Original Article

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Masticatory performance and quality of life before and after the extraction of periodontally hopeless teeth

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Objective: While there have been studies on the effect of periodontal disease on masticatory function, none of them appears to investigate the impact of periodontally hopeless teeth, specifically diagnosed using strict criteria, on masticatory function. This prospective study aimed to compare masticatory performance and quality of life before and after extraction of periodontally hopeless teeth.

Materials and Methods: The study included 11 dental patients. Periodontal status, pain level (Visual Analogue Scale), maximum bite force, masticatory performance based on a* (color in the green-red axis) and ΔE (mean difference between two colors in the CIELAB color space) of a color-changeable chewing gum, and Oral Health Impact Profile-14 (OHIP-14) scores were recorded before and 2 weeks after the extraction of periodontally hopeless teeth. Wilcoxon signed-rank and paired t-tests were used to compare the parameters before and after extraction ($p<0.05$).

Results: Significant reductions in pain VAS ($p=0.005$) during chewing (34.2±25.4 vs. 4.9±13.8 mm) and OHIP-14 (16.9±10.0 vs. 9.9±8.8) after the extraction ($p=0.03$) were found. Additionally, there was a notable improvement in masticatory performance on the side with periodontally hopeless teeth (a*: 14.2±9.5 vs 19.4±4.0 and ΔE: 36.3±12.3 vs 42.6±6.1).

Conclusion: Extraction of periodontally hopeless teeth was associated with a reduction in pain, a positive impact on masticatory performance, and an overall improvement in the quality of life for the patients. The present study was limited by the small sample size, however, the findings could still be beneficial in advising patients of the advantages of extracting periodontally hopeless teeth.

Keywords: chronic periodontitis, mastication, quality of life, tooth extraction

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Introduction

Periodontal disease is one of the causes of tooth loss. Although the periodontally hopeless teeth are planned for extraction [1], some patients refuse to have their teeth extracted for many reasons. For example, they can chew food normally, have a sense of regret for losing natural teeth, worry about their appearance after extraction, and experience discomfort when wearing dentures. Studies on the effect of retaining periodontally hopeless teeth on adjacent teeth have yielded conflicting conclusions.

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Machtei *et al.* [2] reported more bone loss in adjacent teeth following the retention of periodontally hopeless teeth compared to the extraction group. In contrast, a retrospective study by DeVore *et al.* [3] found no significant differences in alveolar bone level on radiographs and the width of the periodontal ligament between adjacent and non-adjacent teeth that were retained after treatment.

It remains unclear which factors of periodontal disease affect masticatory performance. However, tooth mobility has been shown to impact masticatory performance and reduce the maximum bite force [4]. Teeth with periodontitis having 30-70% alveolar bone loss seemed to lose control of the bite force [5]. Borges *et al.* [6] found that periodontal disease affects masticatory performance and the quality of life in dimensions such as physical pain, psychological discomfort, and physical disability. Eating problems are commonly observed in periodontal patients. Additionally, probing depth has been found to be positively correlated with the Oral Impact on Daily Performance (OIDP) score [7].

The purpose of this study is to compare masticatory performance and quality of life before and after extraction of periodontally hopeless teeth.

Materials and Methods

The study protocol was approved by the Center for Ethics in Human Research, Khon Kaen University (HE 641222) and Mukdahan Provincial Public Health Office's Ethics Committee of Human Research, Mukdahan Provincial Public Health Office (20.0032.2565). After obtaining consent, 11 dental patients at Nongsung Hospital in Mukdahan Province were enrolled in this study. The inclusion criteria were patients aged 35 to 70 years with periodontally hopeless teeth according to Becker *et al.* [8, 9] which were planned for extraction, and having at least one occlusal unit (defined as a pair of occluding premolars = 1 unit, pair of occluding molars = 2 units) on the side designated for extraction post-procedure. Exclusion criteria were patients who declined the extraction of their periodontally hopeless teeth, having acute infection and/or acute pain, currently under orthodontic treatment, and having masticatory muscle pain.

All patients had their pre-operative data collected during the initial visit and then again at 2 weeks after the extraction of periodontally hopeless teeth. General information such as age, gender, medical history, and dental history were recorded, alongside clinical parameters including probing depth, keratinized mucosa, gingival margin, clinical attachment loss, furcation involvement, tooth mobility, number of remaining teeth and number of occlusal units. The amount of remaining bone support, calculated as a percentage, was determined from periapical film of the periodontally hopeless teeth. Pain experienced during chewing was assessed using the visual analog scale (VAS) [10]. The maximum bite force was measured using a force measuring device (Occlusal Force-MeterGM10®; Nagano Keiki, Higashimagome, Ohta-ku, Tokyo, Japan), placed on the occlusal surface of the premolar/molar teeth adjacent to the periodontally hopeless tooth, on both the side with periodontally hopeless teeth and the opposite side. In addition, masticatory performance was measured by instructing the patient to chew a color-changeable chewing gum (Masticatory Performance Evaluating Gum XYLITOL®; Lotte Co., Ltd., Saitama, Japan) [11] for 80 cycles on the side with periodontally hopeless teeth, the opposite side and habitual chewing, with 2-minute rests between each chewing session. Individuals who were unable to continue chewing until the preset cycles were not forced to chew; their minimum chewing cycles were instead recorded.

The chewed gum was then wrapped in a polypropylene film and compressed between 2 glass plates to a thickness of 1.5 mm. The color of the chewed gum was assessed using a colorimeter (NR110/3NH, Shenzhen 3NH Technology, China) at 5 locations: center, 3 mm above, 3 mm below, and 3 mm to the left, and right of the center. The value a* (indicating color in the green-red axis) and the mean difference between two colors in the CIELAB color space (ΔE) of each position were then averaged and used to quantify changes in masticatory performance before and after extraction.

The Oral Health Impact Profile (OHIP-14) questionnaire was employed to assess the impact of oral health on individuals' quality of life [12]. The Thai version of OHIP-14 demonstrates good validity and acceptable reliability [13]. The questionnaire consists of 14 items that cover seven dimensions of oral health-related quality of life: (1) functional limitation, (2) physical pain, (3) psychological discomfort, (4) physical disability, (5) psychological disability, (6) social disability, and (7) handicap. Responses were recorded on a Likert scale ranging from 0 (never) to 4 (very often). The scores for each dimension and the overall questionnaire were calculated by summing the scores of the relevant items. Higher scores indicate a greater negative impact of oral health on quality of life. A decrease in the score over time indicates an improvement in quality of life.

Statistical analyses were performed using IBM SPSS statistics software version 28.0 (IBM Corp., Armonk, USA). To compare the masticatory performance and quality of life of the patients before and after tooth extraction, we used paired t-test for normally-distributed data and Wilcoxon matched-pairs signed rank for skewed data. *p*-values <0.05 were considered statistically significant.

Results

The study comprised 11 patients including 6 males and 5 females, with a mean age of 56.0±6.5 years. The remaining teeth averaged 27.4±4.1 teeth, and the mean occlusal unit was 8.3±3.0. One of the patients postponed the follow-up to 3 weeks after extraction due to personal reasons but since the delay was not marked and the inclusion of the patient in the study did not affect the result of the data analyses, such patient was not excluded from the study. The patients had an average of 1.7±1.8 periodontally hopeless teeth per person, a mean probing depth of 3.2±0.7 mm, and a mean clinical attachment loss of 4.2±1.4 mm. All hopeless teeth had 0% remaining bone support except one tooth had 12% bone left.

Table 1 compares the pain scores and masticatory performance of the patients before and after the extraction of periodontally hopeless teeth. The pain score significantly decreased after tooth extraction. Additionally, patients exhibited an increase in masticatory performance on the periodontally hopeless side after extraction, although the results were not statistically significant.

In terms of quality of life, the overall OHIP-14 score improved significantly after the extraction of periodontally hopeless teeth. However, a statistically significant difference was observed only in the "difficulty in daily work" domain of the "social disability" dimension (Table 2).

Table 1 Comparison of pain scores and masticatory function before and after extraction of periodontally hopeless teeth

Variable	Before extraction Mean±SD	After extraction Mean±SD	*p*-value[†]
Pain score	34.2±25.4	4.9±13.8	0.005*[‡]
Maximum bite force on hopeless side (N)[§]	148.2±105.9	165.5±100.2	0.44
Maximum bite force on opposite side (N)	201.8±148.2	230.9±141.0	0.29
a*[¶] (hopeless side)	14.2±9.5	19.4±4.0	0.08
a* (opposite side)	19.9±4.0	19.4±4.5	0.63
a* (habitual)	19.4±5.1	21.1±2.8	0.21
ΔE[#] (hopeless side)	36.3±12.3	42.6±+6.1	0.10
ΔE (opposite side)	42.9±8.2	43.4±6.0	0.48[‡]
ΔE (habitual)	43.7±6.5	46.0±3.4	0.16
Minimum chewing cycle	48.2±37.0	68.4±26.4	0.07[‡]

[†]Statistical test performed using paired t-test unless indicated otherwise

[‡]Wilcoxon signed rank test

[§]N = newton, [¶]a*= color in the green-red axis, [#]ΔE = mean difference between two colors in the CIELAB color space

* Statistically significant ($p<0.05$)

Table 2 OHIP-14 scores before and after extraction of periodontally hopeless teeth

Question	Before extraction			After extraction			*p*-value[§]
	Min[†]	Max[‡]	Mean±SD	Min	Max	Mean±SD	
Functional limitation							
- Difficulty with Pronunciation	0	4	0.5±1.2	0	4	0.5±1.2	1.00
- Taste impairment	0	4	1.3±1.5	0	3	0.7±1.1	0.39
Physical pain							
- Pain in the mouth	0	3	1.5±0.8	0	3	1.4±0.9	0.76[¶]
- Uncomfortable with some food	0	4	2.1±1.4	0	3	1.2±1.0	0.06[¶]
Psychological discomfort							
- Worried	0	3	2.0±1.2	0	3	1.1±1.2	0.08
- Stressed	0	3	1.5±1.1	0	3	0.7±1.0	0.08
Physical disability							
- Food impairment	0	4	2.1±1.3	0	3	1.2±1.0	0.12[¶]
- Interruption of meal	0	3	1.6±1.2	0	3	0.9±0.8	0.07

Table 2 OHIP-14 scores before and after extraction of periodontally hopeless teeth (Continued)

Question	Before extraction			After extraction			*p*-value[§]
	Min[†]	Max[‡]	Mean±SD	Min	Max	Mean±SD	
Psychological disability							
- Difficult to relax	0	2	0.9±0.8	0	2	0.4±0.7	0.08
- Ashamed	0	2	0.5±0.7	0	1	0.5±0.5	0.32
Social disability							
- Mad at some people	0	2	0.9±0.7	0	2	0.5±0.7	0.13
- Difficulty in daily work	0	2	1.1±0.9	0	2	0.5±0.7	0.04*
Handicapped							
- Life less satisfactory in general	0	2	0.8±1.0	0	2	0.4±0.7	0.10
- Totally handicapped	0	1	0.1±0.3	0	1	0.1±0.3	1.00
Total	2	31	16.9±10.0	0	32	9.9±8.8	0.03*[¶]

[†] Min=minimum, [‡] Max=maximum

[§] Statistical test performed using Wilcoxon signed rank test unless indicated otherwise

[¶] Paired t-test

* Statistically significant ($p<0.05$)

Discussion

Among few studies which investigated the effect of reduced periodontal support on masticatory function, the present study compared the masticatory performance, maximum bite force, and quality of life before and after the periodontally hopeless tooth removal and showed that patients had significantly reduced pain on chewing and improved quality of life. Additionally, the extraction of periodontally hopeless teeth also demonstrated tendencies toward increased masticatory performance.

The findings on the effect of conserving periodontally hopeless teeth on neighboring teeth have been inconsistent. Devore *et al.* [3] and Wojcik *et al.* [14] concluded that retaining periodontally hopeless teeth did not significantly affect the periodontium of the adjacent teeth after periodontal surgery. On the other hand, Machtei *et al.* [2] compared the alveolar bone changes of adjacent teeth with and without extraction. Adjacent teeth from the retained hopeless teeth group had 10 times more bone loss than the extraction group. With respect to the masticatory function, non-periodontitis patients had better masticatory performance [6]. Nevertheless, there seem to be no studies on the impact of hopeless teeth, especially based on strict criteria, on masticatory function.

There are other test foods used to evaluate masticatory performance such as peanuts, carrots, artificial test food, gummy jelly, *etc.* but chewing gum seems to be the one that is the most suitable for patients with compromised dentition since it is not too hard to chew and with the adequate number of chews, it can indicate the improvement of masticatory function in various groups of patients [15]. The present study has demonstrated significant pain improvement but only a tendency towards the increase in the masticatory performance, as measured by

a* and ΔE on the same side of the periodontally hopeless teeth after the extraction. A study by Kosaka et al. demonstrated that within the same group of Eichner's index, patients with moderate periodontitis (Community Periodontal Index: CPI levels 2-3) and severe periodontitis (CPI levels 3-4) still exhibited lower efficiency compared to non-periodontitis groups [16], suggesting that the number of occluding teeth alone did not necessarily determine the ability to chew and periodontitis could lead to decreased masticatory performance even the teeth was conserved. Similar results were found in Borges *et al.* [6] found a negative effect on masticatory performance when periodontal support was lost, being that periodontitis patients with less than 50% alveolar bone loss had increased masticatory performance and quality of life compared to those with more than 50% bone loss.

Chronic periodontitis could negatively affect the sensory perception of tooth support and the ability to produce bite forces, resulting in a decreased ability to chew food [5]. Although previous studies showed inconclusive results on whether the local anesthetic would increase or decrease maximum bite force in healthy teeth [17-19], teeth with reduced periodontal support due to periodontitis would be mobile and tended to increase pain or discomfort during biting. This was in agreement with the present finding that pain was reduced after extraction and subsequently resulted in more comfortable function. Regarding the assessment of bite force, Alkan *et al.* [20] demonstrated that periodontal disease patients with pocket depths greater than 5 mm had a maximum bite force of 668.95±297.54 N, significantly less than the non-periodontal disease group (maximum bite force 904.35±197.20 N). Palinkas *et al.* [4] also found that patients with periodontal disease had a lower maximum bite force than the non-periodontal group. However, this study did not find a significant increase in the maximum bite force after extraction, probably due to the small sample size and too short follow up periods.

In terms of oral health-related quality of life, the present study found a statistically significant reduction of the OHIP-14 score, specifically in difficulty in daily work after the extraction of periodontally hopeless teeth. The present study also found a marginally significant reduction in terms of eating discomfort. This was partly in agreement with Borges *et al.* [6] who found that the impact of periodontal disease on quality of life was related to physical pain, psychological discomfort, and physical disability dimensions. Meusel *et al.* [21] also demonstrated lower oral health related quality of life in Brazilian patients with severe periodontal disease with clinical attachment loss greater than 5 mm. Our findings suggested that the reduced pain and eating discomfort improved patients' daily work life.

The limitation of the present study was the small sample size. The improvement in masticatory function after the extraction of periodontally hopeless teeth could reach a significant level if more patients are recruited in the future. However, with the limited number of patients, pain and quality of life were readily shown to be significantly improved after the extraction.

Conclusion

The present study has provided preliminary evidence that the extraction of periodontally hopeless teeth results in a significant reduction in pain and improvement in the overall quality of life, especially in terms of reducing patient's difficulties in daily work. The masticatory performance showed a tendency to increase on the extraction side although it did not reach a significance level. Extraction of periodontally hopeless teeth could be advantageous to the patient's oral function and

overall quality of life. Despite the limitation of the study, the findings could still be beneficial in advising patients of the reduced pain and improved quality of life resulting from the extraction of periodontally hopeless teeth. However, future studies with a larger sample size will offer further insights.

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References

1. Avila G, Galindo-Moreno P, Soehren S, Misch CE, Morelli T, Wang HL. A novel decision-making process for tooth retention or extraction. *J Periodontol*. 2009 Mar;80(3):476-491. doi:10.1902/jop.2009.080454.
2. Machtei EE, Zubrey Y, Ben Yehuda A, Soskolne WA. Proximal bone loss adjacent to periodontally "hopeless" teeth with and without extraction. *J Periodontol*. 1989 Sep;60(9):512-515. doi:10.1902/jop.1989.60.9.512.
3. DeVore CH, Beck FM, Horton JE. Retained "hopeless" teeth. Effects on the proximal periodontium of adjacent teeth. *J Periodontol*. 1988 Oct;59(10):647-651. doi:10.1902/jop.1988.59.10.647.
4. Palinkas M, Borges TF, Junior MT, Monteiro SAC, Bottacin FS, Mestriner-Junior W, *et al.* Alterations in masticatory cycle efficiency and bite force in individuals with periodontitis. *Int J Health Sci (Qassim)*. 2019 Jan-Feb;13(1):25-29.
5. Johansson AS, Svensson KG, Trulsson M. Impaired Masticatory Behavior in Subjects With Reduced Periodontal Tissue Support. *J Periodontol*. 2006 Sep;77(9):1491-1497. doi:10.1902/jop.2006.050355.
6. Borges TdeF, Regalo SC, Taba M Jr, Siéssere S, Mestriner W Jr, Semprini M. Changes in Masticatory Performance and Quality of Life in Individuals With Chronic Periodontitis. *J Periodontol*. 2013 Mar;84(3):325-331. doi:10.1902/jop.2012.120069.
7. Pereira LJ, Gazolla CM, Magalhães IB, Ramos-Jorge ML, Marques LS, Gameiro GH, *et al*. Treatment of Chronic Periodontitis and Its Impact on Mastication. *J Periodontol*. 2011 Feb;82(2):243-250. doi:10.1902/jop.2010.100178.
8. Becker W, Becker BE, Berg LE. Periodontal treatment without maintenance. A retrospective study in 44 patients. *J Periodontol*. 1984 Sep;55(9):505-509. doi:10.1902/jop.1984.55.9.505.
9. Becker W, Berg L, Becker BE. The long term evaluation of periodontal treatment and maintenance in 95 patients. *Int J Periodontics Restorative Dent*. 1984;4(2):54-71.
10. Flaherty SA. Pain measurement tools for clinical practice and research. *AANA J*. 1996 Apr;64(2):133-140.
11. Kamiyama M, Kanazawa M, Fujinami Y, Minakuchi S. Validity and reliability of a Self-Implementable method to evaluate masticatory performance: use of color-changeable chewing gum and a color scale. *J Prosthodont Res*. 2010 Jan;54(1):24-28. doi:10.1016/j.jpor.2009.08.001.
12. Slade GD. Derivation and validation of a short-form oral health impact profile. *Community Dent Oral Epidemiol*. 1997 Aug;25(4):284-290. doi:10.1111/j.1600-0528.1997.tb00941.x.
13. Chatalongkorn S. Psychometric Properties of Thai Version of the Oral Health Impact Profile (OHIP-14Thai). *J Prapokklao Hosp Clin Med Educat Center*. 2017 Jul-Sep;34(3):158-170.
14. Wojcik MS, DeVore CH, Beck FM, Horton JE. Retained "Hopeless" Teeth: Lack of Effect Periodontally-Treated Teeth Have on the Proximal Periodontium of Adjacent Teeth 8-Years Later. *J Periodontol*. 1992 Aug;63(8):663-666. doi:10.1902/jop.1992.63.8.663.
15. Tarkowska A, Katzer L, Ahlers MO. Assessment of masticatory performance by means of a color-changeable chewing gum. *J Prosthodont Res*. 2017 Jan;61(1):9-19. doi:10.1016/j.jpor.2016.04.004.
16. Kosaka T, Ono T, Yoshimuta Y, Kida M, Kikui M, Nokubi T, *et al*. The effect of periodontal status and occlusal support on masticatory performance: the Suita study. *J Clin Periodontol*. 2014 May;41(5):497-503. doi:10.1111/jcpe.12241.

17. Lund JP, Lamarre Y. The importance of positive feedback from periodontal pressoreceptors during voluntary isometric contraction of jaw-closing muscles in man. ***J Biol Buccale***. 1973 Dec;1(4):345-351.
18. van Steenberghe D, de Vries JH. The influence of local anaesthesia and occlusal surface area on the forces developed during repetitive maximal clenching efforts. ***J Periodontal Res***. 1978 May;13(3):270-274. doi:10.1111/j.1600-0765.1978.tb00179.x.
19. Orchardson R, MacFarlane SH. The effect of local periodontal anaesthesia on the maximum biting force achieved by human subjects. ***Arch Oral Biol***. 1980; 25(11-12):799-804. doi:10.1016/0003-9969(80)90137-5.
20. Alkan A, Keskiner I, Arici S, Sato S. The Effect of Periodontitis on Biting Abilities. ***J Periodontol***. 2006 Aug;77(8):1442-1445. doi:10.1902/jop.2006.060025.
21. Meusel DR, Ramacciato JC, Motta RH, Brito Júnior RB, Flório FM. Impact of the severity of chronic periodontal disease on quality of life. ***J Oral Sci***. 2015 Jun;57(2):87-94. doi:10.2334/josnusd.57.87.