of furcation involvement should be higher at the lingual than at the buccal surface. The lack of difference in furcation involvement may be due to the root morphology with a more apically located furcation entrance on lingual side, and therefore a later exposure for disease progression [22].

Svardstrom and Wennstrom in 1996 studied the prevalence of furcation involvement in 222 patients who had been referred for the treatment of periodontitis. The age group was 14 to 73 years old with 1570 molars. The prevalence of furcation involved molars was higher in maxilla than in mandible. The results appear to be in agreement with our study [23,24].

Association between clinical variables and furcation involvement was demonstrated at univariate and multivariate level. There are many factors which participate in the initiation and progression of furcation involvement and periodontitis [25-27]. Some of these are smoking, level of education, age, dental plaque and gingival inflammation [28]. Plaque, age, gingival inflammation, presence of periodontal pockets were significantly correlated to furcation involved molars. Plaque is the main factor initiating inflammatory reaction in periodontal tissue [28]. Smoking is the main identifiable risk factor for chronic periodontitis [29]. Several studies have shown that age is strongly associated with bone and probing attachment loss [30]. An epidemiological study carried out in the USA showed the pocket depth, attachment level, and molars with furcation involvement increased with age [31]. The level of education was correlated with furcation involvement. Individuals with a low level of education had a higher risk of having molars with furcation involvement. Education and socioeconomic status have a considerable impact on periodontal status [32]. Gingival bleeding has been found to have significant association with the progression of periodontitis [33]. Difficulty in maintaining the oral hygiene in furcation area is the reason behind more plaque scores and gingivitis in molar regions [34]. Progression of the disease becomes faster once the disease progresses till the furcation area that is the reason why more pocket depth was observed at furcation involved molar sites. Though furcation involvement was found more in male compared to female but it is not statistically significant. These results are in correlation with previous studies [35]. Both the clinical and radiographic examination are very helpful methods in detecting furcation involvement [35,36].

Limitation

The higher mean probing depth value and the high prevalence of furcation involvement is observed, together with the fact that the subjects had all been referred for periodontal treatment, indicate that the sample examined represent a selected group of patients with respect to periodontal disease severity. Consequently, the prevalence figures of furcation involvement reported is more likely higher than that for the population in general. In grading of furcation Hamp., *et al.* classification was used which is on the basis of horizontal component of the furcation. In future studies vertical components can also be considered by using other classification of furcation involvement.

Conclusion

Furcation involvement is a very important clinical and radiographic sign of periodontitis. Difficulty are encountered by the patient in maintaining the oral hygiene and also by the clinician in nonsurgical periodontal therapy in furcation defects. So prevalence studies will be helpful in consideration of furcation involvement in routine diagnosis of periodontal disease. Findings in the present study indicate that tooth morphology is a factor which may explain the observed variability in the prevalence of furcation involvement. It seems reasonable to suggest that such morphological variations also may influence the outcome of treatment of lesions in the furcation area. Results by Pontoriero., *et al.* 1988, 1989, 1995 on the effect of GTR therapy at furcation sites may be interpreted to support this hypothesis. The authors demonstrated that GTR attempts were less successful in maxillary than in mandibular molars and least effective at proximal sites [37-39]. Periodontal pockets, age, and smoking are risk indicators for furcation involvement.

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