

Changes in Periodontal Status after Removal of Symptomatic Third Molars

Maura Helen Partrick, DDS

A thesis submitted to the faculty of the University of North Carolina in partial fulfillment of the requirements for the degree of
Master of Science in the School of Dentistry (Orthodontics)

Chapel Hill
2010

Approved by:

Committee Chair: Professor Raymond P. White, Jr, DDS, PhD

Committee Member: Professor Ceib Phillips, PhD, MPH

Committee Member: Professor William Proffit, DDS, PhD

© 2010
Maura Helen Partrick, DDS
ALL RIGHTS RESERVED

ABSTRACT

Maura Helen Partrick: Changes in Periodontal Status after Removal of Symptomatic Third Molars
(Under the direction of Dr. Raymond P. White, Jr., Dr. Ceib Phillips and Dr. William Proffit)

Subjects and Methods: Healthy subjects (ASA I, II) with minor pericoronitis symptoms affecting mandibular 3rd molars excluding those who used tobacco or antibiotics, were enrolled in an IRB-approved study. Full mouth periodontal probing was conducted at 6 sites per tooth at 2 time points: enrollment and post-surgery. A periodontal probing depth (PD) ≥ 4 mm was considered an indicator variable for periodontal inflammatory disease. Patients at enrollment were stratified into two groups based on at least one distal of 2nd molar (D2M) PD ≥ 4 mm or none, and at least one PD ≥ 4 mm on probing sites on teeth more anterior in the mouth, the principal explanatory explanatory variables for these analyses at both the subject and jaw levels. Outcome variables post-surgery were the frequency of subjects detected with at least one PD ≥ 4 mm or none, and the number and the extent (% possible probing sites) of PD ≥ 4 mm on D2M and on teeth more anterior in the mouth.

Results: Median age for 39 subjects was 22 years (IQ 20.2-25.8). Fifty-nine percent subjects were male; 62% were Caucasian. Significantly fewer subjects post-surgery, 20%, had at least one D2M PD ≥ 4 mm as compared to 92% subjects at enrollment ($P < 0.001$). Removal of 3rd molars reduced the extent (% possible) of subjects total number of probing sites ≥ 4 mm, 4.4 to 0.5, and the median number of PD ≥ 4 mm for the D2M, 2 (IQR 2-3) to 0 (IQR 0-0), and for teeth more anterior in the mouth, 2 (IQR 0-5) to 0 (IQR 0-1).

Conclusion: Removal of 3rd molars in subjects with minor pericoronitis symptoms may improve periodontal health on the distal of 2nd molars and on teeth more anterior in the mouth.

ACKNOWLEDGEMENTS

Many people have contributed to this project and I would like to thank them publicly. Professor Raymond P White Jr, DDS, PhD has mentored me through this project and others and I will always be indebted to him, especially for his kindness and patience. I also owe my gratitude to my committee members Professor Ceib Phillips, PhD, MPH, and Professor William Proffit, DDS, PhD for their guidance when there were other more pressing projects. Professor Camilla Tulloch, my department chair, has also generously contributed to my training in an indelible way. Many thanks for their support also go to Tiffany Hambright RDH for unparalleled project management and data collection and to Debbie Price for efficient and accurate data analysis. A thesis can serve as a symbol of graduation and so I would also like to thank those who have helped me throughout my graduate career.

TABLE OF CONTENTS

Chapter

I.	LITERATURE REVIEW	1
II	MANUSCRIPT.....	7

List of Tables

Table 1. Characteristics of subjects having symptomatic 3rd molars removed, N=39.....17

Table 2. The number and percent of subjects at enrollment and post 3rd molar removal, with at least one periodontal probing depth (PD)≥4mm or all PD<4mm on the distal of all 2nd molars (D2M), N=39.....18

Table 3. The number and percent of subjects at enrollment and post 3rd molar removal with at least one periodontal probing depth (PD)≥4mm or all PD<4mm, on any non-3rd molar tooth-type (probing sites anterior D2M), N=39.....19

Table 4. The number and percent of subjects at enrollment and post 3rd molar removal with at least one periodontal probing depth (PD) ≥4mm or all PD<4mm on the distal of maxillary 2nd molars (D2M) N=39.....20

Table 5. The number and percent of subjects at enrollment and post 3rd molar removal with at least one periodontal probing depth (PD) ≥4mm or all PD<4mm on the distal of mandibular 2nd molars (D2M), N=39.....21

Table 6. Subject level number and extent (% possible) probing sites at least 4mm for subjects with symptomatic mandibular 3rd molars at enrollment, N=39.....22

Table 7. Number and extent (% possible) maxillary probing sites at least 4mm for subjects with symptomatic mandibular 3rd molars at enrollment, n=37*23

Table 8. Number and extent (% possible) mandibular probing sites at least 4mm for subjects with symptomatic mandibular 3rd molars at enrollment, N=39.....24

SECTION I

Literature Review

Definition of Pericoronitis

Pericoronitis is a chronic painful inflammatory condition of the periodontal tissues that most often is found around mandibular third molars (M3M) which are either partially or fully erupted(1-3). Rarely are the maxillary third molars affected. A more descriptive term for pericoronitis is symptomatic periodontal inflammatory disease(4). Pericoronitis is usually unilaterally expressed, but symptoms may occur bilaterally(5). Though it is considered a chronic condition, recurrent symptoms of pain are common. Minor signs and symptoms of pericoronitis include spontaneous pain, localized swelling, purulence or drainage, a foul taste and difficulty in swallowing. Major signs/symptoms of pericoronitis may occur, indicating spread beyond the local alveolar anatomic site, including enlarged lymph nodes, fever, trismus and facial cellulitis.

Epidemiology

Incidence measured for patients presenting to general dental Norwegian practices was estimated at 8-10%(6). Among military recruit populations studies from the US and Scandinavia, incidence is reported between 2-7%(7, 8). Any age group can be affected, but the disease is more common in the late teens and early twenties(9). Venta et al. in 1993 studied consecutive patients with third molar problems at the Finnish Student Health Service. Over half of the 100 students (53%) were diagnosed with pericoronitis; over half of those who were affected had recurrent symptoms(10). Of patients with pericoronitis, 50% had experienced a previous episode, 36% had experienced ≥ 2 episodes and 60% had experienced symptoms in contralateral 3rd molars within a 12 month monitoring period(11). In a period of one year, Fernandes found in 2009 that out of 421 subjects and

676 mandibular third molars, 22% of all vertically impacted teeth examined had developed symptoms and 23% of all partially erupted teeth became symptomatic(12). Kay found a cyclical recurrence of pericoronitis at 6 week intervals, but the most common interval for an additional attack was between the 3rd to the 6th month(13). Data on the frequency of major signs/symptoms occurring with pericoronitis are limited. Piironen and Ylipaavalniemi did report facial swelling associated with pericoronitis in 23% of subjects(14).

In 2003 White et al. looked at 630 subjects with an average age of 21 and found that most subjects' health-related quality of life measures were recovered by 5 days post-surgery, while the "pain" category was improved to a status of "little or none" by day 7(15), which is comparable to what Conrad et al. found in 1999(16).

Based on subjects' quality of life responses, McNutt et al. found that oral function difficulty and the pain associated with acute episodes of pericoronitis is likened to third molar removal. Mouth opening, chewing and eating were compromised according to two questionnaires. Additionally, 40% of subjects reported the worst pain as severe(17).

The Biological Basis of Pericoronitis

Subgingival anaerobic periodontal pathogens, which are risk factors for periodontal inflammatory disease, accumulate at the biofilm-gingival interface (BGI) on the non-sheddable tooth surface(18, 19). The anaerobic environment at the BGI allows the pathogens to interact with the host immune system(20). The inflammatory immune response results in symptoms, and over time the inflammatory mediators lead to destruction of tissue. Periodontal probing depths reflect the surface area of the BGI: the deeper the probing depths are, the more likely an anaerobic environment exists, favoring colonization of pathogens.

Blakey's pilot study revealed that high levels of IL1- β in gingival crevicular fluid from subjects with pericoronitis reflect the severity of the inflammatory response to microbial challenge(21). Increased IL1- β and PGE₂ inflammatory mediators in gingival crevicular fluid samples are considered risk indicators for more severe periodontal disease(22).

Treatment

Effective immediate treatment for minor symptoms of pericoronitis includes frequent irrigation until symptoms subside, usually 48-72 hours, and analgesic medications (acetaminophen, and NSAIDs as examples). Some clinicians recommend systemic antibiotic administration which also can be effective. However, due to the recurrent nature of pericoronitis, acute symptoms return after a period of time. Mechanical debridement, scaling and root planning, is likely to be no more effective. Mechanical debridement in subjects with visible 3rd molars did not reduce the total pathogen count in Blakey's 1996 pilot study, nor the anaerobic pathogen numbers(23). Moss et al. also found similar results(24). Subjects in Phillips' 2003 study showed twice the risk of delayed healing after third molar removal if there were third molar symptoms pre-surgically with clinically delayed healing requiring at least one additional post-surgery visit(25).

In the 1996 pilot study Blakey et al. found that 3rd molar removal eradicated pericoronitis symptoms, but the patient's inflammatory response (IL-1b) remained elevated at the third month post-surgery visit when compared to control subjects(26). More recently, Blakey and Rajasuo separately reported that removal of asymptomatic mandibular 3rd molars resulted in an improvement of periodontal status on the distal of 2nd molars and teeth more anterior in the mouth(27, 28). Not all subjects were improved; 20% of subjects who had all 3rd molars removed had at least one PD \geq 4mm on the distal of the 2nd mandibular molar 9 months after surgery(29).

In comparing prevalence and severity of periodontal inflammatory disease in pericoronitis subjects with those with asymptomatic 3rd molars, Gelesko et al. found that symptomatic subjects had more periodontal inflammatory disease based on periodontal probing depths at least 4mm, incipient disease 31% vs. 25% and early disease 55% vs.38%, respectively(30).

In summary, interesting information can be garnered by following symptomatic pericoronitis subjects over time for changes in periodontal inflammatory disease prevalence pre- and post-removal of all third molars. In patients with pericoronitis, the current concept is that the most

optimal treatment is removal of the third molars. Recurrent symptoms and transmission of the microbial burden to additional teeth more anteriorly are strong arguments towards this model.

References

1. Hamilton, J.W. Pericoronitis. *Dent Clin North Am* 481, 1957
2. Bean LR, King DR: Pericoronitis: its nature and etiology. *J Am Dent Assoc* 83:1074, 1971
3. Piironen J, Ylipaavalniemi P: Local predisposing factors and clinical symptoms in pericoronitis. *Proc Soc Dent Soc* 77:278, 1981
4. Offenbacher S, Barros SP, Singer RE, Moss K, Williams RC, Beck JD: Periodontal disease and the biofilm-gingival interface. *J Periodontol* 78:1911, 2007
5. Kay LW: Investigations into the nature of pericoronitis. *Br J Oral Surg* 3:188, 1966
6. Berg TI: Third molars in Norwegian general dental practice. *Acta Odontol Scand* 50:17, 1992
7. Leone SA, Edenfield MJ: Third molars and acute pericoronitis, a military problem. *Military Med* 152:146, 1987
8. Rajasuo A, Murtomaa H, Meurman JH: Comparison of the clinical status of third molars in young men in 1949 and 1990. *Oral Surg Oral Med Oral Pathol* 76:694, 1993
9. Berg TI: Third molars in Norwegian general dental practice. *Acta Odontol Scand* 50:17, 1992
10. Venta I, Turtola L, Murtomaa H, Ylipaavalniemi P: Third molars as an acute problem in Finnish university students. *Oral Surg Oral Med Oral Pathol* 76:135, 1993
11. Venta I, Turtola L, Murtomaa H, Ylipaavalniemi P: Third molars as an acute problem in Finnish university students. *Oral Surg Oral Med Oral Pathol* 76:135, 1993
12. Fernandes MJ, Ogden GR, Pitts NB, Ogston SA, Ruta DA: Incidence of symptoms in previously symptom-free impacted lower third molars assessed in general dental practice. *Br Dent J* 12:207(5): E10
13. Kay LW: Investigations into the nature of pericoronitis. *Br J Oral Surg* 3:188, 1966
14. Piironen J, Ylipaavalniemi P: Local predisposing factors and clinical symptoms in pericoronitis. *Proc Soc Dent Soc* 77:278, 1981
15. White RP Jr, Shugars, DA, Shafer, DM, Laskin DM, Buckley MJ, Phillips C: Recovery after third molar surgery: clinical and health-related quality of life outcomes. *J Oral Maxillofac Surg* 61:535, 2003
16. Conrad SM, Blakey GH, Shugars DA, Marciani RD, Phillips C, White RP Jr.: Patients' perception of recovery after third molar surgery. *J Oral Maxillofac Surg* 57:1288, 1999
17. McNutt M, Partrick M, Shugars DA, Phillips C, White RP Jr: Impact of symptomatic pericoronitis on health-related quality of life. *J Oral Maxillofac Surg* 66:2482, 2008
18. Offenbacher S, Barros SP, Singer RE, Moss K, Williams RC, Beck JD: Periodontal disease and the biofilm-gingival interface. *J Periodontol* 78:1911, 2007

19. Socransky SS, Haffajee AD, Cugini MA et al: Microbial complexes in subgingival plaque. *J Clin Periodontol* 25:134, 1998
20. Offenbacher S, Barros SP, Singer RE, Moss K, Williams RC, Beck JD: Periodontal disease at the biofilm-gingival interface. *J Periodontol* 78:1911, 2007
21. Blakey GH, White RP Jr, Offenbacher S, Phillips C, Delano EO, Maynor G: Clinical/biological outcomes of treatment for pericoronitis. *J Oral Maxillofac Surg* 54:1150, 1996
22. Blakey GH, White RP Jr, Offenbacher S, Phillips C, Delano EO, Maynor G: Clinical/biological outcomes of treatment for pericoronitis. *J Oral Maxillofac Surg* 54:1150, 1996
23. Blakey GH, White RP Jr, Offenbacher S, Phillips C, Delano EO, Maynor G: Clinical/biological outcomes of treatment for pericoronitis. *J Oral Maxillofac Surg* 54:1150, 1996
24. Moss KL, Serlo AD, Offenbacher S, Beck JD, White RP Jr: Third molars and the efficacy of mechanical debridement in reducing pathogen levels in pregnant subjects: A pilot study. *J Oral Maxillofac Surg* 66:1565, 2008
25. Phillips C, White RP Jr, Shugars DA, Zhou X: Risk factors associated with prolonged recovery and delayed healing after third molar surgery. *J Oral Maxillofac Surg* 61:1436, 2003
26. Blakey GH, Parker DH, Hull DJ, White RP Jr, Offenbacher S, Phillips C, Haug RH: The impact of removal of third molars on periodontal pathology. *J Oral Maxillofac Surg* 67:245, 2009
27. Blakey GH, Parker DH, Hull DJ, White RP Jr, Offenbacher S, Phillips C, Haug RH: The impact of removal of third molars on periodontal pathology. *J Oral Maxillofac Surg* 67:245, 2009
28. Rajasuo A, Meurman JH, Murtomaa H, Torkko H: Effect of extraction of partly erupted third molars on subgingival microorganisms. *Oral Surg Oral Med Oral Pathol* 74:431, 1992
29. Blakey GH, Parker DH, Hull DJ, White RP Jr, Offenbacher S, Phillips C, Haug RH: The impact of removal of third molars on periodontal pathology. *J Oral Maxillofac Surg* 67:245, 2009
30. Gelesko S, Blakey GH, Partrick M, Hill DL, White RP Jr, Offenbacher S, Phillips C, Haug RH: Comparison of periodontal inflammatory disease in young adults with and without pericoronitis involving mandibular third molars. *J Oral Maxillofac Surg* 67:134, 2009

SECTION II

Manuscript

Changes in Periodontal Status after Removal of Symptomatic Third Molars

Introduction

Blakey et al have reported that two-thirds of young adults enrolled with four asymptomatic 3rd molars had at least one periodontal probing depth (PD) ≥ 4 mm in the 3rd molar region(1). Subjects having at least one PD ≥ 4 mm in the 3rd molar region or those with high subject counts of anaerobic periodontal pathogens, “orange and red cluster” bacteria $\geq 10^5$ at enrollment, were at increased risk for disease progression in the 3rd molar region over 2 years, measured by a deepening of PD of at least 2mm(2). After a six year follow-up of 195 subjects in the study population with asymptomatic 3rd molars, periodontal pathology had worsened for the 3rd molar region and non-3rd molars(3). As compared to subjects with all PD < 4 mm at enrollment, if one to three PD ≥ 4 mm were detected in the 3rd molar region at baseline, odds were 12 fold of finding at least four PD ≥ 4 mm at follow-up(4). Having at least one 3rd molar region PD ≥ 4 mm at baseline increased the odds almost four-fold of periodontal pathology being detected on non-3rd molar teeth at follow-up(5).

Subsequently, a subset of the enrolled subjects had 3rd molars removed. Significantly fewer subjects who had all 3rd molars removed had a PD ≥ 4 mm detected on the distal of mandibular 2nd molars (D2M) post-surgery as compared to pre-surgery(6). In addition the total number of PD ≥ 4 mm around all remaining teeth in the mandible were reduced post-surgery if all 3rd molars were removed. These data suggested that removal of mandibular 3rd molars with at least one PD ≥ 4 mm might improve the periodontal status of 2nd molars and possibly the overall periodontal health of teeth more anterior in the mouth.

Gelesko et al studied subjects enrolled with inflammatory symptoms affecting mandibular 3rd molars, termed pericoronitis by most clinicians(7). Subjects with pericoronitis involving mandibular 3rd molars had more underlying periodontal inflammatory disease in affected young adults as measured by PD \geq 4mm than was detected in young adults with retained asymptomatic 3rd molars.

This study was designed to determine if removing 3rd molars in subjects with pericoronitis, symptomatic 3rd molars, improves the periodontal status of 2nd molars and of teeth more anterior in the mouth.

Subjects and Methods

The data for this IRB approved, prospective, exploratory clinical study were collected from patients/subjects at a single academic clinical center, the University of North Carolina over a four year period ending in 2010. The convenience sampling plan was non-random, with recruiting via advertisements in the university newspaper and “word of mouth.” Inclusion criteria included the following: mild signs/symptoms of pericoronitis affecting at least one lower 3rd molar (spontaneous pain, localized swelling, purulence, drainage), between 18-35 years old, and a health status as determined by the American Society of Anesthesiologists’ classification I or II. Subjects were excluded from the study if they were experiencing major signs or symptoms of pericoronitis (a core temperature > 101°F, dysphagia, trismus with opening <20mm at the incisors), facial swelling or cellulitis, severe uncontrolled discomfort, American Association of Periodontology class 4 periodontal status, an acute illness, systemic antibiotic use within the past 2 months, current tobacco use, a body mass index (BMI)>29, a medical contraindication to full mouth probing or pregnancy.

Subjects/patients were seen for baseline data collection at entry and those who elected to have 3rd molars removed were seen at least three months post-surgery. The entry visit included screening for determination of eligibility, collection of baseline data, discussion of treatment options, and consent for participation. Baseline data included demographic data and full mouth periodontal probing (PD), six sites per tooth including the 3rd molars to determine periodontal status. PDs were rounded to the nearest lower whole number (example: 3.6mm was rounded to 3.0mm). A PD \geq 4mm

was considered a clinical indicator of periodontal inflammatory disease(8). The same PD data were collected post-surgery.

Based on the report by Dicus et al subjects at enrollment were stratified into two groups according to the subject and jaw level with at least one distal of 2nd molar PD \geq 4mm or none, and at least one PD \geq 4mm on probing sites on teeth more anterior in the mouth, the principal explanatory variables for these analyses. Outcome variables post-surgery were the frequency of subjects having at least one PD \geq 4mm or none detected as well as the number and the extent (% possible probing sites) of PD \geq 4mm on the distal of 2nd molars and on teeth more anterior in the mouth. Possible confounding variables included gender, race/ethnicity, age at enrollment, and education level (high school or less and at least some college)(9).

Cochran Mantel Haenszel row mean score tests compared age for the two groups. Fisher's Exact test compared ethnicity and gender, while the Exact McNemar's test was used to assess the association between subjects' pre- and post-surgery periodontal status. Level of significance was set at 0.05.

Results

Fifty-nine percent of the 39 subjects with pericoronitis symptoms having all 3rd molars removed were male (Table 1). The majority (61.5%) of subjects were Caucasian. More subjects were well educated: 90% had at least some college education. The median age at enrollment was 22 years (IQR 20.2 - 25.8) and the median time for the post-surgery follow-up was 7.3 months (IQR 5.8-11.2).

The periodontal status of the distal of 2nd molars (D2M) was improved for most subjects post-surgery as compared to pre-surgery. Of the 36 subjects (92.3%) who had at least one D2M PD \geq 4mm at enrollment, only 7 subjects (19%) had at least one D2M PD \geq 4mm post-surgery (Table 2). Of the 3 subjects with all pre-surgery D2M PD<4mm, only one subject had at least one D2M PD \geq 4mm post-surgery.

The periodontal status, a reduction in the depth of probing sites more anterior to the D2M, also was improved post-surgery for most subjects (Table 3). Of the 24 subjects (61.6%) with at least

one $PD \geq 4\text{mm}$ pre-surgery on any non-3rd molar tooth type (probing sites anterior to the D2M), only 4 subjects (10.3%) had at least one $PD \geq 4\text{mm}$ post-surgery. Only 2 of 15 subjects with all pre-surgery $PD < 4\text{mm}$ on probing sites anterior to the D2M had worsened post-surgery with at least one $PD \geq 4\text{mm}$ detected.

Only 6 subjects (15.4%) had a $PD \geq 4\text{mm}$ on the distal of maxillary 2nd molars pre-surgery (Table 4). No maxillary D2M $PD \geq 4\text{mm}$ were detected at follow-up. Mandibular D2M pre-surgery were more likely to have at least one $PD \geq 4\text{mm}$ than maxillary D2M (Table 5). Thirty-six subjects (92.3%) had at least one D2M $PD \geq 4\text{mm}$ pre-surgery. The periodontal status of the mandibular D2M of most subjects was improved post-surgery; only 8 of the 36 subjects (20.5%) had a D2M $PD \geq 4\text{mm}$ at follow-up. Of the 3 subjects with all mandibular $PD < 4\text{mm}$ at enrollment, 1 had a mandibular D2M $PD \geq 4\text{mm}$ post-surgery.

Removal of all 3rd molars reduced the total number of D2M $PD \geq 4\text{mm}$ and the total number of $PD \geq 4\text{mm}$ on probing sites more anterior in the mouth (Table 6). The median number of $PD \geq 4\text{mm}$ for the D2M and for probing sites more anterior decreased from 2 (IQR 2-3) and 2 (IQR 0-5), to 0 (IQR 0-0) and (IQR 0-0), respectively. The median number of $PD \geq 4\text{mm}$ for all possible probing sites also were decreased post-surgery, 4 (IQR 7-11) to 0 (IQR 0-1). The extent (% possible) of probing sites was also reduced post-surgery, 4 (IQR 7-11) to 0 (IQR 0-1). The extent (% possible) of probing sites was also reduced post-surgery (Table 6). The extent scores for D2M $PD \geq 4\text{mm}$ pre-surgery were greater than the extent scores for all probing sites more anterior, 13.1% vs. 0.5% respectively. Post-surgery extent scores were reduced for the D2M and for probing sites more anterior, 2.6% and 0.1% respectively. The extent scores overall encompassing all probing sites were also reduced post-surgery, 4.4% to 0.5%.

Although the maxilla was less affected pre-surgery than the mandible, the extent (% possible) of $PD \geq 4\text{mm}$ also were reduced post-surgery (Table 7). The pre-surgery extent scores of maxillary D2M $PD \geq 4\text{mm}$ were greater than the extent scores for maxillary non-3rd molars, 3.8% vs. 0.2% respectively. Post-surgery extent scores were reduced for the D2M and for probing sites more

anterior, both were 0.0%. The extent scores for all possible maxillary probing sites were also reduced post-surgery, from 0.9% to 0.1%.

Removal of 3rd molars reduced the number and extent PD>4mm of mandibular D2M and the mandibular probing sites more anterior (Table 8). The pre-surgery median number of PDs for the mandibular D2M and probing sites more anterior was 2 (IQR 2-3) and 2 (IQR 0-5), respectively. The median number was reduced for both mandibular anatomic regions to 0 (IQR 0-0) post-surgery. The median number of PD≥4mm for all possible mandibular probing sites also were reduced pre- to post-surgery, 7 (IQR 4-9) to 0 (IQR 0-0). The pre-surgery mandibular D2M extent scores were higher than the extent scores for more anterior probing sites. Post-surgery, the extent scores for the mandibular D2M were reduced from 22.4% to 5.1%, and more anterior probing sites extent scores were reduced from 0.7% to 0.2%. The extent scores for all possible mandibular probing sites were also reduced post-surgery, from 7.9% to 0.9%.

Discussion

Our findings suggest that removing all 3rd molars may improve the periodontal status of adjacent 2nd molars in patients with pericoronitis symptoms, reducing the severity of periodontal inflammatory disease in affected individuals. Of the 36 subjects with at least one D2M PD≥4mm pre-surgery, only 7 (19%) had a D2M PD≥4mm post-surgery, with an average follow-up of 7 months, which most clinicians would deem adequate for healing. Perhaps more important, the periodontal status of teeth more anterior, fewer PD≥4mm anterior to D2M, was also improved.

Overall the pre-surgery periodontal status of these young, healthy adults with pericoronitis symptoms was good. The median number of PD≥4mm for all probing sites pre-surgery was 4 (IQR 7-11); 4.4% of all possible probing sites were affected. Pre-surgery the median number of PD≥4mm was similar for the D2M and 3rd molars, 2 (IQR 2-3) and 2 (IQR 1-3). However, 13.1% of all possible D2M probing sites were affected as compared to 3.8% of all 3rd molar probing sites. The median number and the extent (% possible) of D2M PD≥4mm, and the median number and the extent

of $PD \geq 4\text{mm}$ more anterior were less post-surgery, D2M 0 (IQR 0-0) and 2.6%, and 0 (IQR 0-0) and 0.1%, respectively.

Other authors have reported similar outcomes. Blakey et al recently suggested that removal of asymptomatic 3rd molars may improve the periodontal status of young adults with the early stages of periodontal inflammatory disease, with beneficial changes particularly affecting the distal of 2nd molars(10). In that study, fewer of the 56 subjects with all asymptomatic 3rd molars removed had periodontal inflammatory disease 9 months post-surgery than were detected pre-surgery. Similar to our findings, for Blakey et al.'s subjects the total number of $PD \geq 4\text{mm}$ were reduced not only on D2M but also on probing sites more anterior in the mouth. Not all of the subjects with asymptomatic 3rd molars studied by Blakey et al had an improved periodontal status; 20% of subjects had at least one D2M $PD \geq 4\text{mm}$ at 9 months post-surgery(11). After a systematic review of reports on the impact of 3rd molar surgery on 2nd molar periodontal status, Dodson and Richardson reported that, in the aggregate, detrimental periodontal changes on the D2M pre-surgery to post-surgery were clinically insignificant. However, not all subjects included in their analyses were improved; 20 of their 48 subjects (42%) had a D2M $PD \geq 4\text{mm}$ or a D2M clinical attachment level $\geq 2\text{mm}$ post-surgery(12).

Kan et al performed a periodontal examination on mandibular D2M at least 6 months after removal of impacted 3rd molars on subjects who averaged 29 years old. Three-quarters of the 3rd molars were mesioangular pre-surgery. Mean post-surgery D2M PD was 5.4mm (SD 0.8mm) with two-thirds of the subjects having at least one D2M $PD > 4\text{mm}$ (13). Karapataki et al also reported PD after removal of bilateral mandibular mesioangular impacted 3rd molars in subjects with a mean age of 32 years. Two-thirds of the subjects had at least one D2M $PD \geq 4\text{mm}$ at the follow-up examination(14). Krausz et al reported post-surgery D2M PD data on subjects with a mean age of 30 years who had one impacted mandibular 3rd molar removed while retaining the contralateral 3rd molar(15). At three year post-surgery follow-up, mean D2M PD was greater in the quadrant with the retained 3rd molar as compared to the quadrant with the 3rd molar removed (5.1mm vs. 4.9mm). No pre-surgery periodontal data were reported for these three studies(13-15).

Are our findings biologically plausible? The data we report are compatible with current biological models of periodontal inflammatory disease which focus on the Biofilm Gingival Interface (BGI)(16). In affected individuals increased periodontal probing depths suggest a BGI with an enlarged surface area with an enlarged anaerobic environment, facilitating the colonization of subgingival pathogens. Periodontal pathology is a result of the interaction of increased numbers of periodontal pathogens with the immune system at the BGI. It is possible that 3rd molar removal would effectively reduce the surface area of the BGI, thus altering the subgingival anaerobic conditions which facilitate colonization of pathogens and an immune response to the bacteria, and potentially improve the periodontal condition.

Are treatment options other than 3rd molar removal effective in improving symptoms for subjects with pericoronitis? Palliative treatment for minor symptoms of pericoronitis includes irrigation of the affected anatomic site and medications to relieve pain. Some clinicians may add antibiotics to the regimen. The reports by Kay et al and Venta et al suggest that symptoms recur for most patients in a few months unless 3rd molars are removed(17-18). Although we report that most subjects with symptomatic 3rd molars had at least one D2M PD \geq 4mm, no periodontal data were included in these reports for purposes of comparison.

The findings in this study should be examined with some caution. Our subjects are not representative of the US population; the number of Asians, and Hispanics were few. Additionally, 90% of our subjects had “some college” experience, an education level higher than the US population. Subjects who reported tobacco use or antibiotic treatment were excluded. Further study of subjects with pericoronitis symptoms using tobacco or being treated short-term with antibiotics is warranted. With these limitations, the data we report suggests that most subjects with pericoronitis symptoms have clinical evidence of early periodontal inflammatory disease, and periodontal health can be improved after 3rd molar removal. These findings should assist clinicians advising patients seeking treatment for pericoronitis, a chronic condition with recurring acute episodes. Research

support includes: GCRC RR00046, Oral and Maxillofacial Surgery Foundation, American Association of Oral and Maxillofacial Surgeons, and the Dental Foundation of North Carolina.

References

1. Blakey GH, Jacks MT, Offenbacher S, Nance PE, Phillips C, Haug RH, White RP Jr: Progression of periodontal disease in the second/third molar region in patients with asymptomatic third molars. *J Oral Maxillofac Surg* 64:189, 2006
2. White RP Jr, Offenbacher S, Blakey GH, Haug RH, Jacks MT, Nance PE, Phillips C: Chronic oral inflammation and the progression of periodontal pathology in the third molar region. *J Oral Maxillofac Surg* 64:880, 2006
3. Blakey GH, Hull D, Haug RH, Offenbacher S, Phillips C, White RP Jr: Changes in third molar and non-third molar periodontal pathology over time. *J Oral Maxillofac Surg* 65:1577, 2007
4. White RP Jr, Phillips C, Hull DJ, Offenbacher S, Blakey GH, Haug RH: Risk Markers for Progression of Periodontal Pathology in the Third Molar and non-Third Molar Regions in Young Adults. *J Oral Maxillofac Surg* 66:749, 2008
5. White RP Jr, Phillips C, Hull DJ, Offenbacher S, Blakey GH, Haug RH: Risk Markers for Progression of Periodontal Pathology in the Third Molar and non-Third Molar Regions in Young Adults. *J Oral Maxillofac Surg* 66:749, 2008
6. Blakey GH, Parker DW, Hull DJ, White RP Jr, Offenbacher S, Phillips C, Haug RH: The impact of removal of third molars on periodontal pathology. *J Oral Maxillofac Surg* 67:245, 2009
7. Gelesko S, Blakey GH, Partrick M, Hill DL, White RP Jr, Offenbacher S, Phillips C, Haug RH: Comparison of periodontal inflammatory disease in young adults with and without pericoronitis involving mandibular third molars. *J Oral Maxillofac Surg* 67:134, 2009
8. Blakey GH, Jacks MT, Offenbacher S, Nance PE, Phillips C, Haug RH, White RP Jr: Progression of periodontal disease in the second/third molar region in patients with asymptomatic third molars. *J Oral Maxillofac Surg* 64:189, 2006
9. Dicus C, Blakey G, Faulk-Eggleston J, Hoverstad E, Offenbacher S, Phillips C, White R: Second Molar Periodontal Inflammatory Disease After Third Molar Removal in Young Adults. Submitted *J Oral Maxillofac Surg* 12/09
10. Blakey GH, Parker DW, Hull DJ, White RP Jr, Offenbacher S, Phillips C, Haug RH: The impact of removal of third molars on periodontal pathology. *J Oral Maxillofac Surg* 67:245, 2009
11. Blakey GH, Parker DW, Hull DJ, White RP Jr, Offenbacher S, Phillips C, Haug RH: The impact of removal of third molars on periodontal pathology. *J Oral Maxillofac Surg* 67:245, 2009
12. Dodson TB, Richardson DT: Risk of periodontal defects after third molar surgery: an exercise in evidenced-based clinical decision making. *Oral Maxillofac Surg Clin NA* 19:93, 2007
13. Kan KW, Liu JKS, Lo ECM, Corbet EF, Leung WK: Residual periodontal defects distal to the mandibular second molar 6-36 months after impacted third molar extraction. *J Clin Periodontol* 29:1004, 2002

14. Karapataki S, Hugoson A, Kugelberg CF: Healing following GTR treatment of bone defects distal to mandibular 2nd molars after surgical removal of impacted 3rd molars. *J Clin Periodontol* 5:325, 2000
15. Krausz AA, Machtel EE, Peled M: Effects of lower third molar extraction on attachment level and alveolar bone height of the adjacent second molar. *Int J Oral Maxillofac Surg* 34:756, 2005
16. Offenbacher S, Barros SP, Singer RE, Moss K, Williams RC, Beck JD: Periodontal disease at the biofilm-gingival interface. *J Periodontol* 78:1911, 2007
17. Kay LW: Investigations into the nature of pericoronitis. *Br J Oral Surg* 3:18, 1966
18. Venta I, Turtola L, Murtomaa H, Ylipaavalniemi P: Third molars as an acute problem in Finnish university students. *O Surg O Med O Path* 76:135, 1993

Table 1. Characteristics of subjects having symptomatic 3rd molars removed, N=39.

	Subjects with Pericoronitis Signs/symptoms	
	n	%
Female	16	41.0
Male	23	59.0
Caucasian	24	61.5
African American	7	18.0
Asian	6	15.4
Other	2	5.1
High School Grad	4	10.3
Some College	21	53.9
College Grad	7	17.9
Post College Education	7	17.9
Age In Years median (IQR)	39	21.9 (20.2 - 25.8)
Median Interval (IQR) from Pre-surgery to Post-surgery in Months	7.3 (5.8-11.2)	

(IQR) = Interquartile range, 25th to 75th percentile

Table 2. The number and percent of subjects at enrollment and post 3rd molar removal, with at least one periodontal probing depth (PD) \geq 4mm or all PD<4mm on the distal of all 2nd molars (D2M), N=39.

		Subjects Post-surgery D2M PD					
		All PD<4mm		At Least 1 PD \geq 4mm			
Subjects at Enrollment D2M PD		n	%	n	%	n	%
	All PD<4mm	2	5.1	1	2.6	3	7.7
	At Least One PD \geq 4mm	29	74.4	7	17.9	36	92.3
		31	79.5	8	20.5	39	100

Note- The percentage of subjects with at least one PD \geq 4mm on the distal of 2nd molars was significantly less post-surgery after all 3rd molars were removed, P<0.001

Table 3. The number and percent of subjects at enrollment and post 3rd molar removal with at least one periodontal probing depth (PD) \geq 4mm or all PD $<$ 4mm, on any non-3rd molar tooth-type (probing sites anterior D2M), N=39.

		Subjects Non-3 rd Molar PD Post-surgery					
Subjects Non-3 rd Molar PD at Enrollment		All PD $<$ 4mm		At Least 1 PD \geq 4mm			
		n	%	n	%	n	%
	All PD $<$ 4mm	13	33.3	2	5.1	15	38.4
	At Least One PD \geq 4mm	20	51.3	4	10.3	24	61.6
	33	84.6	6	15.4	39	100	

Table 4. The number and percent of subjects at enrollment and post 3rd molar removal with at least one periodontal probing depth (PD) ≥ 4 mm or all PD <4 mm on the distal of maxillary 2nd molars (D2M) N=39.

		Subjects Maxillary D2M PD Post-surgery					
Subjects Maxillary D2M PD at Enrollment		All PD <4 mm		At Least 1 PD ≥ 4 mm			
		n	%	n	%	n	%
	All PD <4 mm	33	84.6	0	0	33	84.6
	At Least One PD ≥ 4 mm	6	15.4	0	0	6	15.4
		39	100	0	0	39	100

Note- The percentage of subjects with at least one PD ≥ 4 mm on the distal of maxillary 2nd molars was significantly less post-surgery after all 3rd molars were removed, P <0.001

Table 5. The number and percent of subjects at enrollment and post 3rd molar removal with at least one periodontal probing depth (PD) ≥ 4 mm or all PD <4 mm on the distal of mandibular 2nd molars (D2M), N=39.

	Subjects Mandibular D2M PD Post-surgery						
		All PD <4 mm		At Least 1 PD ≥ 4 mm			
Subjects Mandibular D2M PD at Enrollment		n	%	n	%	n	%
	All PD <4 mm	2	5.1	1	2.6	3	7.7
	At Least One PD ≥ 4 mm	29	74.4	7	17.9	36	92.3
		31	79.5	8	20.5	39	100

Note- The percentage of subjects with at least one PD ≥ 4 mm on the distal of mandibular 2nd molars was significantly less post-surgery after all 3rd molars were removed, P <0.001

Table 6. Subject level number and extent (% possible) probing sites at least 4mm for subjects with symptomatic mandibular 3rd molars at enrollment, N=39.

Location	Enroll	Post-surgery	Enroll	Post-surgery
	Median Number (IQR)		Extent (% possible PD)	
3 rd Molar	2 (1-3)	--	3.8	--
Distal 2 nd Molar	2 (2-3)	0 (0-0)	13.1	2.6
Non-3 rd Molar*	2 (0-5)	0 (0-0)	0.5	0.1
Total subjects	4 (7-11)	0 (0-1)	4.4	0.5

* All PD anterior to D2M

All 3rd molars removed in each subject

Table 7. Number and extent (% possible) maxillary probing sites at least 4mm for subjects with symptomatic mandibular 3rd molars at enrollment, n=37*.

	Enroll	Post-surgery	Enroll	Post-surgery
Location	Median Number (IQR)		Extent (% possible PD)	
3 rd Molar	0 (0-0)	--	0.5	--
Distal 2 nd Molar	0 (0-0)	0 (0-0)	3.8	0.0
Non-3 rd Molar**	0 (0-0)	0 (0-0)	0.2	0.0
Total Maxilla	0 (0-0)	0 (0-0)	0.9	0.1

*Two subjects were missing both maxillary 3rd molars

** All PD anterior to D2M

All 3rd molars removed in each subject

Table 8. Number and extent (% possible) mandibular probing sites at least 4mm for subjects with symptomatic mandibular 3rd molars at enrollment, N=39.

	Enroll	Post-surgery	Enroll	Post-surgery
Location	Median Number (IQR)		Extent (% possible PD)	
3 rd Molar	2 (1-3)	--	6.6	--
Distal 2 nd Molar	2 (2-3)	0 (0-0)	22.4	5.1
Non-3 rd Molar*	2 (0-5)	0 (0-0)	0.7	0.2
Total Mandible	7 (4-9)	0 (0-0)	7.9	0.9

*Does not include the distal of the 2nd molar
 All 3rd molars removed in each subject.