

The Influence of Molar Furcation Involvement and Mobility on Future Clinical Periodontal Attachment Loss

Hom-Lay Wang,* Frederick G. Burgett,* Yu Shyr,[†] and Sigurd Ramfjord*

THE PURPOSE OF THIS STUDY was to determine the influence of furcation involvement (FI) and mobility (MO) on change in probing periodontal attachment level (AL) on molar teeth. Twenty-four patients were selected from The University of Michigan longitudinal periodontal clinical trial. The patients who met the entry criteria received a baseline examination and were treated by periodontal scaling and root planing followed by different periodontal surgical approaches in a split-mouth design. Patients were placed on a 3-month interval for maintenance prophylaxis and had yearly periodontal scorings for a period of 8 years. The scorings included determination of AL, FI, MO, and tooth loss (TL). Data for molar teeth from three different time periods (at entry (A) and at 1 (B) and 8 (C) years) were analyzed. The results demonstrated that teeth with FI were 2.54 times more likely to be lost when compared to teeth without FI during the maintenance period. By using paired *t* test approach to the probing attachment level data, molars with FI had significantly more loss between times B and C but not between A and B or A and C. Teeth with increased MO demonstrated significantly more AL between times A and C and B and C. When the interaction between MO and FI was analyzed, teeth with both FI and MO had significantly more attachment loss during the maintenance period (B to C). No statistically significant difference was found among the three different therapeutic approaches (pocket elimination, curettage, and modified Widman flap) during any of the time periods. From these limited data it was concluded that during periodontal treatment and maintenance, molars with FI had a higher tendency to lose periodontal attachment and be extracted as compared to molars without furcation involvement. The inclusion of MO in the analysis suggests mobile teeth and mobile teeth with FI are at greater risk of AL when compared to teeth without these characteristics. *J Periodontol* 1994;65:25–29.

Key Words: Furcation; tooth mobility/etiology; periodontal attachment; tooth loss/etiology; follow-up studies.

Previous studies have demonstrated that different tooth types respond differently to treatment.^{1–3} Ramfjord and co-workers indicated that when the interaction between initial probing depth and tooth type was considered, tooth types affected the response to different treatments. Maxillary molars showed less short-term reduction in pocket depth and more long-term increase in pocket depth than did the other tooth types.¹ Pihlstrom et al., comparing the response between molar and non-molar teeth after 6 1/2 years, found that in moderately deep pockets non-molar teeth responded better to both scaling and root planing and to surgery than did molar teeth.³ McFall, in a retrospective study, reported that

over a 15-year period, 57% of the teeth that had furcation involvement at the initial examination were lost.⁴ Norland and co-workers indicated that furcation sites reacted less favorably to plaque control and root debridement than molar flat surfaces and non-molar sites.⁵ Kalkwarf and associates confirmed that progression of periodontitis in the furcation was different than that found on other tooth surfaces. They demonstrated that, during the second year of maintenance care, furcation sites tended to lose probing attachment levels regardless of the type of therapy provided.⁶ A recent study by Grbic and Lamster indicated that following treatment, clinical attachment loss occurred most frequently in the molar teeth, followed by maxillary premolars and mandibular anterior teeth in that order.⁷ Factors such as root concavities, bifurcation ridges, enamel pearls, and cervical enamel projections with small furca entrances (<0.75 mm)

*Department of Periodontics/Prevention/Geriatrics, School of Dentistry, University of Michigan, Ann Arbor, MI.

[†]Department of Biostatistics, School of Public Health.

may explain these treatment results for molar teeth.⁸ *The Proceedings of the World Workshop in Clinical Periodontics* stated that: "Teeth with furcation invasion are at greater risk than those without such involvement, but even with furcation invasion, teeth can be successfully treated and be kept for many years if proper maintenance occurs."⁹

A number of studies have looked at various clinical parameters as possible predictors of future attachment at individual sites in subjects with periodontal disease both in untreated patients and following therapy.¹⁰⁻¹³ While studies using "non-traditional" parameters such as microbiological and immunologic assays have shown some limited promise,¹⁴⁻¹⁵ except for bleeding on probing,¹² none of the traditional clinical indicators of disease have been shown to be useful as predictors of future disease activity. Little information exists in the literature about the use of tooth mobility as a predictor of disease progression. Therefore, the purpose of this study was to determine the influence of molar furcation involvement and mobility on the response to periodontal treatment as measured by tooth loss and probing periodontal attachment loss over an 8-year period.

MATERIAL AND METHODS

Twenty four patients, 18 males and 6 females with mean age of 42.9 ± 6.4 years (range, 30 to 54 years), were selected from the population of 78 patients who had been treated and maintained in one of the University of Michigan longitudinal studies. The patients selected from this patient pool had completed an 8-year clinical trial without missing appointments and had no more than 2 first or second molars missing at baseline. During the original study, the patients received a baseline examination and were treated with periodontal scaling and root planing followed by one of three possible periodontal surgical procedures: pocket elimination surgery, modified Widman flap surgery, or gingival curettage. Once treated the patients were placed on a 3-month recall interval for maintenance prophylaxis and received yearly examinations for a period of 8 years. Data for molar teeth, either first or second maxillary or mandibular molars, were obtained from the periodontal examinations done at entry (A), and at 1 (B) and 8 (C) years. Examination criteria included the clinical determination of FI, either 0 (no furca involvement; i.e., no exposure at the furca of a horizontal nature) and 1 (furca involvement; i.e., exposure at the furca of a horizontal nature); clinical attachment level by measuring the distance in mm from the cemento-enamel junction (CEJ) to the most apical penetration of the Michigan O probe into the pocket while using light probing forces (20 to 25 pounds); tooth mobility (MO), either 0 (no movement = Miller's classification 0 and 1) and 1 (a movement of the tooth which allowed the crown to deviate within 1 mm of its normal position = Miller's classification 2 and 3),¹⁶ and tooth loss (TL). The clinical attachment level was measured at 4 sites on each tooth, with one on the mesio-buccal and one on the disto-buccal interproximal surfaces, as well as the midpoint of mesio-

Table 1. Frequency Table of the Molar Teeth Involved

Tooth No	Frequency	Percent	Cumulative Frequency
2	22	13.3	22
3	20	12.1	42
14	20	12.1	62
15	21	12.7	83
18	23	13.9	106
19	18	10.9	124
30	21	12.7	145
31	20	12.1	165

buccal and palatal root in the maxillary or midpoint of mesio-buccal and mesio-lingual root in the mandible. Data were organized and means calculated using a statistical program.[‡] The statistical analysis was done using odds ratio and paired *t* test. To develop an approach to combine TL with the AL data, mean values for the individual molar teeth were obtained using the statistical program. By comparing the attachment levels found at the various time intervals, mean attachment change values during each time interval were determined. The largest attachment difference for any time period was 3.25 mm. In order to incorporate tooth loss into the statistical analysis, a penalty was assigned for teeth lost. It was felt that a tooth lost during the study period because of periodontal breakdown should be given a greater attachment loss penalty than loss that occurred on any retained tooth. Therefore, a "penalty" of 3.50 mm was given to the teeth lost for periodontal reasons in the analysis of the attachment level data. With any higher penalty (>3.50 mm), TL data dominated the data set. Mean attachment changes were calculated by subtracting B from A, C from A, C from B, MO = 1 from MO = 0, and FI = 1 from FI = 0. Therefore, positive values signified a gain of attachment and negative values an attachment loss.

RESULTS

Table 1 shows the molar types involved in this study. Altogether of the 24 patients involved in the study, there were 165 molar teeth present at baseline with about half having FI. Between baseline and the end of the maintenance period (8 years), molars with FI were 2.03 times more likely to be lost than molars without FI (Table 2) while during maintenance, the period between 1 and 8 years, molars with FI were 2.54 times more likely to be lost (Table 2).

For mean periodontal attachment change during the different time intervals (with the penalty of 3.50 mm assigned for the teeth lost), FI involved molars had significantly ($P < 0.05$) more mean AL than the teeth without FI during the maintenance period (Table 3). Molar teeth with MO also showed higher AL when compared to the molar teeth without MO. Statistical analysis revealed significantly ($P < 0.05$) more mean AL for molars with MO than those without MO between times A and C and between times B and C (Table 3).

[‡]SAS 6.03 statistical package, SAS Institute, Cary, NC.

Table 2. Relationship Between Furcation Involvement and Tooth Loss

Furcation	Total Teeth at Baseline	Present at Year 8	Lost by Year 8	Percentage	Odds Ratio
Entire study period (baseline to 8 years)					
No	78	68	10	14.7	2.03
Yes	87	67	20	30.2	
Maintenance period (1 to 8 years)					
No	78	71	7	9.9	2.54
Yes	80	64	16	25.0	

By including presence or absence of FI and MO into a paired *t* test model using AL as the outcome variable, results indicate no significant differences were found in the time period from A to B and from A to C. However, in the maintenance period (times B to C), furcation involved molars with MO showed significantly more AL than furcation involved molars without MO. Also mobile molars with FI had significantly more AL than mobile molars without FI (Table 4).

Table 5 presents the mean periodontal AL changes for the molars treated by three different treatment modalities at the different time periods. Using the paired *t* test to compare the mean attachment changes for molars with or without FI and MO, no statistically significant differences were found among pocket elimination, curettage, or modified Widman flap surgery treatment at any time.

DISCUSSION

From this data analysis, it was concluded that molars with FI had a higher tendency to be lost (2.54 times) during

Table 5. Mean Attachment Change (mean ± standard error) for the Different Treatment Modalities at Different Time Periods

Factor	Time	Pocket Elimination Surgery	Gingival Curettage	Modified Widman Surgery
Baseline MO=0	1 year	3.00 ± 0.32	3.17 ± 0.39	2.53 ± 0.35
	8 years	2.83 ± 0.31	2.89 ± 0.27	2.57 ± 0.34
Baseline MO=1	1 year	2.95 ± 0.25	3.23 ± 0.28	2.82 ± 0.25
	8 years	4.45 ± 0.38	4.31 ± 0.43	3.95 ± 0.48
Baseline FI=0	1 year	3.77 ± 0.38	4.51 ± 0.48	4.58 ± 0.76
	8 years	5.06 ± 0.61	4.40 ± 0.46	4.20 ± 0.58
Baseline FI=1	1 year	3.09 ± 0.33	2.52 ± 0.28	2.28 ± 0.31
	8 years	2.68 ± 0.29	2.62 ± 0.30	2.46 ± 0.29
Baseline FI=1	1 year	3.03 ± 0.36	3.27 ± 0.37	2.75 ± 0.33
	8 years	3.86 ± 0.45	4.55 ± 0.32	4.75 ± 0.37
Baseline FI=1	1 year	3.54 ± 0.43	4.15 ± 0.33	4.75 ± 0.52
	8 years	3.68 ± 0.52	4.19 ± 0.25	4.32 ± 0.38

periodontal maintenance periods. This study confirmed previous studies by Hirschfeld and Wasserman¹⁵ and McFall⁴ in which it was reported that molar teeth with FI were found to be the most difficult teeth to maintain after periodontal therapy. Hirschfeld and Wasserman¹⁵ found that in otherwise well-maintained patients, 20 to 50% of teeth with initial FI were lost during 15 to 29 years of periodontal maintenance.¹⁵ The same observation was reported by Nordland et al.⁵ who demonstrated that molar teeth with FI responded less favorably to therapy when compared to flat root sites on molar or to non-molar sites with probing depths greater or equal to 4.0 mm. The results also agree with Ramfjord et al.¹⁷ who found that of the 1,881 teeth initially treated,

Table 3. Mean Attachment Level Differences (mean ± standard error) for Molars with -3.50 mm Penalty Assigned for Teeth Lost

Time Period	Difference		Mean Difference (FI=0 - FI=1)	P value
	0	1		
With and without furcation involvement				
Baseline to 1 year	0.05 ± 0.15	-0.01 ± 0.22	0.06 ± 0.19*	0.76
1 year to 8 years	-0.64 ± 0.22	-1.24 ± 0.33	0.60 ± 0.26*	0.03†
Baseline to 8 years	-0.80 ± 0.24	-1.32 ± 0.35	0.52 ± 0.26*	0.06
With and without mobility				
Baseline to 1 year	0.15 ± 0.18	-0.14 ± 0.37	0.29 ± 0.27‡	0.30
1 year to 8 years	-0.53 ± 0.27	-1.73 ± 0.31	1.20 ± 0.36‡	0.03†
Baseline to 8 years	-0.48 ± 0.25	-1.08 ± 0.41	0.59 ± 0.24‡	0.01†

*FI = 0 - FI = 1.

†MO = 0 - MO = 1.

‡Significant at *P* < 0.05 level.

Table 4. Interaction Between Furcation Involvement (FI) and Mobility (MO) on Mean Attachment Loss With -3.50 mm Penalty Assigned for Tooth Loss (mean ± standard error)

Factors	Baseline to 1 Year		1 Year to 8 Years		Baseline to 8 Years	
	Mean ± SE	P Value	Mean ± SE	P Value	Mean ± SE	P Value
FI=0 MO=0 vs 1	-0.24 ± 0.31	0.46	0.52 ± 0.33	0.15	0.13 ± 0.29	0.69
FI=1 MO=0 vs 1	0.59 ± 0.45	0.24	0.57 ± 0.32	0.12	2.01 ± 0.67	0.02*
MO=0 FI=0 vs 1	-0.18 ± 0.26	0.57	0.06 ± 0.19	0.77	-0.25 ± 0.19	0.22
MO=1 FI=0 vs 1	0.11 ± 0.23	0.64	0.38 ± 0.41	0.37	1.60 ± 0.44	0.01*

*Significant at *P* < 0.05 level.

16 of the 17 that were lost for periodontal reasons over the 5 years of the trial had FI at baseline.¹⁷ Results from these studies indicated that even after therapy, molar teeth with FI remain at greater risk for loss when compared to teeth without FI. This may be explained by anatomical features of molar teeth such as enamel projections, concavities of the root, development grooves on root trunks, interradi- cular ridges and, most importantly, by the fact that the furcation entrance is smaller than most conventionally used scaling instruments.¹⁸ Often adequate root instrumentation is not possible because of restricted access to furcation areas. Hence, more successful treatments for molars with FI may depend on: 1) development of new instruments which could remove or control local etiologic factors more completely or altering the morphology of the furcation area to provide better access; or 2) treatment approaches such as guided tissue re- generation, which can result in repair of the tissues lost to periodontal disease activity with elimination of the furcation involvement.

The approach to the data involving the use of a "pen- alty" for teeth lost due to periodontal disease seems to be unique to this study. Tooth loss, the worst outcome of peri- odontal treatment, needs to be considered in data analysis. It was felt that the teeth lost because of periodontal disease should have a higher AL assignment than any of the teeth which remained throughout the study period. To obtain a reasonable penalty, mean AL values for all the molar teeth were calculated for the 3 time intervals analyzed. Maximum AL differences between times A and B, A and C, and B and C were found to be 2.50 mm, 3.25 mm, and 2.75 mm respectively. Therefore, a value of 3.50 mm of attachment loss was assigned for each tooth lost. Use of any higher penalty was found to cause tooth loss data to dominate the data set.

During the entire period (A to C), with inclusion of the tooth loss penalty, the differences between molars with FI and without FI were not significant ($P = 0.06$). In a pre- vious report¹⁹ from the Michigan longitudinal studies, no significant differences were found for mean probing attach- ment level response to various therapy modalities regardless of the type of tooth treated. However, in that report such factors as tooth loss, furcation status, and mobility were not considered in the data analysis. Grbic and Lamster⁷ found that molar teeth more frequently lost clinical attach- ment when compared to other tooth types. Similarly, sig- nificantly more periodontal attachment was lost for molar teeth with FI ($P = 0.03$) during the maintenance period in this study. This is in agreement with the Nebraska group which reported that following 2 years of maintenance care, a mean net loss of horizontal probing attachment was pres- ent for molars with FI regardless of the treatment modalities employed.⁶ Results consistent with these findings have been reported in radiographic analysis of periodontal therapy which showed that a loss of 2 mm of bone oc- curred during the first 2 months following either subgin- gival curettage, modified Widman flap, or furcation os-

teoplasty procedures and that this AL was recovered in the months thereafter.²⁰

Molar teeth with MO at baseline (A) or 1 year (B) had more attachment loss at the end of 8 years than the molars without MO. This is in agreement with Ismail et al., who reported that presence of tooth mobility was a significant risk factor for future attachment loss.²¹ This finding is also in agreement with Zahn²² who reported that teeth with higher MO tended to lose more attachment over time than teeth with no or slight MO. In his study, over a 13-year period, the average loss difference between non-mobile teeth and teeth with a mobility score of 1 was 0.4 mm while between non-mobile teeth and teeth with a mobility score of >1 , an average of 1.0 mm more attachment was lost. Wagner²³ supported these finding as initial mobility, gingivitis, and mean probing depth together was found to be a significant risk factor for predicting future attachment level change following periodontal treatment.

When the effect of both FI and MO were considered together, molars with both FI and MO lost more AL, especially during the maintenance period (from time B to C). This is in agreement with other longitudinal studies,^{4,19,24} which strongly indicated that teeth with FI and MO are more difficult to maintain during the maintenance period. Furcation involved molars with mobility have an increased risk of AL compared to molars with MO or FI alone.

When the therapy effects were considered, no statistically significant differences were found among the teeth treated by pocket elimination surgery, gingival curettage, or mod- ified Widman flap surgery during any of the time periods regardless of the FI or MO status. This is in agreement with our previous studies which reported that no appreciable dif- ference between the percentages of sites losing probing at- tachment in the treatment modalities at either baseline, or 1 or 5 years of maintenance.¹⁷ Isidor and Karring also re- ported no difference between root planing, modified Wid- man surgery, and reverse bevel apically positioned flap sur- gery therapy during their 5-year follow-up studies.²⁵ Furthermore, the results obtained from this study are in agreement with the studies reporting no difference between sites treated with flap surgery with and without osseous resection.²⁶⁻²⁸

The findings from this study confirm the observation of others that progression of periodontal disease in molar teeth with FI is greater than that found for non-FI molars.^{3,5,6,24} From this data analysis, it was concluded that molars with FI lose more periodontal attachment and are 2.54 times more likely to be lost when compared to molars without FI during the maintenance period. Mobility itself also resulted in more AL for molar teeth. Furthermore, mobile teeth with FI were found to lose more probing peri- odontal attachment than molars with either MO or FI alone. No differences were found in treatment outcomes among the molars treated by pocket elimination surgery, gingival curettage, or modified Widman flap surgery.

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Send reprint requests to: Dr. Hom-Lay Wang, University of Michigan, School of Dentistry, 1011 N. University Avenue, Ann Arbor, Michigan 48109-1078.

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