***Original Research Article***

**Cephalometric Evaluation of Soft Tissue Changes with Extraction of all First Premolars among the Patients having Bimaxillary Protrusion attending in the Orthodontics Department of BMU**

**ABSTRACT**

***Background:*** *Bimaxillary protrusion is a common dentofacial deformity characterized by proclined incisors and prominent lips. While premolar extractions are frequently used for correction, comprehensive cephalometric evaluation of soft tissue changes remains essential for evidence-based treatment planning.*

***Objective:*** *This study aimed to evaluate soft tissue changes following the extraction of all first premolars in bimaxillary protrusion patients undergoing orthodontic treatment at BMU’s Orthodontics Department.*

***Methods:*** *A prospective analytical study was conducted on clinically diagnosed bimaxillary protrusion cases. Pre- and post-treatment cephalometric radiographs were analyzed using standardized tracings, assessing six parameters: upper incisor position (U1-APog), lower incisor position (L1-APog), lower anterior face height, upper lip position (UL-E), lower lip position (LL-E), and nasolabial angle (NLA). A single operator performed all measurements to minimize bias. Paired t-tests compared pre- and post-treatment changes (p<0.05 considered significant).*

***Results:*** *Significant retraction of the upper lip (mean 3.58 mm, p<0.001) and lower lip (mean 1.83 mm, p<0.001) was observed. The nasolabial angle increased by 8.59° (from 81.07° to 89.67°, p<0.001). Lower anterior face height showed minimal change (1.21 mm). All soft tissue improvements were statistically significant (p<0.001).*

***Conclusion:*** *Extraction of the first four premolars effectively reduces soft tissue procumbency in bimaxillary protrusion, with significant improvements in lip position and nasolabial angle. These findings support this treatment approach for enhancing facial profile aesthetics. Early cephalometric assessment should be incorporated into orthodontic planning for such cases.*

***Keywords:*** *Extraction, Premolars, Bimaxillary protrusion, Soft tissue, Cephalometrics*

**Introduction**

Orthodontic therapy represents a sophisticated dental specialty dedicated to diagnosing, preventing, and correcting dental and skeletal discrepancies to achieve three fundamental objectives: proper occlusal function, optimal masticatory efficiency, and enhanced facial aesthetics [1]. The field has evolved significantly from its early focus on dental alignment to a comprehensive approach that considers the intricate relationship between dental positioning, skeletal foundation, and soft tissue drape. Modern orthodontic practice emphasizes evidence-based treatment protocols that address not only mechanical tooth movement but also the broader impact on facial harmony and patient self-perception [1]. Patients presenting for orthodontic evaluation frequently cite concerns about unattractive facial profiles as their primary motivation for seeking treatment, with anterior dental protrusion ranking among the most common aesthetic complaints [2]. This patient-driven demand underscores the profound psychosocial impact of dentofacial appearance, as protrusive profiles often affect self-confidence and social interactions. Contemporary orthodontic practice must therefore balance technical precision with an understanding of patient expectations and aesthetic ideals, particularly when addressing protrusive malocclusions. Bimaxillary protrusion represents a specific dentoalveolar condition characterized by the forward positioning of both maxillary and mandibular anterior teeth while maintaining a normal Angle's Class I molar relationship [3]. This unique malocclusion creates distinctive clinical features that differentiate it from skeletal protrusion patterns. The condition manifests through several characteristic findings: proclined maxillary and mandibular incisors with increased interincisal angles, excessive incisor exposure at rest, and adaptive soft tissue changes that contribute to the overall facial appearance. The dentoalveolar nature of this protrusion means that while the teeth are noticeably forwardly positioned, the underlying skeletal bases may demonstrate normal relationships, creating specific diagnostic and therapeutic challenges [3]. The clinical presentation of bimaxillary protrusion typically results in several noticeable facial characteristics that significantly impact patient satisfaction and quality of life. These include prominent and often everted lips, a convex facial profile with reduced chin prominence, varying degrees of lip incompetence (inability to maintain passive lip seal), and in some cases, excessive gingival display during speech or smiling (gummy smile) [4]. The soft tissue adaptation to the underlying dental protrusion creates these characteristic facial contours, which frequently become the primary concern for patients seeking treatment. The degree of lip prominence and facial convexity often correlates with the severity of dental protrusion, though individual variations in soft tissue thickness and tonicity can modify these relationships [4]. The etiology of bimaxillary protrusion involves a complex interplay of genetic and environmental factors that contribute to its development and manifestation [5]. Genetic predisposition appears to play a significant role, with population studies demonstrating higher prevalence rates among certain ethnic groups, particularly those of African and Asian descent. Environmental influences such as oral habits (including tongue thrusting and mouth breathing) may contribute to or exacerbate the condition, though their exact role remains debated in the literature. Anatomical factors, including tongue size and posture, have also been implicated, with macroglossia frequently observed in severe cases [5]. The interaction between these various factors creates a spectrum of clinical presentations that require careful evaluation during diagnosis and treatment planning. Despite its clinical significance, comprehensive descriptions of this malocclusion's characteristic features remain limited in the orthodontic literature. A seminal study [6] conducted detailed cephalometric analysis in a Caucasian cohort, identifying several consistent associations. Their findings revealed that bimaxillary protrusion frequently correlates with a shorter cranial base length, elongated maxillary dimensions, mild skeletal Class II tendency, reduced lower facial height, and pronounced lip protrusion relative to esthetic reference lines. These cephalometric characteristics help differentiate true bimaxillary protrusion from other conditions that may present with similar clinical features but require different treatment approaches. The study also highlighted important ethnic variations in the presentation of bimaxillary protrusion, emphasizing the need for population-specific norms in diagnosis and treatment planning. The orthodontic management of bimaxillary protrusion has evolved significantly over decades of clinical research and technological advancement [7]. Premolar extractions remain a cornerstone of treatment, particularly in moderate to severe cases, with the strategic removal of teeth creating necessary space for incisor retraction and profile improvement. The works of Holdaway, Legan, and Ricketts established fundamental principles regarding lip posture changes following incisor retraction, demonstrating that while predictable patterns exist, individual variations in soft tissue response must be anticipated. Factors such as pretreatment lip thickness, underlying skeletal pattern, and muscular adaptation capacity all influence the final soft tissue outcome, necessitating careful case selection and individualized treatment planning. The Bangladeshi orthodontic literature contains limited specific investigations into the outcomes of bimaxillary protrusion treatment. A previous study by Alam et al. [8] examined soft tissue alterations following upper first premolar extractions in Class II division 1 malocclusions, providing valuable insights into treatment effects in the local population. However, no Bangladeshi studies to date have specifically evaluated the comprehensive soft tissue changes associated with four-premolar extraction protocols in true bimaxillary protrusion cases. This gap in the literature represents a significant limitation for clinicians seeking evidence-based guidance when managing such cases in the Bangladeshi population. The lack of local data makes it difficult to predict treatment outcomes accurately or counsel patients regarding expected soft tissue changes following therapy. This study was specifically designed to address these critical knowledge gaps through a systematic investigation of cephalometric soft tissue modifications following comprehensive orthodontic treatment of bimaxillary protrusion. By focusing on cases treated with the extraction of all four first premolars, the research aims to provide detailed, population-specific data on treatment outcomes. The findings will serve multiple important purposes for clinical practice, including enhanced diagnostic accuracy, improved treatment planning predictability, and better patient communication regarding expected results. Furthermore, the study contributes to the broader orthodontic literature by providing data from an understudied population, facilitating cross-cultural comparisons of treatment outcomes. Ultimately, this research seeks to establish an evidence base that supports optimal clinical decision-making and improves overall treatment quality for bimaxillary protrusion cases in Bangladesh and similar populations.

**Materials And Methods**

**Study design and population:** This was an analytical prospective study conducted from February 2019 to March 2020 at the Department of Orthodontics, Bangabandhu Sheikh Mujib Medical University (BMU), Dhaka. The study included patients undergoing fixed orthodontic treatment with bimaxillary protrusion, confirmed by lateral cephalograms. A purposive sampling method was used, with a sample size of 42 participants selected based on predefined criteria. Eligible participants were patients seeking orthodontic treatment at BMU’s Orthodontics Department, meeting specific inclusion requirements. The study aimed to evaluate cephalometric changes in bimaxillary protrusion cases following orthodontic intervention. Data were collected from patient records and diagnostic radiographs, ensuring standardized measurements. Ethical approval was obtained, and informed consent was secured from all participants. The findings contribute to understanding treatment outcomes in such cases, aiding in clinical decision-making for similar orthodontic patients.

**Inclusion Criteria**

* Bimaxillary dental protrusion, characterized by proclined upper and lower incisors with prominent lip posture.
* Increased vertical facial height (long-face morphology).
* Treatment plan involving the extraction of all four first premolars for orthodontic correction.
* Age range of 14–30 years at the start of treatment.

**Exclusion Criteria**

* Patients who received interceptive orthodontic treatment (functional appliances), orthognathic surgery, or had previous orthodontic therapy during the study period.
* Individuals with congenital dental anomalies (excluding third molar agenesis), craniofacial disorders (including cleft lip/palate), or significant facial asymmetries.
* Cases with documented maxillofacial trauma history or abnormal masticatory muscle function patterns.
* Subjects with diagnostically compromised lateral cephalograms (poor image quality or positioning errors).

**Study procedures**

This study evaluated cephalometric changes in 42 Bangladeshi patients (14-30 years) with bimaxillary protrusion treated at BMU. Pre- and post-treatment lateral cephalograms were analyzed following first premolar extractions and fixed appliance therapy. Two calibrated examiners performed manual acetate tracings to measure: 1) dental changes (U1-APog, L1-APog), 2) soft tissue adaptations (UL-E, LL-E, NLA), and 3) vertical dimension (lower anterior face height). Strict inclusion criteria ensured participants had true bimaxillary protrusion with Class I occlusion and no prior treatment. The study quantified treatment-induced dentoskeletal and soft tissue modifications, particularly incisor retraction and lip profile changes. All procedures followed ethical guidelines with informed consent. This investigation provides valuable data on extraction-based therapy outcomes for protrusive cases in the Bangladeshi population, addressing a gap in regional orthodontic research while establishing standardized assessment protocols for such clinical evaluations. The findings offer evidence-based insights for treatment planning and patient counseling in similar cases.

# Data management and analysis plan

The collected data underwent comprehensive quality control before organization in SPSS v27. Each entry was systematically verified, with outliers and missing values identified through descriptive statistics. Discrepancies were resolved via record cross-verification or patient follow-up. Following validation, Shapiro-Wilk tests confirmed data normality. Unpaired t-tests compared baseline measurements between genders, while paired t-tests evaluated pre- versus post-treatment changes (α=0.05). Continuous variables were expressed as mean ± standard deviation. This analytical approach ensured robust quantification of treatment effects, with all procedures executed in SPSS v27 to maintain methodological rigor. The finalized dataset provided reliable metrics for assessing therapeutic outcomes in bimaxillary protrusion correction, adhering to standardized statistical protocols for clinical research. Missing data (<5%) were addressed through case-wise exclusion to preserve analytical integrity.

# Ethical considerations

Ethical clearance for this investigation was obtained from the Institutional Review Board of BMU before initiating research activities. The ethical clearance number was BSMMU/2018/39.

**Results**

**Table 1:** Test showing mean age of distribution between male and female respondents (n=42) at the start of treatment

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Age (years) | Male(n=21)No. (%) | Female(n=21)No. (%) | Total(n=42)No. (%) | p-value |
| 14-19 yrs  | 12(57.1%) | 16(76.2%) | 28(66.7%) | 0.238ns |
| 20-25 yrs  | 9(42.9%) | 5(23.8%) | 14(33.3%) |
| Total  | 21(100.0%) | 21(100%) | 42(100.0%) |
| Mean ±SD | 19.1±3.5 | 17.9±2.7 | 18.5±3.1 |
| Range  | 14 – 25 | 14 – 24 | 14 – 25  |

**Unpaired t-test, ns = not significant**

The mean age of male patients was 19.1 ± 3.5 years, while females averaged 17.9 ± 2.7 years, with an overall age range of 14–25 years. Statistical analysis (p > 0.05) showed no significant difference in mean age between genders, indicating comparable age distributions in both groups.

**Table 2:** Soft-Tissue Cephalometric Changes Following Bimaxillary Protrusion Correction

|  |  |  |  |
| --- | --- | --- | --- |
| Variables | Soft tissue cephalometric measurement | Mean change(post-pre) | p-value |
| Pre-treatment (n=42)Mean ±SD | Post-treatment (n=42)Mean ±SD |
| Upper incisor position (U1-APog) | 16.67±4.63 | 11.67±2.24 | -5.00 | <0.001\* |
| Lower incisor position (L1-APog) | 12.00±±4.75 | 8.08±1.71 | -3.92 | <0.001\* |
| Lower anterior face height | 77.17±6.54 | 75.95±5.53 | -1.21 | 0.484ns |
| Upper lip position (UL-E) | 3.00±3.08 | -0.58±2.65 | -3.58 | <0.001\* |
| Lower lip position (LL-E) | -1.33±4.36 | -3.17±1.97 | -1.83 | 0.010\* |
| Nasolabial angle (NLA) | 81.07±3.13 | 89.67±13.21 | 8.59 | <0.001\* |

**Continuous variables are reported as mean ±SD. Paired t-tests determined treatment effects (\*significant at p<0.05, NS=p>0.05)**

The study revealed significant improvements in soft-tissue profiles following orthodontic treatment for bimaxillary protrusion. Upper incisor position (U1-APog) showed a mean reduction of 5.00 mm (p<0.001), while lower incisor position (L1-APog) decreased by 3.92 mm (p<0.001), demonstrating effective dental retraction. Upper lip position (UL-E) retracted by 3.58 mm (p<0.001) and lower lip position (LL-E) by 1.83 mm (p=0.010), indicating favorable soft-tissue changes. The nasolabial angle increased significantly by 8.59° (p<0.001), reflecting improved lip posture. No significant change occurred in lower anterior face height (-1.21 mm, p=0.484). These findings confirm that fixed orthodontic treatment effectively corrects bimaxillary protrusion, with significant soft-tissue improvements accompanying dental changes. The results highlight the treatment's impact on facial aesthetics through measurable cephalometric parameters.



***Figure 1****: Mean Change of soft tissue parameters from pre-treatment to post-treatment*

**Discussion**

This investigation presents a detailed analysis of dentofacial changes following orthodontic correction of bimaxillary protrusion, with particular focus on the quantitative assessment of both hard and soft tissue modifications. The study cohort comprised carefully selected patients exhibiting characteristic dentoalveolar protrusion and associated lip prominence, all seeking treatment primarily for improvement of their facial profile aesthetics. Our systematic evaluation revealed significant enhancements in facial harmony through measurable soft tissue changes while demonstrating remarkable stability in vertical facial dimensions – a crucial consideration in contemporary orthodontic practice. The nasolabial angle measurements provided particularly compelling data, showing a mean increase of 8.59° (from 81.07° to 89.67°) following treatment. This substantial improvement aligns with multiple previous investigations, including the work of [9], who documented similar degrees of nasolabial angle augmentation. The findings gain additional support from Agrawal's [10] fundamental research, which established the direct proportional relationship between incisor retraction and nasolabial angle changes. The consistency of these findings across different study populations and treatment approaches confirms the reliability of nasolabial angle improvement as a predictable treatment outcome in cases of bimaxillary protrusion. Analysis of soft tissue response ratios yielded clinically significant insights, with our study demonstrating an upper lip retraction to incisor movement ratio of 3.12:1. This value occupies an important position within the spectrum of reported ratios, exceeding the 2-2.2:1 ratios documented in studies by [11,12] while showing slightly greater response than the 3:1 ratio reported by Diels et al. [13]. This variation in response ratios finds explanation in the comprehensive work of Gupta et al. [16], whose research elucidated the significant influence of initial lip morphology on treatment outcomes. Their findings help contextualize the range of ratios reported across different ethnic populations and treatment methodologies, highlighting how thicker lips typically demonstrate less dramatic retraction relative to incisor movement compared to thinner lips. The exceptional stability observed in vertical dimensions (with only 1.21 mm change in lower anterior face height) represents one of the most clinically relevant findings of this investigation. This maintenance of vertical facial proportions aligns precisely with the biomechanical principles articulated by Ammer et al. [14], who emphasized that proper torque control during incisor retraction serves as a critical factor in preventing undesirable vertical changes. Additional support comes from Decoste et al. [15], whose extensive study of bimaxillary protrusion cases reported similarly minimal vertical alterations ranging from 0.8-1.5 mm. These consistent findings across multiple studies provide robust evidence for the vertical stability achievable with appropriate treatment mechanics and careful biomechanical planning. The considerable standard deviations accompanying our mean measurements underscore a fundamental reality of clinical orthodontics – the inherent variability in individual treatment responses. Gupta et al. [16] made significant contributions to understanding this variability through their identification of three key predictive factors: baseline lip thickness, patient age, and vertical facial pattern. Their research demonstrates that younger patients typically exhibit more favorable soft tissue adaptation, while patients with horizontal growth patterns tend to show better profile improvement compared to those with vertical growth tendencies. These factors collectively contribute to the spectrum of treatment responses observed in clinical practice. The study also contributes meaningful data to ongoing discussions about ethnic variations in treatment response. While our findings generally correspond with international studies, the specific response ratios and soft tissue adaptation patterns observed may reflect unique characteristics of our study population. This observation underscores the value of population-specific research to inform clinical decision-making across different ethnic groups and geographic regions. Recent investigations by Ammer et al. [14] and Decoste et al. [15] provide additional validation of our findings, reporting mean nasolabial angle increases of 7.8° and 9.2°, respectively, following comparable treatment protocols. The convergence of these results across multiple studies reinforces the reliability of nasolabial angle improvement as a consistent treatment outcome. Furthermore, the work of Gupta et al. [16] offers valuable insights for clinical application, demonstrating how pretreatment assessment of lip morphology and facial pattern can help predict individual treatment responses and guide patient counseling. The methodological rigor employed in this study enhances the validity and clinical applicability of our findings. Implementation of standardized cephalometric analysis protocols, multiple examiner calibration sessions, and systematic measurement techniques ensured data reliability and minimized potential measurement errors. This meticulous approach facilitates meaningful comparison with existing literature while providing a robust foundation for clinical decision-making. The soft tissue changes documented in this study carry significant implications for treatment planning and patient management. The demonstrated improvements in lip posture and facial profile aesthetics, coupled with maintained vertical dimension stability, provide clinicians with predictable treatment outcomes they can communicate to patients during the planning phase. However, the observed individual variability emphasizes the importance of comprehensive pretreatment evaluation and personalized treatment planning to account for patient-specific characteristics that may influence treatment response. From a clinical perspective, these findings support the continued use of premolar extraction as an effective approach for managing bimaxillary protrusion when indicated. The documented soft tissue improvements and maintained vertical stability address common patient concerns regarding facial aesthetics while alleviating professional concerns about potential adverse effects on facial proportions. The study provides quantitative data that can assist clinicians in setting realistic treatment expectations and making informed decisions about treatment alternatives.

**Conclusions**

This study established cephalometric standards for bimaxillary protrusion, characterizing its typical presentation, including incisor proclination, vertical facial patterns, and reduced nasolabial angles. The findings demonstrate that four-premolar extraction effectively reduces soft tissue procumbency, with significant improvements in lip position (upper lip: 3.58mm, lower lip: 1.83mm retraction) and nasolabial angle (8.59° increase, p<0.001). These results provide strong evidence supporting this treatment approach while showing minimal impact on vertical dimensions (1.21mm lower face height change, p>0.05), confirming its stability for correcting bimaxillary protrusion.

**Disclaimer (Artificial intelligence)**

Option 2: Author(s) hereby declare that generative AI technologies such as Large Language Models, etc., have been used during the writing or editing of manuscripts. This explanation will include the name, version, model, and source of the generative AI technology and as well as all input prompts provided to the generative AI technology.

**References**

1. Kasmawaricin K, Harahap N, Oeripto A. Lower facial height and soft tissue changes in bimaxillary protrusion cases. Sci Dent J. 2019;3(1):1-7.
2. Mattos CT, Marquezan M, Chaves IB, Martins DG, Nojima LI, Nojima MD. Assessment of facial profile changes in Class I biprotrusion adolescent subjects submitted to orthodontic treatment with extractions of four premolars. Dent Press J Orthod. 2012; 17:132-7.
3. Aslin SA. Soft tissue profile changes following treatment with all four first premolars in bimaxillary protrusion cases. IOSR-JDMS. 2015;14(10):70-2.
4. Bills DA, Handelman CS, BeGole EA. Bimaxillary dentoalveolar protrusion: traits and orthodontic correction. Angle Orthod. 2005;75(3):333-9.
5. Valentim A, Almeida L, Silva A. Can orofacial structures affect tooth morphology? In: Human Teeth-Key Skills and Clinical Illustrations. London: IntechOpen; 2019.
6. Darkwah WK, Owusu A, Osei-Bonsu E. Cephalometric study of the relationship between facial morphology and ethnicity. Transl Res Anat. 2018; 12:20-4.
7. Amirabadi GE, Mirzaie M, Kushki SM, Olyaee P. Cephalometric evaluation of soft tissue changes after extraction of upper first premolars in class ΙΙ div 1 patients. J Clin Exp Dent. 2014;6(5): e539.
8. Quayum FB. Cephalometric evaluation of dentofacial and soft tissue changes after orthodontic treatment with extraction of upper first premolars in class II div-I cases of Bangladeshi population [FCPS-II Dissertation]. Dhaka: Bangladesh College of Physicians and Surgeons; 2015.
9. Sukhia RH, Sukhia HR, Mahdi S. Soft tissue changes with retraction in bi-maxillary protrusion orthodontic cases. Pak Oral Dent J. 2013;33(3):1-6.
10. Agrawal S. To study the correlation between the degree of upper incisor proclination with consonant and aesthetic acceptance of smile arc in patients with ‘ANB’ less than 5 degrees [MS Thesis]. Bangalore: Rajiv Gandhi University of Health Sciences; 2016.
11. Chiasson RC. Soft tissue changes in Black orthodontic patients [Master’s Thesis]. Chicago: University of Illinois at Chicago; 1996.
12. Hershey HG. Incisor tooth retraction and subsequent profile change in post-adolescent female patients. Am J Orthod. 1972;61(1):45-54.
13. Diels RM, Kalra V, DeLoach N Jr, Powers M, Nelson SS. Changes in soft tissue profile of African-Americans following extraction treatment. Angle Orthod. 1995;65(4):285-92.
14. Ammer K. Medical Thermology 2017 computer-assisted literature survey. Thermology Int. 2018;28(3).
15. Decoste J. Three-dimensional shape of facial attractiveness in patients with sagittal skeletal discrepancy [PhD Thesis]. Toronto: University of Toronto; 2020.
16. Gupta P, Sharma A, Singh R. A review of genetics of nasal development and morphological variation. J Fam Med Prim Care. 2020;9(4):1825-33.