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Original Article

Dentistry Section

Effect of Extraction of Mesioangularly Impacted Mandibular Third Molars on the Periodontal Status of Adjacent Second Molars: A Retrospective Observational Study

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ABSTRACT

Introduction: The Mandibular Third Molar (M3M), often the last tooth to erupt, is commonly impacted due to insufficient space in the dental arch, leading to various oral health complications such as pericoronitis, infections, root resorption, cysts, and tumours. Notably, mesioangular impaction is the most prevalent type and is closely associated with the caries and periodontal issues of the Mandibular Second Molar (M2M). Periodontal diseases are significant contributors to tooth loss in adults, and the absence of M2M poses challenges for restoration while increasing the burden on remaining teeth.

Aim: To evaluate the effect of extracting mesioangularly impacted M3M on the periodontal status of M2M.

Materials and Methods: A retrospective observational study with pre- and post-comparisons was conducted at Tongji Hospital, affiliated with Tongji University, Shanghai, China, from October 2024 to February 2025. A total of 56 patients were included. Periodontal parameters, including Probing Depth (PD) and Bleeding On Probing (BOP), were evaluated before and after tooth extraction. Statistical analyses were performed using paired comparisons with the Wilcoxon signed-rank test, group comparisons with the Mann-Whitney U test and the Kruskal-Wallis test, and unpaired t-test and Welch's Analysis of Variance (ANOVA) where appropriate. A p-value of <0.05 was considered statistically significant.

Results: There were 32 males and 24 females. The age of patients ranged from 16 to 45 years. Results showed a significant reduction in PD from 4.2±1.1 mm pre-extraction to 2.8±0.9 mm post-extraction ($p<0.01$). Additionally, factors such as the angulation and depth of impaction were identified as significant risk factors for bone loss around M2M.

Conclusion: The extraction of mesioangularly impacted M3M significantly improves the periodontal health of M2M, supporting the need for timely intervention in similar clinical scenarios. Future studies with larger sample sizes and long-term follow-ups are warranted to further elucidate the relationship between third molar management and periodontal health outcomes in adjacent teeth.

Keywords: Alveolar bone loss, Cone beam computed tomography, Periodontal diseases, Tooth extraction

INTRODUCTION

The M3M, commonly referred to as the wisdom tooth, is the last tooth to erupt in the oral cavity, often facing impaction due to limited space within the dental arch. This impaction can lead to various complications, including pericoronitis, oral and maxillofacial infections, root resorption, cysts, and tumours. Among the types of impactions, mesioangular impaction is the most prevalent and has a strong correlation with the caries and periodontal health of the adjacent M2M [1,2]. Periodontal disease is a significant cause of tooth loss in adults [3], and the loss of M2M poses challenges for restoration while increasing the burden on remaining teeth, ultimately accelerating tooth loss [4]. Current literature suggests that the relationship between impacted M3M and M2M periodontal health is complex and multifaceted [5]. Previous studies have indicated that the presence of a partially erupted or impacted M3M can negatively affect the periodontal status of the adjacent M2M, primarily due to increased plaque retention and periodontal inflammation. Ye ZX et al., reviewed 432 impacted M3Ms in 262 patients to explore how impaction patterns relate to associated pathologies. Pericoronitis emerged as the most frequent presentation, while the likelihood of distal caries and periodontal pathology in adjacent second molars increased with patient age. Soft-tissue, vertically impacted teeth were significantly associated with pericoronitis, mesioangular shallow impactions carried a higher risk of distal caries, and mesioangular or horizontal deeper impactions were more likely to cause distal periodontal pathology [6]. Mansfield JM et al., observed that several bacterial and archaeal species implicated in periodontal disease were recovered in greater incidence and abundance from the plaque of partially erupted third molars compared with incisors, supporting the hypothesis that the pericoronal region may provide a favoured niche for periodontal pathogens in otherwise healthy mouths [7]. However, despite these documented associations, the exact mechanisms through which M3M impaction affects M2M periodontal health remain inadequately explored. Previous research has established that the removal of impacted M3Ms can lead to significant improvements in periodontal health [8,9]. However, the specific benefits to M2M following the extraction of M3M have yet to be quantitatively evaluated in detail. By establishing a clear link between M3M extraction and improved periodontal health in M2M, this study seeks to provide a theoretical basis for counselling patients on the benefits of timely surgical intervention. This knowledge can empower both clinicians and patients, facilitating informed decision-making in the management of third molars and their potential impacts on overall oral health. Therefore, the present study aimed to evaluate the impact of extracting mesioangularly impacted M3M on the periodontal status of M2M.

MATERIALS AND METHODS

This retrospective observational study with a pre–post comparison was conducted using clinical records of patients treated between October 2024 and February 2025 at the Department of Oral and Maxillofacial Surgery, Tongji Hospital, affiliated with Tongji University,

Shanghai, China. It was approved by the Ethics Committee of Tongji Hospital Affiliated to Tongji University (approval number: K-2026-047).

Inclusion criteria:

1. Age 16-45 years;
2. Clinical and radiographic diagnosis of mesioangular impaction based on preoperative orientation relative to the adjacent second molar;
3. Good compliance with follow-up protocols;
4. All participating adults, as well as parents or legal guardians of minors or adults without legal capacity, shall provide informed consent and sign an informed consent form.

Exclusion criteria:

1. Pre-existing severe periodontal disease in adjacent second molars (PD ≥5 mm);
2. Systemic contraindications for tooth extraction (e.g., bleeding disorders, immunocompromised status);
3. History of bone metabolism disorders.

As this was a retrospective observational study, no formal sample size calculation was performed. All patients meeting the inclusion criteria between October 2024 and February 2025 were included in the analysis. A total of 56 impacted M3Ms (32 males, 24 females) requiring surgical extraction due to mesioangular impaction were included. All procedures were performed and recorded by the same surgeon to ensure consistency.

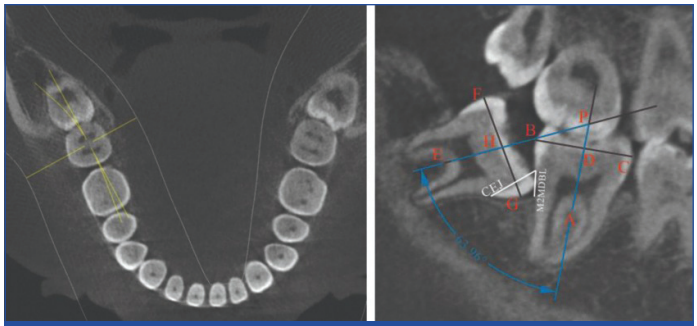
Study Procedure

Extractions were performed under local anaesthesia (2% lidocaine with 1:100,000 epinephrine) using standardised surgical instruments (NSK Surgic Pro+ handpiece, MANI burs). Postoperative care included 4-0 silk sutures and a standardised medication protocol.

Radiographic analysis: Cone Beam Computed Tomography (CBCT) scans (Galileos Comfort Plus, Dentsply Sirona, Germany) were obtained using standardised protocols (voxel size: 0.15 mm, FOV: 8×8 cm). Measurements were performed in SIDEXIS 4 software (Dentsply Sirona) with three-dimensional orientation adjustment [Table/Fig-1]:

- Impaction angle: Measured between M2M and M3M long axes using CorelDraw 2024;
- CEJ distance: Distance between M2M distal CEJ and M3M mesial CEJ;
- Bone defect depth: From M2M distal CEJ to the alveolar bone defect base.

All measurements were triplicated by a calibrated examiner.



[Table/Fig-1]: a) The yellow sagittal line passes through the centers of M2M and M3M; b) Fixed point. Point A: Furcation point of the M2M. Point B: The most convex point on the distobuccal surface of M2M. Point C: The most convex point on the mesiobuccal surface of M2M. Point D: Midpoint of the line segment connecting Points B and C. Point E: Furcation point of the third molar (M3M). Point F: The most convex point on the distobuccal surface of M3M. Point G: The most convex point on the mesiobuccal surface of M3M. Point H: Midpoint of the line segment connecting Points F and G. Point P: Intersection point formed by extending the line segments connecting Points A and D, and Points E and H.

Probing Depth (PD): PD was measured at six sites per tooth (disto-buccal, buccal, mesio-buccal, disto-lingual, lingual, mesio-lingual) parallel to the long axis of the tooth [10], using a calibrated Shanghai Kangqiao (KPC15) periodontal probe (Shanghai Kangqiao Dental Instruments Co., Ltd., China). All measurements were performed by a single calibrated examiner to minimise inter-examiner variability.

For the analysis of PD changes, each site was classified into three mutually exclusive categories based on the change in PD from baseline to the 7-day postoperative follow-up:

- K1: PD increase (postoperative PD > preoperative PD);
- K2: PD decrease (postoperative PD < preoperative PD);
- K3: No change (postoperative PD=preoperative PD).

Proportion of sites with directional changes (K1/K2). Calculus coverage was graded 0-3 using the calculus index [11]. All these assessments were done pre (At baseline) and post-extraction (after 7 days).

STATISTICAL ANALYSIS

Data analysis was performed using Graphpad Prism 10.4.2. The selection of statistical methods was based on the normality of data distribution and homogeneity of variance. For normally distributed data, parametric tests including unpaired t-test, One-way ANOVA, Welch's ANOVA with Tukey's or Dunnett's T3 post-hoc comparisons were applied. For non normally distributed data, non parametric tests including the Wilcoxon signed-rank test, the Mann-Whitney U test, Kruskal-Wallis test with Dunn's post-hoc multiple comparisons were used. A p-value <0.05 was considered statistically significant.

RESULTS

All 56 patients were followed-up completely. There were 32 males and 24 females. The age of patients ranged from 16 to 45 years. ΔPD had no significant association with gender, age, impaction site, and impaction depth [Table/Fig-2].

Characteristics	Number (n)	ΔPD (DB)	ΔPD (DL)
Gender (Mann-Whitney test)			
Males	32	U=285 p=0.0916	U=328.5 p=0.3529
Females	24		
Impaction position (Mann-Whitney test)			
Left lower	35	U=289 p=0.1729	U=304 p=0.2768
Right lower	21		
impaction depth (Mann-Whitney test)			
High position	38	U=271.5 p=0.2051	U=324 p=0.7538
Middle position	18		
Age (average age 28.5) (Kruskal-Wallis test) (in years)			
≤20	3	H=0.4122 p=0.8138	H=1.65 p=0.4383
21-30	34		
≥31	19		
Impaction angulation (Kruskal-Wallis test)			
G1 (25-50°)	10	H=0.0717 p=0.9648	H=2.722 p=0.2564
G2 (50.1-75°)	26		
G3 (75.1-89°)	20		

[Table/Fig-2]: Demographic and clinical characteristics of the study subjects and comparison of ΔPD (DB) and ΔPD (DL) among different groups.

significant site-specific PD variations in M2M both pre- and post-extraction (p<0.0001). Distinct differences were observed between distal sites (DB/DL) versus other measurement points (mid-buccal, mid-lingual, MB, ML), while no significant variations existed among non distal sites [Table/Fig-3].

Dynamic PD Changes Post-extraction

Wilcoxon tests demonstrated significant PD alterations at distal sites compared to minimal changes at other locations. Calculus index: 32.1% cases downgraded ≥1 level (W=-21.0, p=0.0312) [Table/Fig-4].

Stages	Site comparison	Mean rank diff	Adjusted p-value
Pre-op	DB/DL vs. B	128.4/126.0	<0.0001
	DB/DL vs. L	110.7/108.0	<0.0001
	DB/DL vs. MB	114.4/111.8	<0.0001
	DB/DL vs. ML	111.0/108.5	<0.0001
Post-op	DB/DL vs. B	111.2/99.22	<0.0001
	DB/DL vs. L	109.8/97.88	<0.0001
	DB/DL vs. MB	105.1/92.90	<0.0001
	DB/DL vs. ML	105.3/93.13	<0.0001

[Table/Fig-3]: Inter-site Probing Depth (PD) comparisons (DB/DL vs. other sites) at pre- and postoperative stages using Dunn's multiple comparisons test.
DB: Disto-buccal; DL: Disto-lingual; MB: Mesio-buccal; ML: Mesio-lingual; B: Buccal; L: Lingual; BOP: Bleeding on probing

Sites	Number (n)	R+	R-	W	Median difference	p-value
DB	56	332	749	-417	-1.000	0.0196
DL	56	126	777	-651	-1.000	<0.0001
B	56	76	60	16	0.000	0.7120
L	56	67.5	68.5	-1.00	0.000	>0.9999
MB	56	56	80	-24	0.000	0.6509
ML	56	22	56	-34	0.000	0.1992
BOP	56	24	252	-228	0.000	<0.0001
Calculus index	56	0.00	21	-21	0.000	0.0312

[Table/Fig-4]: Pre-op vs. post-op Probing Depth (PD) by site.
R+: Sum of positive ranks; R–: Sum of negative ranks

Dunn's post-hoc analysis of PD, ΔPDs of DB/DL, significantly exceeded other sites (p<0.001). No inter-distal site differences were detected (p>0.05) [Table/Fig-5].

Dunn's multiple comparisons test	Mean rank diff	Adjusted p-value
ΔDB vs. ΔB	71.27	0.0004
ΔDB vs. ΔL	50.84	0.0386
ΔDB vs. ΔML	58.44	0.0080
ΔDL vs. ΔB	91.27	<0.0001
ΔDL vs. ΔL	70.84	0.0004
ΔDL vs. ΔMB	82.90	<0.0001
ΔDL vs. ΔML	78.44	<0.0001

[Table/Fig-5]: Dynamic PD changes post-extraction.

A 78.6% distal sites exhibited directional changes (K1/K2): indicating that most sites showed either an increase or decrease in PD rather than remaining unchanged. K2 (PD reduction) predominated (DB: 60.7%, DL: 64.3%): suggesting an overall trend toward improved PD after surgery [Table/Fig-6].

Part	Groups	n	ΔPD	p-value (pre-PD vs. post-PD)
DB	K1	12	2.800	0.0003
	K2	34	-2.000	<0.0001
	K3	10		
DL	K1	6	2.333	0.0224
	K2	36	-2.000	<0.0001
	K3	14		

[Table/Fig-6]: Subtype analysis of Probing Depth (PD) changes by site.

Soft-tissue Outcomes

Significant improvements were observed in BOP 68% reduction in positive sites (W=-228, p<0.0001).

Radiographic Correlations

Analysis of impaction depth: An unpaired t-test was performed to compare measurements between the high and medium impaction depth groups. A statistically significant difference was found between the two groups (t=2.672, df=54, p=0.0100). The mean value was significantly higher in the high impaction group (6.626) than in the medium impaction group (5.352), with a mean difference of 1.274±0.4768 and a 95% confidence interval of 0.3180 to 2.230.

The Kruskal-Wallis test revealed a significant difference in measurements among the three impaction angle groups (H=13.71, p=0.0011). Multiple comparisons showed that the mean rank of the G1 (25-50°) group was significantly lower than that of the G2 (50.1-75°) group (adjusted p=0.0008). No significant differences were observed between the G1 vs. G3 (75.1-89°) groups or between the G2 vs. G3 groups (p>0.05).

Stratified by impaction depth:

- **High impactions:** Brown-Forsythe and Welch's ANOVAs revealed significant differences among impaction angle categories (Brown-Forsythe: F* (2, 31.18)=18.11, p<0.0001; Welch: W (2, 22.52)=64.81, p<0.0001). Multiple comparisons showed that G1 was significantly lower than both G2 and G3 (both adjusted p<0.0001), with no difference between G2 and G3 (p=0.748) [Table/Fig-7].
- **Medium impactions:** One-way ANOVA showed significant differences across impaction angle categories (F(2, 15)=12.05, p=0.0008). Multiple comparisons showed that G2 had significantly higher values than both G1 (p=0.0008) and G3 (p=0.0196), with no difference between G1 and G3 (p=0.332) [Table/Fig-7].

CEJ distance impact: Brown-Forsythe and Welch's ANOVAs revealed significant differences among the three groups (Brown-Forsythe: F*(2, 41.78)=8.771, p=0.0007; Welch: W(2, 26.00)=14.69, p<0.0001). Multiple comparisons showed that the mean CEJ value was significantly lower in the D1 (4-5.99 mm) group than in the D3 group (p<0.0001), and significantly lower in the D2 (6-7.99 mm) group than in the D3 (8-10 mm) group (p=0.0133) [Table/Fig-7]. Males demonstrated approximately 24.6% higher measurements than females (6.373 vs. 5.115, t=2.451, df=36, p=0.0192), with a mean difference of 1.26±0.51.

Groups	Multiple comparisons	Mean diff.	95% CI of diff.	p-value
High impactions (Dunnett's T3 test)	G1 vs. G2	-3.518	-4.500 to -2.535	<0.0001
	G1 vs. G3	-3.033	-4.115 to -1.952	<0.0001
	G2 vs. G3	0.4842	-0.8695 to 1.838	0.7477
Medium impactions (Tukey's test)	G1 vs. G2	-2.252	-3.493 to -1.011	0.0008
	G1 vs. G3	-0.7800	-2.157 to 0.5966	0.3317
	G2 vs. G3	1.472	0.2311 to 2.713	0.0196
CEJ (Dunnett's T3 test)	D1 vs. D2	-1.182	-2.417 to 0.05336	0.0641
	D1 vs. D3	-2.365	-3.529 to -1.202	<0.0001
	D2 vs. D3	-1.184	-2.152 to -0.2155	0.0133

[Table/Fig-7]: Multiple comparisons of the outcome measure by impaction severity and CEJ distance.

DISCUSSION

The present study evaluated short-term periodontal changes of M2M after extraction of mesioangularly impacted M3M. At the 7-day follow-up, M2M distal PD decreased significantly from 4.2±1.1 mm to 2.8±0.9 mm (p<0.01), and BOP positive sites decreased by 68% (p<0.0001). These results indicate that M3M extraction rapidly alleviates early local inflammation. The 7-day improvements mainly reflect resolution of surgical trauma and acute oedema rather than long-term periodontal healing. Despite the short follow-up, the overall trend of PD improvement was consistent with longer-term studies: Singh S et al., reported a mean distal PD reduction of 0.87±0.67 mm at 9-12 months postoperatively [12], while Pham TAV and Nguyen NH confirmed gradual PD improvement within six months [13]. Collectively, these studies verify that M3M extraction

promotes favourable periodontal changes in adjacent M2M, with early inflammatory relief followed by stable long-term healing.

Using CBCT analysis identified impaction angle, impaction depth, CEJ distance and gender as factor associated with M2M distal bone loss. Males showed significantly greater distal bone loss than females (6.373 vs. 5.115 mm, p=0.0192). Worse bone loss was also associated with deeper impaction, impaction angle over 50°, and longer CEJ distance. The present study findings agree with previous CBCT study by Akkitap MP, and Gumru B [14], which confirmed that mesioangular impaction, deep impaction, sub-CEJ contact and male gender are closely related to increased marginal bone loss of M2M. The threshold effects of impaction angle and depth were quantified, providing more precise clinical evidence for risk evaluation.

Males accounted for 60.5% of the present sample and had more severe distal bone loss (p=0.0192), consistent with Ahmed HA et al., who also found significantly greater alveolar bone loss in males in the non extraction group (p=0.034) [15]. This may be explained by better oral health awareness and earlier treatment-seeking in females, which slows M3M-related pathological progression and M2M distal bone resorption. Nevertheless, some studies reported a stronger adverse impact of M3M on M2M distal defects in females [16], possibly due to variations in sample gender ratio, oestrogen fluctuation and dietary habits [17]. The present cohort had a balanced gender ratio and a young mean age of 28.5 years, with minimal hormonal interference; heterogeneous sample composition may account for inconsistent conclusions across studies.

The present study findings support proactive extraction of mesioangularly impacted M3Ms to protect M2M periodontal health. Clinically, early removal of high-risk impacted M3Ms conforms to evidence-based periodontal intervention principles [18]. This study also favours a preventive management strategy for both symptomatic and asymptomatic mesioangular impactions, helping maintain the long-term periodontal integrity of adjacent second molars [19,20]. Notably, a high proportion of distal sites exhibited a consistent 2.00 mm reduction in PD after extraction of mesioangularly impacted third molars. This concentrated distribution stemmed from our homogeneous young adult cohort, who had similar age, comparable baseline distal pocket depths, and analogous periodontal defect morphology related to mesioangular impaction. All probing measurements were uniformly recorded to the nearest 1 mm; such discrete 1 mm incremental recording naturally yielded integer differences in pre- and postoperative PD changes. Moreover, young adults showed stable, predictable inflammatory resolution and soft tissue repair after surgery, resulting in consistent individual treatment responses. Thus, the frequent exact 2.00 mm PD reduction reflected similar baseline periodontal status, standardised 1 mm measurement, and stable postoperative healing, rather than abnormal data clustering.

Future studies should adopt larger multicentre samples with prolonged follow-up to validate the present study findings and clarify the long-term influence of M3M extraction on M2M periodontal health. More comprehensive periodontal indicators are also recommended to further evaluate the clinical benefits of third molar removal.

Limitation(s)

The relatively small sample size may restrict the generalisability of the results. The 7-day short-term follow-up could not reflect long-term periodontal healing; the early improvements in PD and BOP mainly represented acute inflammation relief rather than definitive tissue repair. In addition, potential confounding factors, including dietary habits, oral hygiene level and systemic health status, were not strictly controlled, which may affect periodontal outcomes.

CONCLUSION(S)

The present study confirms that extracting mesioangularly impacted M3Ms effectively improves the periodontal status of adjacent second molars, especially in PD and BOP. The results support timely clinical intervention for mesioangularly impacted M3Ms to protect the periodontal health of adjacent teeth, and provide a reference for subsequent related research and clinical decision-making.

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