Research Article

# Premolar Extraction's Impact on Vertical Dimension, Cervical Posture in Class-II High-angle Cases: A Cephalometric Analysis

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## ABSTRACT

**Introduction:** Extraction of premolars is frequently selected as an alternative to creating space for correcting tooth material and arch length discrepancies. The decision to extract premolars in orthodontic practice is primarily influenced by the desire to control or influence the vertical facial dimension and mandibular plane.

**Objective:** The objective is to establish a correlation between changes in the vertical dimension and concurrent adjustments in lower neck posture following orthodontic treatment involving premolar extractions in Class II high-angle malocclusions.

**Materials and Method:** A retrospective cephalometric study was conducted with 52 patients aged between 16±10 years. Pre- and post-treatment lateral cephalograms were examined from patients with a Frankfort-Mandibular Angle (FMA) of 27-30 degrees, Point A-Nasion-point B (ANB) angle of 4-5 degrees, and presenting with proclined upper and lower incisors. All patients had undergone extraction of their first premolars. Cephalometric analysis was conducted to evaluate changes in vertical dimension and neck posture.

**Result:** Paired t-tests were utilized to evaluate pre- and post-treatment modifications in cephalograms. Linear measurements of posterior facial height, anterior facial height, and Jarabak's ratio showed changes of 0.35 mm, 1.61 mm, and 0.4, respectively. Angular measurements, including Sella-Nasion to Gonion-Gnathion (SN-GoGn), Frankfort-Mandibular Angle (FMA), and Occlusion plane to Frankfurt Horizontal plane (OP-FH), demonstrated changes of 0.53 degrees, 0.64 degrees, and 0.88 degrees, respectively. Furthermore, alterations of 0.08 degrees and 0.16 degrees were noted in the lower cervical vertebrae tangent to the palatal plane (CVT-PP) and cervical vertebrae tangent to the mandibular plane (CVT-MP), respectively.

**Conclusion:** Orthodontic treatment for skeletal Class II malocclusions with increased mandibular divergence, via premolar extraction, significantly affects the vertical dimension without impacting lower neck posture.

**Keywords:** Bicuspid; cervical vertebrae; malocclusion; posture; retrospective studies; vertical dimension.

## INTRODUCTION

According to Angle's classification, Class II malocclusion occurs when the lower first permanent molar is distally positioned relative to the upper first permanent molar by at least half a cusp width. This malocclusion can result from a prognathic maxilla, retrognathic mandible, or a combination of both, often accompanied by various jaw rotations such as upward or downward divergence of the mandible.[1]

Both skeletal Class II malocclusion and cervical-vertebral anatomy are interconnected components of the craniofacial structure. There is significant discourse within orthodontics regarding the observation of increased extension of cervical vertebrae in children with Class II malocclusion.[2,3]

Orthodontic treatments typically involve mechanisms that induce extrusion and aim to alter the position of the mandible and its related structures. However, existing research presents inconsistent findings regarding the effects of premolar extraction on the vertical dimension of the face and mandibular divergences. Furthermore, no studies have investigated the correlation between premolar extractions and the vertical dimension of the face in conjunction with associated neck posture alterations in Class II skeletal discrepancies.[4]

This study aims to explore the relationship between premolar extraction-induced changes in the vertical dimension and associated lower neck posture adjustments in cases of Class II malocclusion with high angulation.

## MATERIAL AND METHODS

This retrospective comparative study was conducted at the Department of Orthodontics and Dentofacial Orthopedics, College of Medical Sciences, Bharatpur, Chitwan, Nepal. The study spanned two months.

Ethical approval was secured from the Institutional Review Committee (IRC) of the College of Medical Sciences-Teaching Hospital, affiliated with Kathmandu University and accredited by the Nepal Medical Council, under reference number COMSTH-IRC/2023-06-1.

Patients' eligibility was determined consecutively based on specific criteria. These included the requirement of pretreatment and post-treatment lateral cephalograms from patients aged 16±10 years, exhibiting a Skeletal Class II jaw relation with point A-Nasion-point B (ANB) angle of 4-5 degrees, hyper-divergent (Frankfurt mandibular plane angle (FMA) of 27-30 degrees), and presenting with proclined upper and lower incisors (bidental protrusion) necessitating the extraction of all first premolars. Additionally, patients with morphological developmental anomalies such as peg lateral, supernumerary teeth, mesiodens, or retained deciduous teeth were excluded. Growing children in need of myofunctional therapy, those with severe skeletal discrepancies (ANB angle greater than 6 degrees) necessitating orthognathic surgery, and patients with a history of previous orthodontic treatment or premolar extraction were also excluded from this study.

**Sample size calculation:** The sample size was determined using the formula N = Z^2 * SD^2 / d^2, where Z represents the standard normal Z value for a significance level (1.96), SD denotes the standard deviation (taken from the facial axis angle, which is 3.68), and d represents the absolute error (set at 1). Thus, the calculation yielded a sample size of approximately 52.

**Cephalometry:** Pretreatment and post-treatment cephalograms of patients exhibiting a Class II skeletal base and vertical growth pattern, who underwent extraction of all first premolars, were included. All cephalograms were manually traced onto acetate tracing paper and meticulously aligned with radiographs. Radiograph magnification was adjusted and calibrated based on the magnification factor. The traced lateral cephalograms were then analyzed to assess changes in vertical dimension and lower neck posture following premolar extraction in skeletal Class II cases. The same investigator conducted the cephalometric readings twice to ensure consistency. (Figure 1, Figure 2 and Figure 3)

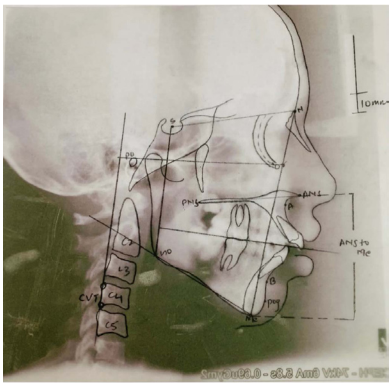

**Fig. 1** Cephalometric tracing of the pre-treatment cephalogram.

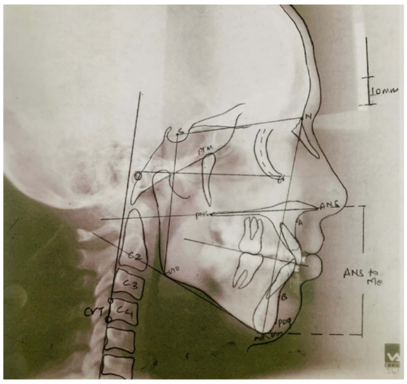

**Fig.2** Cephalometric tracing of the post-treatment cephalogram.

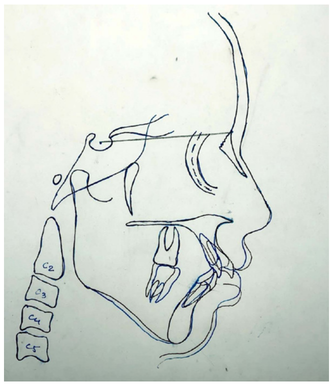

**Fig.3** Superimposition of pre-treatment and post-treatment cephalogram.

**Data analysis:** The data were inputted into a Microsoft Excel spreadsheet and analyzed using SPSS for Windows (Statistical Presentation System Software, SPSS Inc.) version 20.0. Continuous data were presented as mean and standard deviation. Paired t-tests were employed for appropriate comparisons.

## RESULT

A total of 52 patients, with a mean age of 16±10 years, were included in the study. Table 1 presents the cephalometric variable changes following premolar extraction and orthodontic treatment in Class II vertical growers. Post-treatment variables exhibited significant changes in posterior facial height, anterior facial height, Jarabak's ratio (the ratio of posterior facial height to anterior facial height), Sella-Nasion to Gonion-Gnathion plane, Frankfurt plane to mandibular plane, occlusal plane to mandibular plane, Cervical Vertebrae Tangent (CVT) to Palatal plane, and CVT to mandibular plane.

Linear measurements such as posterior facial height and anterior facial height significantly increased from

75.65±6.08mm to 76.0±5.17mm and 135.0±7.65 mm to 136.61±4.8 mm, respectively, following orthodontic treatment. Additionally, Jarabak's ratio significantly decreased from 56.03±6.5% to 55.63±3.2%, and lower anterior facial height significantly increased from 68.95±5.5 mm to 70.88±6.54 mm post-treatment. Angular measurements including SN-GoGn (Sella Nasion to Gonion Gnathion), Mandibular plane to Frankfurt horizontal (FH) plane angle, and occlusal plane to FH plane angle significantly increased from 35.65±2.25 degrees to 36.18±2.09 degrees, 30.46±1.75 degrees to 31.10±1.72 degrees and 17.78±1.20 degrees to 18.66±1.15 degrees, respectively, pre and post orthodontic treatment. However, Cervical Vertebrae Tangent to Palatal Plane(CVT-PP) and Cervical Vertebrae Tangent to Mandibular Plane (CVT-MP) showed non-significant angular changes from 98.98±1.83 degrees to 98.90±1.61 degrees and 80.04±1.76 degrees to 80.20±1.67 degrees. The alterations in linear and angular parameters of the vertical dimension were clinically significant, whereas changes in cervical vertebrae position were not statistically significant.

**Table 1: Comparison of variables assessing pre- and post-treatment changes in Class II high-angle cases following premolar extractions.**

| Variables | Pre-treatment (T1) N=52 | | Post-treatment (T2) N=52 | | Mean Difference | P value |
|---|---|---|---|---|---|---|
| | Mean | Standard Deviation | Mean | Standard Deviation | | |
| Posterior facial height(mm) | 75.65 | 6.08 | 76.0 | 5.17 | 0.35 | <0.005 |
| Anterior facial height(mm) | 135.0 | 7.65 | 136.61 | 4.8 | 1.61 | <0.005 |
| Jarabak's ratio (Posterior facial height/anterior facial height)(%) | 56.03 | 6.5 | 55.63 | 3.2 | 0.4 | <0.005 |
| Lower anterior facial height (Menton to ANS) (mm) | 68.95 | 5.5 | 70.88 | 6.54 | 1.93 | <0.005 |
| SellaNasion – GonionGnathion(degree) | 35.65 | 2.25 | 36.18 | 2.09 | 0.53 | <0.005 |
| Mandibular plane to frankfurt horizontal plane angle (degree) | 30.46 | 1.75 | 31.10 | 1.72 | 0.64 | <0.005 |
| Occlusal plane to frankfurt horizontal plane angle(degree) | 17.78 | 1.20 | 18.66 | 1.15 | 0.88 | <0.005 |
| Angle between CVT and PP(degree) | 98.98 | 1.83 | 98.90 | 1.61 | 0.08 | 0.14 |
| Angle between CVT and MP(degree) | 80.04 | 1.76 | 80.20 | 1.67 | 0.16 | 0.19 |

Abbreviation: ANS: Anterior Nasal Spine, CVT: Cervical Vertebrae Tangent, PP: Palatal Plane, MP: Mandibular Plane.

## DISCUSSION

According to etiology, Class II malocclusion can be managed through growth modification, orthodontic camouflage, or orthognathic surgery. Mild to moderate cases can be addressed with camouflage techniques such as distalization or premolar extraction. Extraction of premolars has become a common practice in orthodontics, often chosen to address issues such as tooth and arch length discrepancies, proclined incisors, mild to moderate jaw discrepancies, management of partial malocclusions involving impacted canines, and anterior open bites.[5,6] In Class II cases, premolar extraction is typically performed to correct overjet, retract incisors, and alter the soft tissue profile.

The decision to extract premolars in orthodontic practice is primarily influenced by the desire to control or impact the vertical facial dimension and mandibular plane.[7,8] Despite premolar extraction being a common procedure in orthodontics, its effect on the vertical dimension remains a topic of debate. Some studies have suggested that in cases where premolars are extracted, there may be a tendency for the posterior teeth to migrate forward, resulting in mandibular overclosure and a reduction in vertical dimension.[9] Additionally, there are concerns raised by studies regarding the effect of premolar extraction followed by retraction on the position of the mandible and condyle, potentially causing posterior displacement and alterations in tongue space and upper pharyngeal airway dimensions.[10] Class II skeletal discrepancies can be associated with various facial divergences, such as upward or downward jaw rotation.[11] Considering the lower anterior facial height and facial divergence, both treatment planning, such as extraction or non-extraction, and biomechanics are adjusted accordingly. Orthodontic mechanisms typically involve extrusion, aimed at opening the bite by extruding posterior teeth to open the mandibular axis. This approach is beneficial in cases with a flat mandibular plane angle but may lead to downward and backward rotation of the mandible in high-angle cases, potentially exacerbating open bite issues and affecting aesthetics.

This study evaluated the effects of premolar extraction on vertical dimension and lower neck posture in 52 adolescent Class II hyperdivergent cases through cephalometric analysis. Premolar extraction in Class II hyperdivergent cases is typically performed to control the vertical dimension of the face. The tendency of bite closure associated with premolar extractions is attributed to the protraction of posterior teeth into extraction sites, which may enable counterclockwise mandibular rotation, thereby reducing the "wedge effect."[12]

This study demonstrated an increase in all vertical parameters following the extraction of all four premolars in Class II patients. Contrary to the theory proposed by several authors suggesting a loss in the vertical dimension of occlusion after the extraction of first premolars,[13,14] our findings did not support this notion. Specifically, the SN-GoGn, Frankfurt Mandibular plane angle, and the ratio of posterior facial height to anterior facial height all showed increased values in post-extraction Class II cases.These results diverge from a study by Porto et al., who reported a statistically significant decrease in the SN-GoGn angle in the extraction group compared to an increase in the non-extraction group.[15]

This study revealed a significant increase in lower anterior facial height and total anterior facial height. The observed slight clockwise rotation of the mandible resulted in a steeper mandibular plane and inferior positioning of the Menton, contributing to the augmentation of lower anterior and total anterior facial height.[16,17] Another contributing factor may be the biomechanics employed for space closure and anterior retraction. Class II mechanics typically involve extrusion, leading to the opening of the mandibular axis, as suggested by various authors.[18,19] Additionally, Dwivedi *et al.*[20] also reported a significant increase in the mandibular plane angle post-extraction treatment in subjects with a hyperdivergent growth pattern.

This study also aimed to assess the associated alterations in lower neck posture alongside changes in vertical dimension in Class II high-angle cases following the extraction of all first premolars. The relationship between the mandible and cervical spine is governed by a chain of muscles, and neck posture is influenced by the musculoskeletal system, growth patterns, and mandibular divergence.[21] Moreover, orthodontic interventions, such as removable appliances, splints to increase vertical dimension, and the use of anterior repositioning devices in skeletal Class II cases, can impact the position of cervical vertebrae.[22]

Vertical growers typically exhibit weaker muscle attachments, reduced cross-sectional area of muscles, and diminished bite force.[23] Additionally, the extrusive mechanics employed in orthodontic treatment can influence the vertical position of the mandible and subsequently affect the cervical spine.

Although changes in vertical dimension were observed in post-extraction cephalograms, no alterations were noted in lower neck posture. While neck posture changes have been documented in the literature following functional appliance therapy,[24] no studies have yet investigated the comparison between premolar extraction and its effects on neck posture.

## CONCLUSION

Skeletal Class II high-angle cases exhibited a notable increase in vertical dimension following orthodontic management involving premolar extraction, with no significant impact observed on lower neck posture. Further research is warranted to compare the effects of extraction on neck posture, comparing with a control group and other skeletal patterns.

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