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Case report

Optimizing frictionless space closure in bimaxillary dentoalveolar protrusion with Opus loop mechanics: A case report

Poonam Bharat Ghodke*[1], Atul Singh[1], Ankit Chaudhari[1], Joggeswar Kundu[1], Rashmi Singh[1]

[1]Dept. of Orthodontics and Dentofacial Orthopedics, KD Dental College and Hospital, Mathura, Uttar Pradesh, India

Abstract

Bimaxillary dentoalveolar protrusion is a common malocclusion marked by forward positioning and proclination of anterior teeth in both arches. It often results in lip incompetence, a convex facial profile, and compromised soft tissue balance. Management typically involves premolar extractions to enable significant anterior tooth retraction.

This case report presents the successful orthodontic treatment of a 14-year-old male with Class I bimaxillary dentoalveolar protrusion, using frictionless biomechanics. Following the extraction of all four first premolars, space closure was achieved with titanium molybdenum alloy Opus loops.

The patient initially showed proclined incisors (U1 to NA: 28°, L1 to NB: 36°), lip strain, and a convex profile. Treatment aimed to correct incisor proclination, midline deviation, and crowding, while maintaining occlusal relationships and enhancing facial appearance. Levelling and alignment were done with sequential archwires in MBT 0.022” × 0.028” prescription. Anchorage was reinforced using a Nance palatal arch and lingual holding arch.

Opus loops, fabricated from 0.017” × 0.025” TMA, were activated initially by 5.5 mm. The high moment-to-force ratio (8:1–9:1) for efficient en-masse retraction with minimal tipping and controlled bodily movement preserving Class I molar and canine relationships and improving facial aesthetics. Treatment concluded in 14 months.

Post-treatment cephalometrics showed improved incisor angulations (U1-NA: 20°, L1-NB: 25°). Soft tissue enhancements included a nasolabial angle increase and reductions in upper and lower lip protrusion by 2 mm and 4 mm, respectively (Rickett’s E-line).

The case highlights the clinical effectiveness of Opus loops as a precise and efficient tool in contemporary orthodontic biomechanics.

Keywords: Opus loop, Orthodontic premolar extraction, Bimaxillary protrusion, Frictionless mechanics, Orthodontic space closure, Orthodontic Biomechanics

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1. Introduction

Bimaxillary dentoalveolar protrusion is a prevalent dentofacial anomaly characterized by the excessive proclination and anterior positioning of both maxillary and mandibular dentoalveolar structures. Clinically, this condition often presents with lip incompetence, increased incisor display and suboptimal facial esthetics. The orthodontic correction of such cases typically involves extraction of premolars followed by precise space closure to achieve significant incisor retraction, improved soft tissue balance, and functional occlusion.[1,2]

A pivotal decision in space closure mechanics is the choice between friction and frictionless systems. In friction mechanics, space closure is achieved by sliding the archwire through the bracket slots and tubes, where frictional resistance at the bracket-wire interface can impede tooth movement, necessitating higher forces that may risk unwanted rotations and tipping. Conversely, frictionless mechanics, as exemplified by loop mechanics, eliminate this resistance by utilizing loops or springs integrated into the archwire. These loops deliver controlled, continuous forces and moments without the need for wire sliding, thereby enhancing biomechanical efficiency and anchorage control.[3–5]

Among various loop designs, the Opus loop has emerged as a particularly versatile and effective configuration. Its unique geometry and capacity for precise adjustment of moment-to-force ratios through selective loop activation make it especially suitable for cases requiring significant

*Corresponding author: Poonam Bharat Ghodke
Email: poonamghodake22741@gmail.com

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anterior retraction without undesirable posterior movement. The Opus loop permits differential force application, promoting bodily tooth movement while minimizing adverse tipping effects.[2,6]

This case report presents the clinical application of Opus loop mechanics for orthodontic space closure in a patient with bimaxillary dentoalveolar protrusion. It highlights the biomechanical principles underpinning frictionless mechanics, discusses loop design parameters, and evaluates treatment outcomes—reinforcing the utility of loop-based strategies in modern orthodontic practice.[7,8]

2. Case Report

A 14-year-old male patient came to the department of orthodontics with the chief complaint of protruding upper and lower anterior teeth. He had no significant medical or dental history. On pre-treatment extraoral examination he showed a convex profile with mentalis strain and potentially competent lips. He had average nasolabial angle and had shallow mentolabial sulcus. His lower lip was more protuberant than the upper lip. **(Figure 1)** On pre-treatment intraoral examination he had 2 mm overjet and 2 mm overbite with proclined maxillary and mandibular anteriors. His maxilla and mandible were U-shaped with molars and canines in Class I relationship on both right and left sides. According to the London Space Analysis, there was 2 mm of dental crowding in the maxilla and 1 mm in the mandible. The mandibular midline was shifted to right side by 2 mm. **(Figure 2)** The panoramic radiograph showed that all the teeth were present. Cephalometric analysis showed Class I skeletal pattern. Patient had normodivergent (average) growth pattern according to, Sn-GoGn, Jarabak Ratio and MPA with normal lower anterior facial height (Table 1). Maxillary incisors were proclined according to UI-NA by, 6 mm and 6°. Mandibular incisors were proclined according to LI-NB by, 7 mm and 11° (Steiner's Analysis). **(Figure 3)**

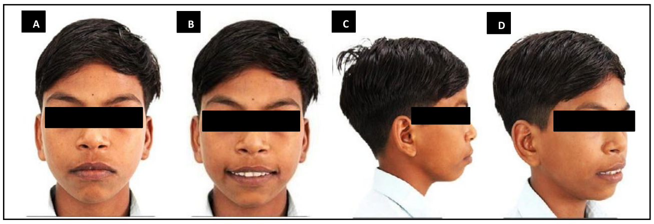

Figure 1: Pre-treatment extraoral photographs. (A) Frontal at rest (B) Frontal at smile (C) Profile view (D) 45° view

Figure 2: Pre-treatment intraoral photographs (A) Right buccal view (B) Frontal view (C) Left buccal view (D) Maxillary occlusal view (E) Mandibular occlusal view

Figure 3: Pre-treatment radiographs. (A) Lateral cephalogram (B) Orthopantomogram

Table 1: Cephalometric analysis values

Parameters	Normal range	Pre-treatment values	Post-treatment values
Skeletal parameters			
SNA	82° ± 2°	84°	82°
SNB	80° ± 2°	81°	80°
ANB	2°	3°	2°
Wits Appraisal	– 2 to 4 mm	– 4 mm	–2 mm
Sn-GoGn	27-36°	30°	30°
Mandibular Plane Angle	17° – 28°	24°	24°
Jarabak Ratio	62–65%	64%	65%
LAFH	57–58 mm	58 mm	57 mm
Dental parameters			
Upper Incisor-NA (Angle)	22°	28°	20°
Upper Incisor–NA (Linear)	4 mm	10 mm	5 mm
Lower Incisor -NB (Angle)	25°	36°	25°
Lower Incisor-NB (Linear)	4 mm	11 mm	5 mm
Upper Incisor -SN plane	102° ± 2°	113°	103°
IMPA	90° ± 5°	105°	93°
Soft tissue parameters			
Nasolabial Angle	90° – 110°	90°	110°
Upper Lip-S line	0 mm	6 mm	3 mm
Lower Lip-S line	0 mm	7 mm	4 mm
Upper Lip-E line	– 4 mm	3 mm	1 mm
Lower Lip-E line	– 2 mm	6 mm	2 mm

2.1. Treatment objectives

1. To correct crowding in upper arch .
2. To correct proclination of incisors in upper and lower arches while maintaining Class I molar and canine relation on both the sides.
3. To correct dental midline shift in lower arch.
4. To maintain normal overjet and overbite.
5. To improve protrusive facial aesthetics and protrusive lip posture.

2.2. Treatment plan

The treatment plan to achieve the established objectives is as follows:

After the extraction of the first premolars in all four quadrants decrowding, levelling and alignment of the maxillary and mandibular arches were planned. This was followed by the retraction of the maxillary and mandibular anterior teeth, along with the protraction of the maxillary and mandibular molars, using moderate anchorage (Group B anchorage). The aim was to reduce anterior proclination. For the retraction phase, frictionless loop mechanics, continuous Opus Loop was employed to achieve controlled and efficient space closure.

2.3. Treatment progress

Maxillary and mandibular first premolars were extracted from all the four quadrants. All the teeth were banded and bonded with Mclaughlin Bennet and Trevisi (MBT) 0.022 × 0.028-inch slot pre-adjusted edgewise bracket prescription in the upper and lower arches. Due to the presence of dental fluorosis, enamel etching was performed using 37% phosphoric acid for 60–90 seconds to ensure optimal bonding. The Nance palatal arch and lingual holding arch were used as anchorage reinforcements during the initial phase of treatment, primarily to maintain molar position during levelling, aligning, and early decrowding. The archwires were cinched distal to the last banded molar to prevent proclination of the maxillary and mandibular anterior teeth.

After five months of levelling, aligning, and decrowding, and once sufficient alignment had been achieved with sequential arch wires in both arches, the Nance palatal arch and lingual holding arch were removed, as the anterior segment was ready for retraction using frictionless mechanics.

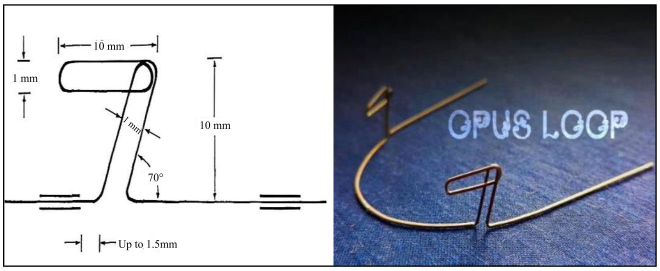

Figure 4: Opus loop

Maxillary and mandibular anterior teeth were then retracted using a continuous Opus loop, which was fabricated with 0.017 × 0.025-inch titanium molybdenum alloy (TMA) wire. **(Figure 4)** The loop was activated by 5.5 mm, generating a force of 200 g per side, and was secured with ligation into each bracket slot, extending through the molar tubes. **(Figure 5)**

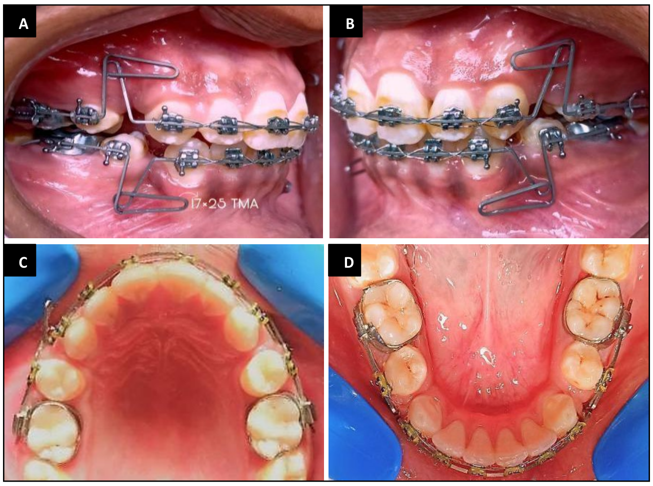

Figure 5: Mid-treatment photographs with opus loop in maxilla and mandible (A) Right buccal view (B) Left buccal view (C) Maxillary occlusal view (D) Mandibular occlusal view

After sequential activation over approximately eight months, anterior segment retraction and posterior segment protraction were achieved in both the upper and lower arches using the continuous Opus loop, and the extraction spaces were successfully closed.

The patient's primary concern was aesthetic correction; however, comprehensive treatment planning revealed the need for root alignment of several teeth. This requirement was discussed with and clearly communicated to the patient. Due to time constraints and personal commitments, the patient was unable to proceed with the complete treatment plan. Consequently, occlusal settling was achieved using 2oz vertical elastics, while root correction was not performed. The treatment outcomes obtained up to this stage are presented in the Results section.

Fixed orthodontic treatment was completed after 14 months, achieving normal overjet, overbite and a Class I molar and canine relationship. Hawley's retainers were provided in both the maxillary and mandibular arches for retention.

2.4. Treatment results

After 14 months of fixed orthodontic treatment, the patient exhibited remarkable improvements in both facial aesthetics and smile harmony. Post-treatment extraoral photographs demonstrated enhanced lip competency and a noticeable reduction in facial convexity. **(Figure 6)** The protrusion of the maxillary and mandibular anterior teeth was effectively corrected using the continuous Opus loop mechanics, while successfully maintaining a Class I molar and canine relationship with ideal overjet and overbite. **(Figure 7)**

Cephalometric analysis following treatment **(Table 1)** and superimpositions confirmed significant improvements in the inclination of the maxillary and mandibular incisors, contributing to the overall enhancement of facial balance and dental function. **(Figure 8)** and **(Figure 9)**

Figure 6: Post-treatment extraoral photographs (A) Frontal at rest (B) Frontal at smile (C) Profile view (D) 45° view

Figure 7: Post-treatment intraoral photographs (A) Right buccal view (B) Frontal view (C) Left buccal view (D) Maxillary occlusal view (E) Mandibular occlusal view

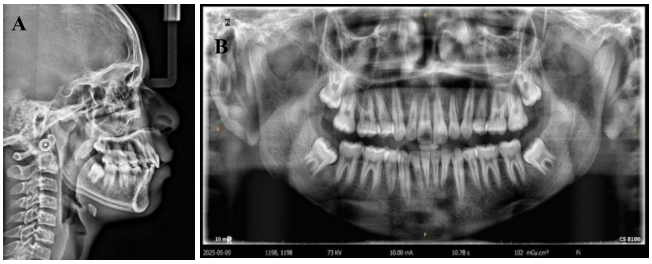

Figure 8: Post-treatment radiographs (A) Lateral cephalogram (B) Orthopantomogram

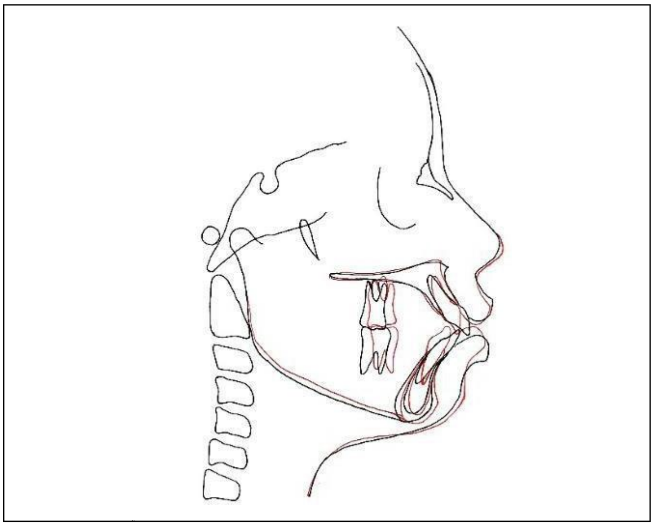

Figure 9: Cephalometric superimposition

3. Discussion

Managing bimaxillary protrusion necessitates a thorough evaluation of both dental alignment and skeletal structure. Identifying the root cause is essential before initiating treatment. When the jaws are positioned excessively forward in relation to the cranial base, achieving desirable facial outcomes may require a combination of orthodontic therapy and orthognathic surgery. However, in Class I malocclusions where the protrusion is primarily dentoalveolar, non-surgical orthodontic treatment is often sufficient.

This condition is frequently observed across multiple ethnicities, with a higher prevalence among individuals of Asian descent and African-American populations. It is typically marked by significant anterior tooth proclination in both upper and lower arches, which contributes to increased lip protrusion. As facial appearance—especially lip profile—is a key concern in such cases, premolar extractions followed by incisor retraction are common strategies to reduce lip prominence. According to a study by Drobocky and Smith, patients undergoing premolar extractions demonstrated notable improvements in lip posture, showing average reductions of 3.4 mm in the upper lip and 3.6 mm in the lower lip relative to Rickett's E-line.[9–12]

This case report presents a Class I bimaxillary dental protrusion characterized by protrusive lips and a convex facial profile, leading to an unesthetic appearance. To address these issues, all four first premolars were extracted to provide sufficient space for the retraction of the anterior teeth, with the goal of reducing facial convexity and enhancing lip competence.

Anterior retraction can be achieved using either friction-based or frictionless mechanics. In this case, frictionless loop mechanics were chosen due to their advantages, including minimal friction and reduced anchorage demands. Various loop designs can be utilized in either continuous or segmental mechanics for space closure. For this case, the Opus loop—introduced by Raymond Siatkowski in 1997—was selected. This loop is uniquely designed in an L-shape with a helix at the apex of the vertical segment, enhancing the moment-to-force (M/F) ratio.

According to Siatkowski's findings, when the vertical legs of the Opus loop are angled 70° distally, it can achieve an M/F ratio of up to 8.7 mm, outperforming similarly sized vertical or T-loops. A significant advantage of the Opus loop is its ability to deliver the ideal M/F ratio necessary for bodily movement during en-masse retraction without the need for additional bends or adjustments to the wire before placement. Its reliable and versatile design enables controlled tooth movement, typically providing an M/F ratio in the range of 8:1–9:1.[13–15]

The advent of beta-titanium (TMA) wires has allowed for simplification in loop design, enabling the Opus loop to exhibit a low load-deflection rate and a high degree of springback while delivering lighter forces. These light, continuous forces are advantageous in minimizing the risk of root resorption during anterior retraction. Compared to stainless steel, TMA wires generate approximately 42% less force, making them a more biologically compatible option.

One of the primary challenges faced by orthodontists during retraction is the control of anchorage. Unintended forward movement of the posterior teeth can compromise effective space utilization for anterior retraction. Clinical studies have documented mesial molar shifts ranging from 1.6 mm to 4 mm during canine retraction with conventional methods when no additional anchorage reinforcement is used. While Temporary Anchorage Devices (TADs) are commonly employed to support anchorage control, their success can be influenced by anatomical constraints and a potential risk of failure, making their reliability somewhat variable.[16,19]

MBT appliance was used in this case because this prescription can achieve excellent force levels and resulting in tooth movement with excellent control of the biomechanics during the space closure of the extraction sites.[20]

Initially, the loop was activated by 5.5 mm during placement. Subsequently, it was reactivated by 1 mm every 45 days. Space closure was successfully completed within a six-month period. Utilizing a continuous archwire with incorporated Opus loops for en-masse retraction ensures a consistent and well-regulated force system, facilitating more accurate and predictable tooth movement when executed correctly. If the loop is reactivated prematurely, it may lead only to controlled tipping of the teeth, while excessively frequent activations may prove counterproductive. To achieve bodily movement, it is crucial to allow time for the moment-to-force (M/F) ratio to increase. Although the initial loop fabrication may be time-consuming at the chairside, subsequent evaluations and reactivations are quick and efficient. However, the effectiveness of this method relies heavily on the clinician's expertise in biomechanics and manual dexterity to properly anticipate and manage tooth movement.

In this case, post-treatment evaluation showed that a bilateral Class I molar and canine relationship was successfully preserved. Optimal overjet and overbite were maintained, while maxillary crowding, incisor angulation, and midline deviation were effectively corrected by Class I mechanics. The patient's facial profile showed considerable improvement, indicating that the treatment objectives were comprehensively achieved.

Cephalometric evaluation demonstrated notable dental changes. The upper incisor to NA angle reduced from 28° to 20°, and the lower incisor to NB angle decreased from 36° to 25°, reflecting significant uprighting of the anterior teeth. Similarly, the linear distances from the upper incisor to NA and the lower incisor to NB decreased from 10 mm to 5 mm and 11 mm to 5 mm respectively, confirming effective anterior retraction.

Soft tissue assessment revealed a 7 mm retraction of the incisors, which contributed to a substantial increase in the nasolabial angle—from 90° to 110°. Additionally, lip protrusion was markedly reduced, with the upper lip moving from 3 mm to 1 mm and the lower lip from 6 mm to 2 mm in relation to Ricketts' E-line. Skeletal measurements remained relatively stable, with cephalometric superimpositions indicating minimal alterations in vertical dimensions.

As the main concern of the patient to seek treatment was esthetics, patient was pleased with the results attained. By employing loop mechanics in the above case, we achieved effective space closure with desirable biomechanical responses, ensuring structural balance, functional efficiency and aesthetic harmony.

4. Conclusion

This case report of a Class I bimaxillary protrusion demonstrates the effectiveness of frictionless mechanics, specifically continuous Opus loop mechanics, for space closure following bilateral first premolar extractions. The approach successfully addressed the patient's concern of anterior tooth protrusion while providing excellent control over orthodontic forces. By minimizing unwanted rotations and tipping, it delivered stable, predictable, and efficient treatment outcomes, reinforcing its value in extraction-based management of bimaxillary protrusion.

5. Source of Funding

None.

6. Conflict of Interest

None.

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