Differences in Periodontal Health Mesial to the Mandibular First Molar Following First vs. Second Premolar Extractions for Orthodontic Purposes

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Abstract

Objective: The purpose of this study was to investigate the impact on the periodontal health of the mandibular first premolar and the mandibular first molar in patients who had second premolars extracted for orthodontic therapy.

Methods: Participants for the study were invited to participate in the study if they had either mandibular first or second premolars extracted for orthodontic therapy. The participants who had first premolars extracted served as the control group, due to the fact that the contact between their mandibular second premolar and mandibular first molar was in its anatomically natural state. The experimental group consisted of patients who had mandibular second premolars extracted and now had a contact between the mandibular first premolar and the mandibular first molar. Patients between the ages of 16 and 31 who were at least two years post debond were invited to participate in the study. Participants were excluded from the study if they had periodontal disease, rampant caries, or interproximal restorations at the contact between the remaining premolar and the molar. Participants were also excluded if they were pregnant or were smokers. Recordings for clinical attachment loss, probing depth, bleeding on probing, plaque accumulation, and food impaction were recorded for the mandibular first molar and the adjacent premolar.

Results: The second premolar extraction group (contact between the mandibular first premolar and molar) showed statistically significant more periodontal problems in all six measurements observed; all measurements were greater at the distolingual of the first premolar vs. the second premolar ($p<0.05$). The study showed that the contact between first premolar and first molar had a greater percentage of food impaction (55% vs. 17%),

a higher percentage of loose and open contacts (19% vs. 0%), and a higher percentage of plaque accumulation (67% vs. 22%). It also showed that the distolingual side of the first premolar had deeper probing depths (3.57mm vs. 2.61mm), increased clinical attachment loss (.48mm vs. 0mm), and a higher percentage of bleeding on probing (10% vs. 0%). Conclusion: Extracting mandibular second premolars and placing the mandibular first premolar in contact with the mandibular first molar may lead to periodontal breakdown of the tissue surrounding the contact between these two teeth. All participants in the study who had first premolars extracted were found to be periodontally healthy. The participants who had second premolars extracted exhibited signs of localized periodontitis at the distal aspect of their mandibular first premolar and at the mesial aspect of their mandibular first molar. Further long term studies are needed to access the severity of the periodontal destruction caused by this contact point.

Introduction and Literature Review

Dental extractions are an integral part of orthodontic treatment. The use of extractions provides the orthodontist space to align crowded teeth. [1] The alternative to extraction treatment is to expand the dental arches enough to allow the full complement of teeth to be aligned. [2] All things being equal, dentists would choose not to extract teeth if they are not diseased. The problem with simply expanding the dental arch is that expansion is not stable long term; expansion can also cause decreased bony support. [2]

In the early 1900's Edward Angle stressed that extraction of teeth was not considered a reasonable treatment for crowding. [1] After Angle passed away his now famous student Charles Tweed began treating cases with extractions, and by the 1960's more than half of all orthodontic patients were treated with extraction of some teeth as one can see in Figure 1. [1] Currently approximately 30% of orthodontic patients receive extractions of some form.[3]

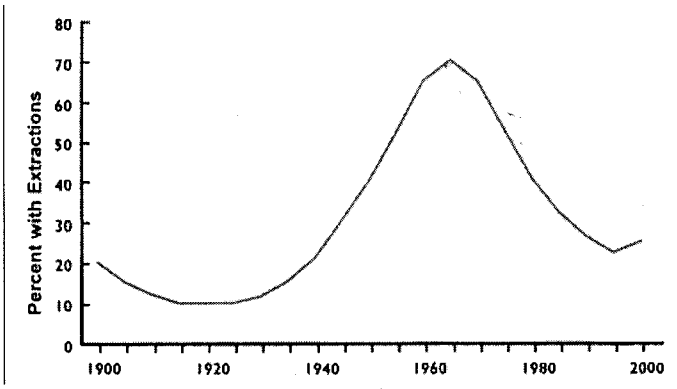

Figure 1. Graph showing the percentages of cases treated with extraction over time.

During the 1940's and 50's when extraction therapy was the norm, the discussions to extract the first or second premolars became prevalent in the orthodontic

literature. [4,5] Indications for second premolar extractions were if these teeth had large restorations, were blocked out of the arch, were abnormally small, or the patient was a borderline extraction case. Currently these same criteria exist, plus mandibular second premolars may be extracted in Class II cases in order to ease treatment mechanics. [6] By extracting the maxillary first premolars and the mandibular second premolars the underlying Class II molar discrepancy can be more easily corrected than if all four first premolars were extracted.

In the maxillary arch the tooth anatomy of first and second premolars is very similar. The contact with the first molar is similar after extraction of either the first or second premolar. Figure 2 shows patients who had a maxillary first premolar extracted on one side of the arch, and a second premolar extracted on the other side of the arch and shows that the contact between the remaining premolar and molar is similar bilaterally due to the fact that first and second premolars have similar size and shape.

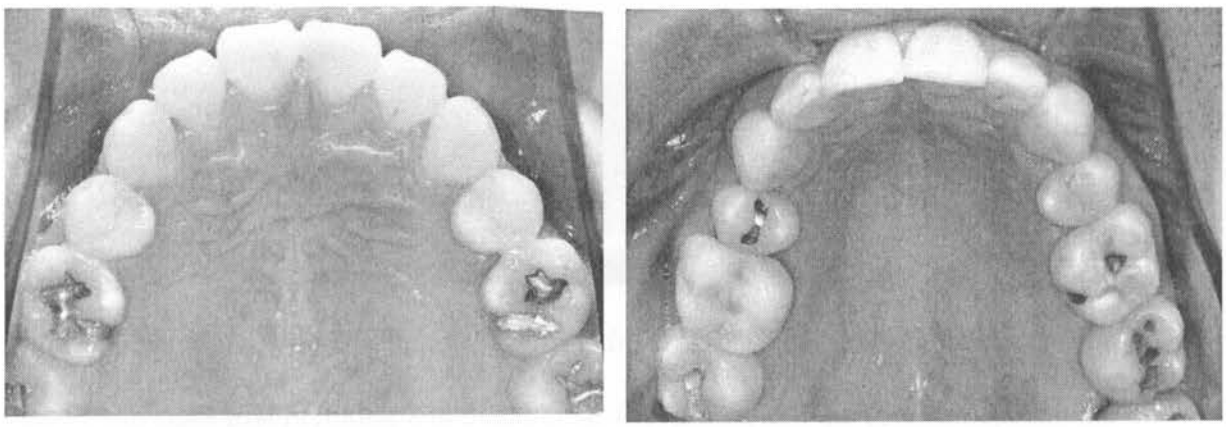

Figure 2. Two maxillary occlusal photos of two different patients who had a maxillary first premolar removed on one side of the arch, and a maxillary second premolar removed on the other side of the arch.

In the mandibular arch, however, the second premolar is frequently larger in size, and has a larger occlusal table than the first premolar (Figure 3). The mandibular first premolar is often tapered and has a poorly developed lingual cusp in comparison to the second premolar. [6] The distal surface of the mandibular second premolar is flattened and provides a better contact point with the first molar than the more convex and pointed shape of the distal surface of the first premolar. Mandibular first premolars are often pointed and shaped like cuspids. [6] In the following picture this patient had the mandibular right second premolar extracted and the mandibular left first premolar extracted. Note how the second premolar has a broad distal contact with the molar, but the first premolar has only a point contact with the molar and a wide lingual embrasure.

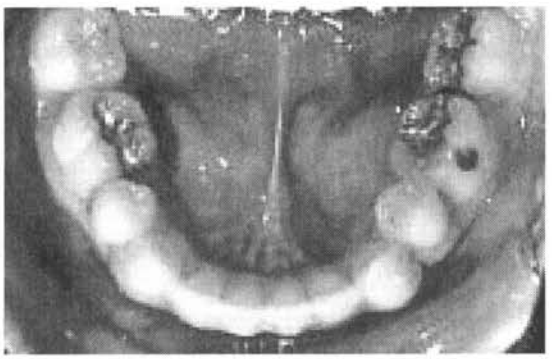

Figure 3. Mandibular occlusal photo showing the difference between the contact of the mandibular right first premolar and mandibular first molar, and the contact between the mandibular left second premolar and mandibular left first molar.

Current periodontal literature has shown that lack of integrity of the proximal contact can be considered a secondary etiologic agent in inflammatory periodontal disease. [7] The prosthodontic literature stresses having a tight broad contact when restoring diseased teeth. [8,9] However, the periodontal literature gives conflicting data. Larato observed 121 dried adult human skulls looking for a relationship between open contacts and interproximal bone loss; he found no significant relationships between open or defective contacts and interproximal intrabony lesions. [10] Geiger et al., in a clinical review study found that maxillary and mandibular teeth showed no difference in the amount of periodontal destruction or gingival inflammation between contacts that were either open or closed. [11] Geiger's study was only looking at anterior tooth contacts. Conflicting data were presented by Gould and Picton who found that teeth with open or poorly shaped contacts had significantly higher Periodontal Index scores than teeth with sound proximal contacts. [12] They compared subjects who on one side of the dental arch had a closed contact and on the other side of the arch had an open contact. There are also

case reports documenting open contacts of cast restorations that have led to periodontal disease which subsequently subsided once the contact was improved. [13] O'Leary, using 124 dental students, showed that in young males who had orthodontic treatment the percentage of open contacts was higher than in non-orthodontically treated patients. [14] If orthodontic therapy is producing more open contacts via extractions and thus possibly contributing to long term periodontal disease, the dental community may need to take this side effect into consideration when evaluating the need for extractions..

This conundrum is even more compelling when looking at Class II correction cases in which the mandibular second premolars may be extracted in order to aid in correcting the molar relationship. The extraction of mandibular second premolars is a common practice in contemporary orthodontics. [6] Some practitioners will routinely extract maxillary first premolars and mandibular second premolars in Class II crowded cases. [15] This extraction pattern is utilized in order to simplify the mechanics needed for Class II correction. If the molar relationship is improved, yet the patient is left with an open or poor contact between the mandibular first premolar and molar, is the patient in better overall dental health? Volchansky, Evans, and Cleaton, measured the palatal embrasure angles between the maxillary first molar and adjacent premolar in 60 children and 20 adults. They showed that a wide palatal angle between maxillary first molar and adjacent premolar predisposed patients to periodontal breakdown in that area. They also found that patients with maxillary premolar extractions had on average a wider palatal embrasure angle than non extraction cases.[16] If a wider palatal embrasure angle in the maxillary arch can predispose a patient to periodontal disease, will a larger lingual embrasure in mandibular premolar extraction cases predispose patients to periodontal

disease? Due to the anatomy of most mandibular first premolars the new established embrasure angle between the mandibular first premolar and molar, after extraction therapy, will be much larger than it was between the mandibular second premolar and the first molar. This new contact between mandibular first premolar and first molar is now a point contact in many cases due to the anatomical distal contours of most mandibular first premolars. [15] Due to this anatomy, the lingual embrasure has a much greater angle than was previously formed between the mandibular second premolar and molar. No published study has specifically looked at the periodontal health at this contact point. Volchansky's research with increased lingual embrasures of maxillary premolar extraction cases leads to the suggestion that increased lingual embrasure angles between mandibular premolar and molar teeth could also be a predisposing factor to periodontal disease.[17]

After analyzing the published literature it can be concluded that open contacts and poor contacts can, but do not always contribute to periodontal disease.[7] It has been shown that wide lingual embrasures can possibly lead to periodontal breakdown. [18] It has also been shown that a significant amount of extraction spaces tend to reopen. [19] Even if the contact is closed does it have a greater tendency to impact food due to the poor anatomical contours of the contact? Hancock, in a group of 40 healthy Naval recruits, showed that there was a significant relationship between food impaction and contact type, and between food impaction and pocket depth.[7] In his study, he found that pocket depths were on average 1mm deeper if the contact was open and had food impacted.

Table I *

Effect of Food Impaction on pocket Depth in Millimeters in Various Types of Interdental Contacts

	Without food Impaction	With food Impaction
Tight	2.89 (N=804)	2.90 (N= 15)
Loose	2.68 (N=94)	3.00 (N=21)
Open	2.64 (N= 100)	3.67 (N=6)
Population mean	2.86 (N= 998)	3.06 (N=42)

($P<0.05$)* reproduced from Hancock[7].

Table I, shows that periodontal probings are significantly greater in cases of an open or even loose contact that impacts food. [7] The average probing depth was 1mm greater in the open contact that impacted food than the contact that did not impact food. Clinically this may not seem that detrimental to the patients' oral health; however, these patients were only 17 to 19 years old. If the pockets on average were already one millimeter greater by age 19, the trend may continue throughout life causing localized periodontal disease. [20] Hancock also makes the point, "the 4% occurrence of food impaction noted in this study may be an underestimation of the problem, as only fibrous material wedged interproximally was considered as food impaction. Soft deposits, or deposits which impact upon the gingiva but were not retained, were not scored." In future studies the percentages of food impaction could be even greater. [7]

Poor contacts, wide lingual embrasures, food retention, and plaque traps have all been shown to be factors contributing to periodontal problems, not to mention their ability to increase the likelihood of caries in these same sites. [20], [7], [21] While orthodontically treating an Angle Class II case with extraction of lower second premolars

will aid in the correction of the Class II molar relationship, it could possibly set the patients up for future periodontal problems.

Study Objectives:

After analyzing the current periodontal literature it is apparent that there is a link between contact type and periodontal health. [12] The exact correlation may be debatable, but several studies report a definite correlation. It is common knowledge in the profession that overhangs, open contacts, and areas of food impaction contribute to local irritation of the gingiva and, of greater importance, impede proper plaque control. [22] The orthodontic community needs to be aware if particular treatment modalities are not contributing to long term periodontal problems. The purpose of this study is to analyze the periodontal health of the teeth mesial and distal to the contact created when the mandibular second premolars are extracted and the mandibular first premolar is in contact with the mandibular first molar. A goal of restorative dentistry is to produce interproximal contacts that are tight, do not impact food, and can be self maintained by the patient. [22] Similar goals should be achieved in orthodontic treatment, but this has yet to be studied in detail. This study was designed to examine the tooth contacts between lower first molars and first premolars following extraction of lower second premolars for orthodontic purposes.

Specific Aim: To determine if patients with mandibular second premolars extracted for orthodontic purposes have differences in probing depths, bleeding on probing, or clinical attachment levels on the distal contact of the mandibular first premolar and the mesial contact of the mandibular first molar relative to patients measurements with first premolars extracted.

Hypothesis: Patients with mandibular second premolars extracted (experimental group) will show greater probing depths, bleeding on probing, and clinical attachment

loss on the mesial of the mandibular first molar and the distal of the mandibular first premolar, relative to patients who had mandibular first premolars extracted (control group) for orthodontic reasons.

Specific Aim: To determine if patients with mandibular second premolar extractions have differences in proximal contacts, food impaction, or plaque retention between the mandibular first premolar and mandibular first molar relative to patients with mandibular first premolar extractions.

Hypothesis: Patients with mandibular second premolars extracted (experimental group) will present more frequently with open contacts, food impaction, and plaque retention between the mandibular first premolar and mandibular first molar relative to patients with mandibular first premolars extracted (control group).

Materials and Methods:

Patients were recruited via three methods. One, patients were recruited by recalling patients who had been treated at the orthodontic department at OHSU. Approximately 1200 charts were reviewed in the order of their start of treatment date to compile a list of 100 possible participants who were at least two years past the date of debond. Second, patients were also recruited from a private orthodontic office. These patients were recalled at random based on their availability to participate in the study. These patients were at least 2 years from the date of debond. Patients were also recruited from the medical and dental school at Oregon Health and Science University.

Participants for the study had to meet the following inclusion requirements:

1. Be between the ages of 16 and 31 years of age at the time at recall.
2. Had at least one mandibular premolar extracted for orthodontic therapy.
3. Volunteer to sit for a 15 minute exam.

Participants were excluded from the study if they were:

1. Presently a smoker
2. Pregnant
3. Diabetic
4. Needing prophylactic antibiotic coverage
5. Positive for generalized periodontitis, defined by having any probing depth greater than 3mm on any of the reference teeth.
6. Had an interproximal restoration facing the contact point being examined

When the participant presented for the exam, he or she was asked to sign a consent form in compliance with the OHSU Internal Review Board policy. The signed Consent for Participation forms were kept on file in the OHSU orthodontic department. Participants were examined by the same dentist using a standard dental chair, light, mouth mirror, and UNC-15 periodontal probe. Before the first patient was examined the dentist conducting all examinations was calibrated for probing technique by a board certified periodontist. The following six determinants for periodontal health were recorded:

1. Probing depth was defined as the distance, to the nearest half millimeter, from the gingival margin to the base of the crevice. [23] The periodontal condition of the Ramfjord Index teeth was recorded. [24] The Ramfjord index teeth consist of teeth #3, 9, 12, 19, 25, 28. If the patient had tooth #12 extracted the probings on tooth #13 were recorded instead. Tooth #28 was extracted in the participants in the experimental group, so it could not be recorded. The Ramfjord teeth were recorded in order to eliminate any participants that have generalized periodontal disease. [25] Once the participant was screened for generalized periodontal disease, the periodontal probings on the mesial (buccal and lingual) of the mandibular first molar and the probing depth on the distal of the adjacent premolar (both buccal and lingual) were recorded. [23] The UNC-15 periodontal probe was placed at the direct buccal or lingual of the tooth being probed. The probe was stepped toward the molar premolar contact. The deepest probing depth was recorded for each surface.

2. Crevicular bleeding on periodontal probing was recorded as present or absent at the sites probed as described above. [23]

3. Plaque deposits were scored on all mandibular first molars and the adjacent premolars. One drop of GUM® disclosing solution was placed under the participants tongue and they were asked to swish the solution that mixed with their saliva for 30 seconds and then expectorated. The presence of plaque was determined approximately 30 seconds later.[26] The presence of plaque was recorded as present or absent based on the presence of pink disclosing solution on each surface.

4. Integrity of the contact between the mandibular first molar and the adjacent premolar. Each contact was tested twice with a single strand of POC® unwaxed dental floss. Each contact was considered closed when there was significant resistance to the passage of floss, loose when there was slight resistance to the passage of floss, or open when there was no resistance to the passage of floss. [23]

5. Clinical attachment level of the mandibular first molar and the adjacent premolar was recorded on both the mesiofacial and mesiolingual of the first molar and on the distofacial and distolingual of the adjacent premolar. [15] The protocol for making the periodontal measurements was to locate the cementoenamel junction (CEJ) and measure the distance from the gingival margin to the cementoenamel junction. A negative value indicated an apical position of the gingival margin

relative to the CEJ. Then the probe was moved apically with a nonstandardized light force to locate the probing attachment level. The distance from the gingival margin to the bottom of the pocket was recorded. All measurements were rounded to the nearest millimeter. The probing attachment level was calculated by subtracting the distance of the gingival margin to the CEJ from the distance of the gingival margin to the bottom of the pocket. [15]

6. Presence of food impaction at the contact between the mandibular first molar and the adjacent premolar was determined approximately one minute after the participant had eaten one Saltine cracker. The participant was asked to chew and swallow the cracker, and was asked to remove the fragments from the biting surfaces of their teeth with their tongue, but was asked not to try to remove any cracker from in between their teeth with either their tongue or finger. The presence or absence of cracker debris was recorded.

Each participant in the study was paid $50 for their time, and was told of the condition of their periodontium after the exam was completed.

Error of the Method:

The reproducibility of the clinical probing depths was assessed by statistically analyzing the difference between two probing depths made within one week on 6 patients selected at random. The error of the method was calculated using the following equation $Sx=\sqrt{\sum} D^2/2N$ where D is the difference between duplicate measurements and N is the number of double measurements. All probing depths for the 6 participants reprobed were analyzed. The difference between duplicate measurements was found to be 0.03mm.

Statistical Analysis:

The SPSS® for windows statistical software program was utilized for statistical analysis. Levene's test for equality of variance was performed to determine if equal variances could be assumed or not. Student's t-tests for two independent samples were performed to determine statistical significance. $P < 0.05$ was required for statistical significance.

Results:

A total of 88 interdental areas were examined in 44 subjects. Forty two of the interdental areas were from the experimental group in which the second premolar was extracted, and the first premolar was now approximated with the first molar. Forty six of the interdental areas examined were from the control group in which the first premolar was extracted, and the second premolar was approximated with the first molar. The ages of both groups, years from debond, and the Ramfjord average probing score were analyzed and compared in order to assure that both experimental and control group were equal in all other factors except for their periodontal condition around the contact between the mandibular first molar and the adjacent premolar. Table II illustrates that both control and experimental groups were of similar age, years from debond, and overall periodontal condition.

Table II
Demoraphic Summary of Extraction Groups

	First premolar Extraction Group	Second Premolar Extraction Group	P value
	mean (sd) (range)	mean (sd) (range)	
AGE(Years)	21.4 (4.8) (16-31)	21.7 (5.5) (16-31)	.768
Years From debond	6.60 (3.8) (2-14)	6.2 (4.3) (2-15)	.626
Average Probing Depths of Ramfjord Teeth	2.1 (0.2) (1.5-2.5)	2.2 (0.2) (1.5-2.5)	.087

($P < 0.05$)

Both groups had a mean age of 21 years old (range 16 to 31 years), and both groups had a mean debond time of 6 years (range 2 to 17 years). Both groups had similar probing depths of Ramfjord Index teeth, indicating that the experimental group and the control group were similar samples.

Table III shows the average probing depths and average clinical attachment loss for the distobuccal and distolingual sites of the remaining mandibular premolar and the mesiobuccal and mesiolingual sites on the mandibular first molar. Table III also shows the percentage of these sites that experienced bleeding on probing.

Table III
First vs. Second Premolar Extraction Periodontal Findings

	First premolar Extraction Group	Second Premolar Extraction Group	Difference	P value
	mean (sd) (range)	mean (sd) (range)		
PROBING DEPTH mm				
DB of premolar	2.6 (0.5) (2.0-3.0)	3.0 (0.6) (2.0-5.0)	0.4*	.001
DL of premolar	2.6 (0.5) (2.0-4.0)	3.6 (0.8) (2.0-5.0)	1.0*	.000
MB of molar	2.8 (0.4) (2.0-3.0)	2.9 (0.5) (2.0-4.0)	0.1	.735
ML of molar	2.8 (0.4) (2.0-3.0)	3.0 (0.5) (2.0-5.0)	0.2*	.043
CLINICAL ATTACHMENT LOSS mm				
DB of premolar	0.0	0.2 (0.6) (0-2.0)	0.2*	.031
DL of premolar	0.0	0.5 (0.8) (0-3.0)	0.5*	.001
MB of molar	0.0	0.1 (0.6) (0-4.0)	0.1	.323
ML of molar	0.0	0.1 (0.5) (0-2.0)	0.1	.096
BLEADING UPON PROBING				
DB of premolar	0%	0%	0%	
DL of premolar	0%	10%	10%*	.044
MB of molar	0%	0%	0%	
ML of molar	0%	0%	0%	

($p<0.05$)

Independent t-tests revealed that the probing depths for the mesiobuccal side of the molar were not statistically significant different between 2 groups. The test showed that there was statistically significant difference on the mesiolingual side of the molar and on the distobuccal side and distolingual side of the premolar. The second premolar extraction group showed an average probing depth that was 0.2 mm greater on the mesiolingual side of the molar. The second premolar extraction group also showed a greater mean probing depth of 0.4 mm on the distobuccal side of the premolar and a mean probing depth that was approximately one millimeter greater (0.96mm) on the distolingual side. All four sites studied showed greater clinical attachment loss for the second premolar extraction group; however only the distolingual side was found statistically significant. The first premolar extraction group had no clinical attachment loss on the distolingual side of the premolar while the second premolar extraction group showed a significant attachment loss of .48 mm at the distolingual site.

Table IV shows the percentage of patients with tight, loose, or open contacts in both the second premolar extraction group and the first premolar extraction group. Figure V shows the number of participants found to have tight, loose, or open contacts.

Table IV

First vs Second Premolar Extraction Plaque percentages

	First premolar Extraction Group Percentage of Contacts	Second Premolar Extraction Group Percentage of Contacts	P value
	number (%)	number (%)	
CONTACT TYPE			
Tight	46 (100%)*	34 (81%)*	.006
Loose	0 (0%)	5 (12%)*	.000
Open	0 (0%)	3 (7%)*	.000

(P < 0.05)

Independent t-tests showed the percentage of loose and open contacts (19% combined) was statistically significant.

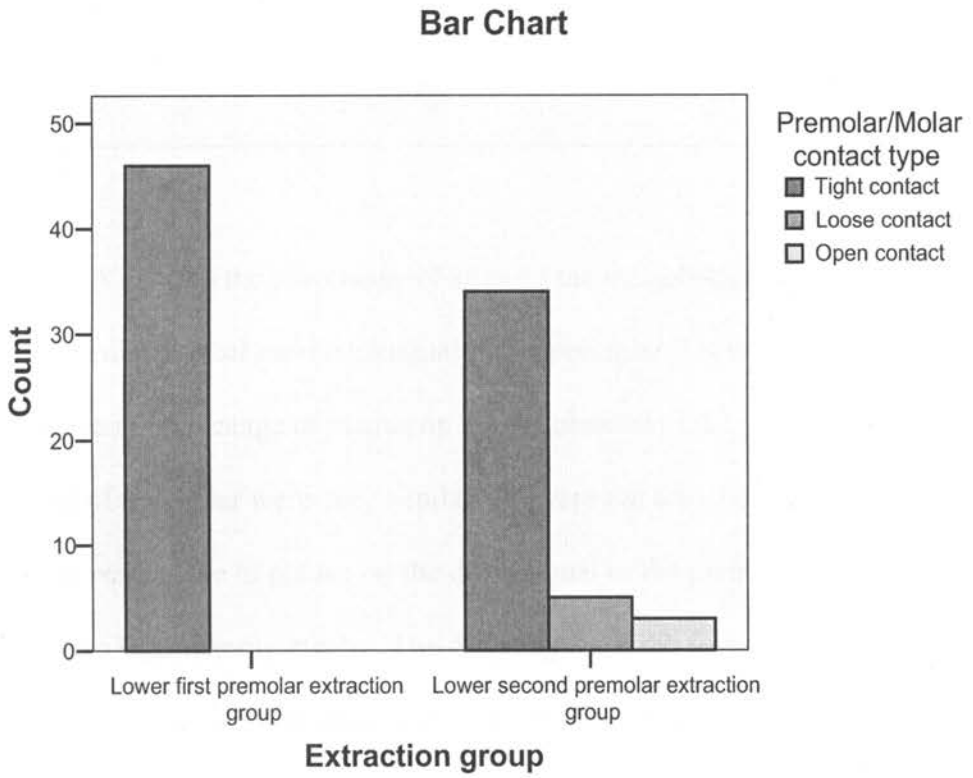

Figure 4. Bar chart showing the number of patients with tight, loose, or open contacts in both experimental groups.

Table V shows the percentage of contacts between the premolar and molar that impacted food. The experimental group showed 38% more food impaction at the premolar molar contact, and this was statistically significant.

Table V
First vs Second Premolar Extraction Food Impaction

	First premolar Extraction Group	Second Premolar Extraction Group	P value
	number (%)	number (%)	
FOOD IMPACTION			
Sites	8 (17%)	23 (55%)*	.000

* ($P < 0.05$)

Table VI shows the percentage of sites on the mesiobuccal and mesiolingual of the molar and distobuccal and distolingual of the premolar that were positive for plaque. The difference in percentage of plaque on the distobuccal of the premolar and the mesiobuccal of the molar were very similar and were not statistically significant. The difference in percentage of plaque on the distolingual of the premolar and mesiolingual of the molar were significantly greater. The distolingual of the first premolar had 45% more surfaces showing plaque accumulation than did the distolingual of the second premolar. The mesiolingual of the first molar when in contact with the first premolar showed a 43% greater plaque accumulation.

Table VI
First vs Second Premolar Extraction Plaque percentages

	First premolar Extraction Group	Second Premolar Extraction Group	P value
	number (%)	number (%)	
PLAQUE			
DB of premolar	8 (17%)	9 (21%)	.636
DL of premolar	10 (22%)	28 (67%)*	.000
MB of molar	12 (26%)	9 (21%)	.613
ML of molar	13 (28%)	30 (71%)*	.000

($P < 0.05$)

A multivariate ANOVA test was conducted to test for a correlation between the participants probing depths and clinical attachment loss and their age, sex, years from debond, contact type, presence of food impaction, bleeding on probing, plaque, average Ramfjord probing depth, and extraction type. Table VII shows the factors that had a positive correlation.

Table VII
Multivariate ANOVA

	Positive Correlation To Probing or CAL	P value
DB of premolar	food impaction	.036
	Extraction	.070
DL of premolar	Age	.045
	Extraction	.007
MB of molar	years debonded	.020
	Contact	.003
	Ramfjord probing	.012
	Plaque	.008
ML of molar	years debonded	.001
	Contact	.003
	Ramfjord probing	.000

($P < 0.05$)

Discussion:

Participants for this study were screened to meet defined inclusion requirements. The participants were required to be between the ages of 16 and 31 years of age in order to eliminate subjects who may have age related periodontal disease. Each participant could not be a smoker, be pregnant, or have diabetes; these criteria were used in order to eliminate potential participants who may have periodontal disease due to these risk factors. If the participant had an interproximal restoration on either the mandibular first molar or the adjacent premolar they were excluded to eliminate confounded data due to contacts altered by restorative dental work. The participants recruited were treated by a variety of orthodontists and no participant who was eligible for the study was excluded. There were an equal number of medical and dental students in the experimental and control groups to eliminate any potential biases between groups, due to the probability that medical and dental students may take better care of their teeth than the general public.

When calculating the average probing depth value of the Ramfjord teeth, tooth # 28 (the mandibular right first premolar) was not included in the calculations because this tooth was the focus of the study. The experimental group had multiple participants who presented with probings of greater than 3mm on tooth #28, thus if this tooth was included the groups would not have similar averages and a statistically significant difference between the two groups would occur.

When looking at the periodontal probing differences between the first premolar extraction group and the second premolar extraction group one may conclude that a 1mm difference (0.96 mm at the distolingual line angle) between groups is negligible. However, the average age of participants in this study was 21 years of age (range 16 to 31

years). When the long term periodontal effects of this deficient contact are experienced in these patients fifth and six decades of life these increased probing depths could present a more significant problem. Albandar, Brunelle, and Kingman found that among Americans age 30 to 90, 64% had probing depths $\geq$ 3mm. They estimated that 35% of the dentate population has periodontitis. [27] If one out of three of the participants from this study experiences generalized bone loss on a tooth that is already prone to periodontitis, they will likely have a greater possibility of either loosing their mandibular first premolar or having a surgical procedure to try to correct the defect. Papapanou and Wennstrom, in a retrospective study of 28 participants, reported that patients who had more plaque, gingivitis, deeper pockets, and more attachment loss had greater loss of periodontal support after ten years than patients who did not have these increased risk factors. [20] The participants in the present that had second premolars extracted experienced all of these risk factors described by Papapanou at their distolingual surface of their mandibular first premolar; more plaque (67% vs. 22%), deeper pockets (3.6 mm vs. 2.6 mm), and more attachment loss (0.5 mm vs. 0 mm). From Papapanou's findings it can be speculated that patients who have had mandibular second premolars extracted and experience more plaque, deeper pockets, and more attachment loss will continue to have increased bone loss at the distolingual surface of their mandibular first premolars. This speculation suggests there is a need for future studies with an older sample mean age, and a longer average time from the date of debond.

Subjects for this study were screened stringently, so as to not allow anyone with generalized periodontitis to participate in the study. Over 2,500 patients or patients charts were screened to find 46 participants who met the strict requirements to participate

in the study. This is apparent when looking at the clinical attachment loss of the control group which had 0 mm of attachment loss at the sites studied. The selection criteria of limiting the upper age range to 31 years old was one factor that made finding participants difficult. Another major factor was not allowing participants to have restorations interproximally at the contact point studied. This along with the fact that no participant could have a 4mm pocket on any of the Ramfjord teeth (Tooth #3, 9, 12, 19, 25, 28) made the eligible participants even smaller. By including dental and medical school students in the sample the overall level of periodontal health was most likely increased. O'Leary, Baudell, and Bloomer reported that a group of periodontally healthy dental students had a high percentage of open or defective restorations. [28] Their study concluded that open and defective contacts did not contribute to periodontal disease. However, there sample was periodontally healthy dental students who may have better oral hygiene than the general population. O'Leary's study was also conducted in 1975, before the 1996 World Workshop in Periodontics, at a time when evidenced based principals were not as prevalent as today. Gould and Picton found that teeth with open or poorly shaped contacts had significantly higher periodontal index scores when compared with teeth that had sound proximal contacts. [12] Their study was published in 1996 and was based on more acceptable scientific methods. The difference between our study and that of O'Leary, Baudell, and Bloomer was that a high level of periodontal health was found in other areas of the mouth except for at the specific contact between the mandibular first premolar and mandibular first molar, and only on the lingual aspect of this contact. As could be expected when visualizing the contact between mandibular first premolar and first molar plaque percentages were much higher on the lingual surface vs.

the buccal surface (67% distolingual of premolar vs. 21% distobuccal of premolar). The results from the present study even suggest that the periodontium on the buccal aspect of this contact between the mandibular first premolar and mandibular first molar is fairly healthy. The plaque scores on the buccal of the experimental group as well as the control group were virtually the same and not statistically significant $p<.05$ (17% vs. 21% on the distobuccal of the premolar, and 26% vs. 21% on the mesiobuccal of the molar). However these same patients experienced a large discrepancy in plaque accumulation when looking at the lingual surface of these teeth. 45% more of the distolingual surfaces of the first premolar presented with plaque accumulation versus the same surface on the mandibular second premolar. When analyzing figure 5, it is apparent that the interproximal surfaces between mandibular first premolar and first molar are very difficult to maintain. The higher percentages of plaque in the experimental group become understandable due to the inability of the patient to clean these surfaces. One can see in Figure 5 that this large lingual embrasure is not present in the normal anatomical contact between the mandibular second premolar and first molar on this patients left side.

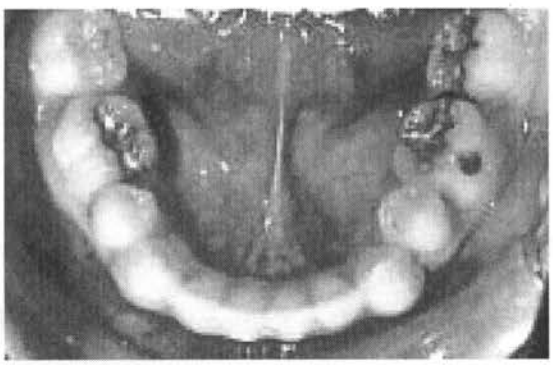

Figure 5. Mandibular occlusal photo showing a patient with a deficient contact between mandibular right first premolar and mandibular right first molar.

The patient in Figure 5 was one of the participants excluded from this study due to the presence of the interproximal restoration between the mandibular first premolar and first molar on the patient's right side. A subjective, but note worthy observation of this patient was that she had the restoration on the lower right first premolar placed approximately two years after having her braces removed, she complained of persistent food impaction at this contact point ever since the braces were removed. One other anecdotal observation from this study was the presence of large pieces of impacted food at the beginning of the examination on two of the experimental subjects, presenting for the study, between their mandibular first premolar and molar. These two participants reported eating lunch a few hours before the exam, but not knowing that they had large pieces of food wedged between their mandibular first premolar and adjacent first molar.

The distolingual of the premolar was the only surface in the comparisons of the means test that showed both statistically significant and clinically significant differences in probing depths and clinical attachment loss. A multivariate ANOVA test was run to determine if there was a positive correlation between the extraction groups and increased probing or clinical attachment loss. The multivariate ANOVA showed that at the distolingual surface there was a positive correlation between the amount of recession and the age of the participant at the contact between first premolar and molar. This data suggests that with increased age, a participant with second premolars extracted will experience attachment loss. The oldest patient in the present study was 31 years of age. As these patients age the periodontal pocketing and attachment loss could reach critical levels.

One of the experimental subjects was a practicing dentist with impeccable hygiene and probing depths of 2 mm at most sites except for at the distolingual surface of the mandibular second premolars seen in Figure 6.

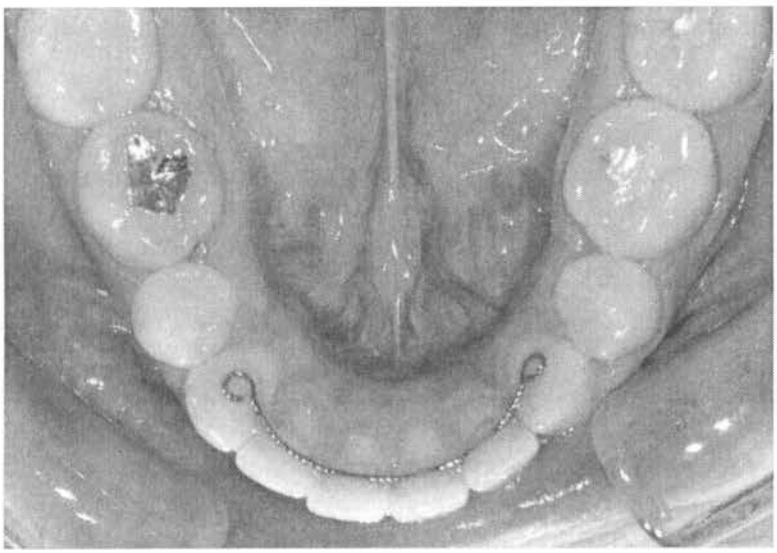

Figure 6. Mandibular occlusal photo showing a participant in the study who had 4 mm pockets on the distolingual aspect of both mandibular first premolars that were in contact with her mandibular first molars.

She had light contacts bilaterally between her mandibular first premolar and molar, and presented with 4mm pockets at the distolingual line angel of her first premolars. She also had 1mm of clinical attachment loss at this same sight and was positive for bleeding on probing. She was asked to return for a follow up examination in which all other contacts were found to be tight, and no other periodontal pockets of more than 3 mm were found. It can be speculated that this participant has overall impeccable hygiene, but even with perfect hygiene the contact between mandibular first premolar and molar just can not be maintained adequately to prevent a localized periodontal problem.

This study was not meant to establish a new trend in the orthodontic extraction patterns; its purpose was to simply see if this contact point was as periodontally healthy as the normal contact found between second premolar and molar. The inspiration for this study was based on a small pilot study in which patients with lower second premolars extracted complained about food impaction between the first premolar and molar. The results from the present study suggest that the contact between first premolar and molar is not as healthy as the one between the second premolar and molar and will impact food more often. It is common knowledge in the orthodontic literature that extraction spaces tend to reopen. [18] This study was not meant to disprove this fact, but to determine what percentage of the contacts between first premolar and molar are open or loose. Future studies are needed in order to look at the long term periodontal health of this contact point.

One weakness of the present study was not looking at the contact point between lower second premolar and canine to determine if this contact point presents with any periodontal problems. In hindsight it would have been beneficial for this study to have looked at the contact between canine and second premolar after first premolar extraction. By comparing the periodontal health at this contact point vs. the one between first premolar and molar the practicing orthodontist could make a more informed decision about the possible future periodontal repercussions of his or her extraction choice. The present study was a cross sectional retrospective study that does not rank high in the hierarchy of levels of evidence for human research. It would be beneficial to the orthodontic community if a future prospective or longitudinal study could be done looking at the periodontal health of these contact points after extraction therapy.

Conclusions:

The study results suggest that extracting mandibular second premolars for orthodontic therapy may result in patients experiencing deeper probing depths on the distolingual side of both the mandibular first premolar and the mesiolingual side of the mandibular first molar. A patient with a second premolar extraction may experience greater clinical attachment loss on the distolingual surface of the first premolar, and may experience more bleeding upon probing at this same site. The contact between the mandibular first premolar and the mandibular first molar will have loose or open contacts more commonly than if the mandibular second premolar was still in contact with the mandibular first molar. This contact will impact food more often than the contact between the mandibular second premolar and mandibular first molar. The lingual surfaces of both the mandibular first molar and mandibular first premolar will show more plaque retention which could lead to future caries and localized periodontitis.

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