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EFFECT OF FIRST PREMOLAR EXTRACTION ON MANDIBULAR THIRD MOLAR ANGULATION IN ORTHODONTICALLY TREATED BIMAXILLARY PROTRUSION CASES: A RETROSPECTIVE CEPHALOMETRIC STUDY

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ABSTRACT
Context: Mandibular third molars are prone to impaction given their late eruption chronology and limited retromolar space. Whether orthodontic extraction of first premolars favourably influences third molar angulation in bimaxillary protrusion patients remains debated, making objective cephalometric evaluation clinically important.
Aims: To assess angular changes of the mandibular third molar following fixed orthodontic treatment with versus without first premolar extraction in patients presenting with bimaxillary dentoalveolar protrusion.
Settings and Design: Retrospective observational study conducted at the Department of Orthodontics and Dentofacial Orthopaedics, Inderprastha Dental College and Hospital, Sahibabad, Ghaziabad.
Materials and Methods: Pretreatment (T1) and posttreatment (T2) lateral cephalograms of 34 patients (mean age 18–35 years) with bimaxillary protrusion were analysed. Group A (n = 17) underwent all four first premolar extractions combined with fixed MBT appliance therapy; Group B (n = 17) received non-extraction fixed orthodontic treatment. Four angular variables were measured: mandibular third molar long axis relative to the sella–nasion (SN) plane, occlusal plane (OP), mandibular plane (MP), and mandibular second molar (M2).
Statistical Analysis Used: Intragroup pretreatment-to-posttreatment differences were evaluated using paired t-tests. Intergroup comparisons of mean angular changes employed independent-samples analysis with F-statistics. The significance threshold was set at $P \leq 0.05$ (95% confidence interval).
Results: Neither group showed statistically significant intragroup angular changes ($P > 0.05$), yet directional trends consistently favoured uprighting in Group A. Intergroup comparison revealed significantly greater and more favourable angular improvements in Group A for all four variables: M3–SN ($F = 14.101$; $P = 0.001$), M3–OP ($F = 83.849$; $P < 0.001$), M3–M2 ($F = 97.263$; $P < 0.001$), and M3–MP ($F = 74.739$; $P < 0.001$).
Conclusions: First premolar extraction in bimaxillary protrusion cases produces significantly more favourable mandibular third molar angular changes than non-extraction therapy, suggesting a potential reduction in impaction risk and improved long-term orthodontic stability.

KEYWORDS: Bimaxillary protrusion, Cephalometric analysis, Mandibular third molar, Orthodontic extraction, Premolar extraction, Third molar impaction

INTRODUCTION
The mandibular third molar holds a uniquely precarious position within the dental arch. Erupting last in the permanent dentition, typically between the ages of 17 and 25 years, it must navigate a retromolar corridor that is frequently too narrow to accommodate it fully. Epidemiological data consistently show that 60–70% of mandibular third molars fail to achieve functional occlusion, making impaction one of the most common conditions encountered in dental practice.[1,2] The consequences extend well beyond the third molar itself: pericoronitis, distal caries of the second molar, periodontal destruction, cystic degeneration, and, in rare instances, pathological mandibular fractures are all well-documented sequelae.[1,2]
From an orthodontic standpoint, the mandibular third molar has generated enduring controversy. Earlier dogma held that erupting third molars exerted mesialising forces transmitted through the dental arch, contributing to post-treatment anterior crowding and relapse.[3,4] This belief influenced clinical protocols for several decades. Accumulating evidence from randomised controlled trials and long-term longitudinal studies has, however, substantially weakened this mechanistic argument. Current consensus positions late incisor crowding as a

multifactorial phenomenon driven largely by residual mandibular growth, physiological mesial drift, soft-tissue pressure, and age-related arch dimensional changes, rather than third molar eruptive forces alone.[5,6] Nonetheless, the spatial and biomechanical implications of third molar development retain genuine clinical relevance.

Contemporary orthodontic philosophy increasingly embraces an anticipatory approach, advocating early radiographic assessment of third molar position and eruption trajectory as an integral part of comprehensive diagnosis and treatment planning.[1,6] Panoramic and lateral cephalometric evaluation during adolescence provides actionable insight into eruption probability and enables proactive interdisciplinary management before complications arise.[7]

Within this framework, the influence of premolar extraction on mandibular third molar development has attracted sustained research interest. First premolar extraction is a cornerstone procedure for patients with bimaxillary dentoalveolar protrusion, reliably correcting incisor inclination, reducing lip procumbency, and resolving crowding. Orthodontic interventions can influence not only dental alignment but also surrounding craniofacial structures, including the upper airway and hyoid bone position. [4,7] The mechanics of extraction closure involve anterior retraction coupled with mesial migration of the posterior buccal segments, collectively redistributing arch length in the posterior region. This redistribution has been hypothesised to enlarge the retromolar space available for third molar eruption and to encourage a more favourable, upright angulation of the developing third molar.[8,9] The biological plausibility of this hypothesis is sound: tooth eruption is sensitive not only to genetic programming but also to local environmental variables, including adjacent tooth positions, available bone volume, and surrounding alveolar morphology.[10] Several investigators have reported that extraction-based orthodontic treatment is associated with measurable uprighting of mandibular third molars relative to cranial, occlusal, and mandibular reference planes, along with a reduced incidence of impaction compared with non-extraction treatment.[9–12] The literature is not, however, uniformly consistent, with some studies documenting modest or variable effects that underscore the complexity of individual growth patterns and treatment timing.[8]

Angular cephalometric analysis offers a valid, standardised, and reproducible method for quantifying positional changes of the mandibular third molar over the course of treatment.[13,14] By evaluating the orientation of the third molar long axis relative to established skeletal and dental reference planes at pretreatment and posttreatment time-points, clinicians can objectively compare the effects of different treatment protocols without the subjectivity inherent to qualitative assessments.

The present retrospective study was therefore designed to evaluate angular changes of the mandibular third molar in orthodontically treated bimaxillary protrusion patients, comparing outcomes between those managed with first premolar extraction and those treated without extractions.

MATERIALS AND METHODS

Study Design and Ethical Considerations

This retrospective observational study was carried out in the Department of Orthodontics and Dentofacial Orthopaedics, Inderprastha Dental College and Hospital, Sahibabad, Ghaziabad. All patients had provided informed consent at the time of treatment for their diagnostic records to be used for academic and research purposes. The study was conducted in accordance with the ethical standards laid down by the institutional review board.

Source of Data and Sample Selection

Lateral cephalometric radiographs archived in the departmental records formed the primary data source. Thirty-four patients who had completed full fixed orthodontic treatment for bimaxillary protrusion were included. The sample was divided into two equal groups of 17 patients each. Group A comprised patients treated with extraction of all four first premolars in addition to fixed MBT appliance therapy, whereas Group B comprised patients treated using a non-extraction fixed appliance protocol. Pretreatment and posttreatment radiographs were labelled T1 and T2, respectively.

Inclusion and Exclusion Criteria

Patients aged 18–35 years with a complete permanent dentition and fully erupted mandibular third molars were eligible. All had completed standardised MBT fixed appliance treatment. Records were excluded when teeth other than the orthodontically extracted premolars were absent, when mandibular third molars were impacted or partially erupted, when third molar apices could not be clearly identified on the radiograph, or when image quality was insufficient for reliable landmark identification.

Radiographic Technique

All lateral cephalometric radiographs were acquired using a CS 8000C cephalostat (Carestream Health, Inc., France) with standardised exposure parameters of 90 kV, 15 mA, and 0.5 seconds, at a source-to-image distance of 1.5 m. Patients were positioned in natural head posture with the Frankfort horizontal plane parallel to the floor, the midsagittal plane perpendicular to the floor, and bilateral ear rods seated in the external auditory meata to ensure reproducible head orientation.

Cephalometric Analysis

Manual tracing was performed on 8 × 10-inch matte acetate sheets (0.003-inch thickness) under standardised viewing conditions. To enable superimposition of T1 and T2 tracings, three stable reference points—two in the cranial region and one on the cervical vertebrae—were identified on each radiograph. The long axes of the mandibular third molar (M3) and second molar (M2) were carefully traced, as were the standard cephalometric planes detailed in Table 1. Four angular variables were recorded at each time-point:

- Angle between the long axis of the mandibular third molar and the SN plane (M3–SN)
- Anterior angle between the long axis of the mandibular third molar and the occlusal plane (M3–OP)
- Anterior angle between the long axes of the mandibular third and second molars (M3–M2)
- Angle between the long axis of the mandibular third molar and the mandibular plane (M3–MP)

Figure 1: Angular measurement of mandibular third molar wrt SN, MP, M2,OP

Table 1: Cephalometric landmarks and reference planes used in the study

Landmark/Plane	**Definition**
M3	Long axis of the mandibular third molar
M2	Long axis of the mandibular second molar
SN Plane	Line connecting the centre of the sella turcica (S) to nasion (N), the most anterior point of the nasofrontal suture
MP (Mandibular Plane)	Tangent to the lower border of the mandible
OP (Occlusal Plane)	Line bisecting the overlapping cusps of the first molars and incisal edges

Statistical Analysis

Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics (Version 22.0; IBM Corporation, Armonk, NY, USA). Descriptive statistics (mean ± standard deviation) were computed for all angular variables at T1 and T2. Intragroup pretreatment-to-posttreatment differences were assessed using paired t-tests. Intergroup comparisons of mean angular change (T2 − T1) were performed using independent-samples analysis with F-statistics. Statistical significance was defined as $P \leq 0.05$ (two-tailed; 95% confidence interval).

RESULTS

Intragroup Changes: Extraction Group (Group A)

In Group A, all angular variables showed directionally consistent and clinically meaningful changes from T1 to T2 [Table 2]. The M3–SN angle increased from a mean of 40.12° to 55.12°, indicating progressive uprighting of the third molar relative to the cranial base. The M3–OP angle decreased from 125.8° to 119.5°, reflecting improved alignment with the functional occlusal plane. The M3–M2 angle—arguably the most clinically relevant measure for impaction risk—showed a substantial reduction from 21.87° to 10.25°, denoting markedly better mesiodistal orientation between the second and third molars. Finally, the M3–MP angle increased from 75.93° to 89.06°, indicating a more upright inclination relative to the mandibular base. Despite these positive directional trends, none of the intragroup differences reached statistical significance (all $P > 0.05$), likely reflecting the relatively modest sample size and inherent biological variability.

Table 2: Intragroup angular changes of the mandibular third molar — Extraction Group (Group A)

Angle	Time	Mean (°)	SD	SEM	P-value
M3–SN	T1 (Pre)	40.12	1.454	0.363	0.608 (NS)
	T2 (Post)	55.12	2.061	0.515	
M3–OP	T1 (Pre)	125.8	1.682	0.420	0.801 (NS)
	T2 (Post)	119.5	3.076	0.769	
M3–M2	T1 (Pre)	21.87	1.408	0.352	0.976 (NS)
	T2 (Post)	10.25	2.863	0.715	
M3–MP	T1 (Pre)	75.93	1.436	0.359	0.866 (NS)
	T2 (Post)	89.06	3.086	0.771	

SD = Standard Deviation; SEM = Standard Error of Mean; NS = Not Significant; paired t-test

Intragroup Changes: Non-Extraction Group (Group B)

In Group B, angular changes were comparatively modest and lacked a consistently favourable trend [Table 3]. The M3–SN angle increased from 45.37° to 56.68°, suggesting some natural uprighting over the treatment period. However, the M3–OP angle worsened slightly, rising from 116.4° to 120.8°. The M3–M2 angle showed negligible change (10.81° to 10.12°), and the M3–MP angle increased marginally from 87.25° to 90.56°. No intragroup comparison reached statistical significance (all $P > 0.05$), consistent with the absence of mechanically driven posterior space redistribution in this group.

Table 3: Intragroup angular changes of the mandibular third molar — Non-Extraction Group (Group B)

Angle	Time	Mean (°)	SD	SEM	P-value
M3–SN	T1 (Pre)	45.37	1.087	0.271	0.253 (NS)
	T2 (Post)	56.68	3.004	0.751	
M3–OP	T1 (Pre)	116.4	1.093	0.273	0.114 (NS)
	T2 (Post)	120.8	3.242	0.810	
M3–M2	T1 (Pre)	10.81	0.750	0.187	0.052 (NS)
	T2 (Post)	10.12	2.629	0.657	
M3–MP	T1 (Pre)	87.25	1.290	0.322	0.931 (NS)
	T2 (Post)	90.56	2.756	0.689	

SD = Standard Deviation; SEM = Standard Error of Mean; NS = Not Significant; paired t-test

Intergroup Comparison: Extraction versus Non-Extraction

The intergroup comparison of mean angular change (ΔT2 − T1) revealed statistically significant differences in favour of the extraction group for all four variables [Table 4]. The M3–SN angular change was greater in Group A (−15.0°) than in Group B (−11.3°), reaching significance ($F = 14.101$; $P = 0.001$). The M3–OP difference was highly significant ($F = 83.849$; $P < 0.001$): Group A showed a favourable reduction of 6.25° whereas Group B demonstrated a slight adverse increase of 4.43°. The most pronounced intergroup difference was observed for the M3–M2 angle, where Group A exhibited a clinically substantial mean change of 11.6° compared with a near-negligible 0.68° in Group B ($F = 97.263$; $P < 0.001$). Similarly, the M3–MP angle changed by 13.1° in Group A versus 3.31° in Group B ($F = 74.739$; $P < 0.001$).

Table 4: Intergroup comparison of mean angular changes (ΔT2 − T1) in mandibular third molar angulation between extraction and non-extraction groups

Variable	Group	Mean Change (°)	SD	F-value (P-value)
M3–SN	Group A (Extraction)	−15.0	2.683	14.101 (0.001)*

Variable	Group	Mean Change (°)	SD	F-value (P-value)
	Group B (Non-extraction)	−11.3	2.868	
M3–OP	Group A (Extraction)	6.25	3.605	83.849 (<0.001)**
	Group B (Non-extraction)	−4.43	2.965	
M3–M2	Group A (Extraction)	11.6	3.201	97.263 (<0.001)**
	Group B (Non-extraction)	0.68	3.070	
M3–MP	Group A (Extraction)	−13.1	3.344	74.739 (<0.001)**
	Group B (Non-extraction)	−3.31	3.070	

*P ≤ 0.05 = Significant; **P < 0.001 = Highly Significant; CI = 95%; SD = Standard Deviation

DISCUSSION

The central finding of the present study is that first premolar extraction, when performed as part of fixed orthodontic treatment for bimaxillary protrusion, produces significantly more favourable angular changes of the mandibular third molar compared with non-extraction treatment. This outcome was consistent across all four angular measurements evaluated, lending robust multidimensional support to the hypothesis that extraction-based therapy creates a more conducive biomechanical environment for mandibular third molar development.

In the extraction group, each angular variable moved in a clinically desirable direction: the M3–SN and M3–MP angles increased, reflecting progressive uprighting of the third molar relative to the cranial base and mandibular plane respectively, while the M3–OP and M3–M2 angles decreased, indicating improved alignment with the functional occlusal plane and a more upright orientation relative to the second molar. The directional consistency of these changes is biologically plausible and aligns with findings reported by Mendoza-García et al.,[5] Miclotte et al.,[3] and Di Giovanni et al.,[12] all of whom documented improved third molar angulation following extraction-based orthodontic treatment and attributed the changes to posterior space redistribution and mesial molar migration.

The non-extraction group showed comparatively modest changes, with no consistent favourable trend. Notably, the M3–OP angle actually worsened slightly, and the M3–M2 angle remained essentially unchanged. These observations are consistent with longitudinal data indicating that, in the absence of posterior space redistribution, the mandibular third molar's developmental trajectory is governed predominantly by intrinsic growth patterns rather than treatment mechanics.[10,17] The lack of space-gaining forces in non-extraction patients may predispose their third molars to persistent mesioangular inclination and a higher impaction probability.

The intergroup comparison results were particularly compelling. The M3–M2 angular change stands out as the most clinically meaningful finding: Group A demonstrated a mean improvement of 11.6° compared with a trivial 0.68° in Group B (P < 0.001). Mesioangular impaction is the single most prevalent type of mandibular third molar impaction, and the angle between the second and third molars is a widely accepted predictor of eruption success.[18,19] A reduction of this magnitude—nearly 12 degrees on average—could plausibly translate into a meaningful clinical reduction in mesioangular impaction risk, reduced pathological contact between the third and second molars, and lower susceptibility to distal second molar caries and periodontal attachment loss.[18,19]

The underlying biomechanical mechanism most commonly invoked to explain these findings is the mesial drift of posterior molars following premolar extraction space closure. As the first and second molars migrate mesially to close the extraction space, the retromolar arch dimension is expanded and the alveolar environment posterior to the second molar is remodelled.[7–10] Several authors have emphasised that it is primarily this change in molar angulation—rather than an absolute increase in retromolar space—that drives the improvement in third molar eruption probability.[7–10] The present findings are consistent with this interpretation, as angular improvements occurred even in a sample where direct space measurement was not performed.

The absence of statistically significant intragroup changes in either group, despite clinically meaningful directional trends in Group A, warrants discussion. This pattern is commonly encountered in retrospective studies with relatively small sample sizes, where statistical power may be insufficient to detect moderate within-group changes but remains adequate for detecting the larger between-group differences that emerged. This interpretation is consistent with the work of Durgesh et al.[2] and Sheikhzadeh et al.,[6] who similarly reported that intragroup changes were not always statistically significant, yet intergroup differences clearly favoured the extraction protocol.

It is also worth noting that no significant correlation was observed between baseline third molar angulation and posttreatment outcomes, suggesting that the pretreatment position of the third molar is an unreliable predictor of its developmental trajectory. This finding agrees with longitudinal data indicating that third molar eruption is a dynamic process influenced by the direction of mandibular growth, timing of root development, and genetic predisposition—factors that cephalometric snapshots alone cannot fully capture.[18–21]

From a broader interdisciplinary perspective, the findings reinforce the value of routinely incorporating third molar assessment into orthodontic treatment planning. For patients presenting with bimaxillary protrusion in whom extraction is already indicated on the basis of incisor inclination, lip prominence, or arch length discrepancy, the additional likelihood of improved mandibular third molar angulation provides a supplementary evidence-based rationale for extraction therapy. Conversely, a non-extraction decision should acknowledge the potential for suboptimal third molar angulation and prompt long-term surveillance, with a lower threshold for prophylactic removal if impaction develops.

The limitations of this study include its retrospective design, restricted sample size, and inability to directly measure eruption success, retromolar space, or long-term functional outcomes. Growth contributions during the treatment period could not be fully isolated. Future prospective studies with larger samples, three-dimensional imaging (cone beam computed tomography), and extended follow-up periods are needed to more precisely characterise the relationship between extraction therapy and third molar eruption.

CONCLUSION

First premolar extraction in bimaxillary protrusion patients is associated with significantly more favourable angular changes of the mandibular third molar across all four cephalometric planes evaluated, compared with non-extraction orthodontic treatment. These findings support the incorporation of third molar positional assessment into early orthodontic diagnosis and treatment planning, with the potential to reduce impaction risk, limit the need for future surgical intervention, and improve long-term stability. Clinicians and interdisciplinary teams managing bimaxillary protrusion should consider third molar angulation as an additional outcome variable when formulating and evaluating treatment plans.

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