Original Article - Retrospective Study

# Esthetic Outcome and Airway Evaluation following Bi-Jaw Surgery V/S Mandibular Setback Surgery in Skeletal Class III Malocclusion Using Surgery First Approach

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## Abstract

**Background:** Class III skeletal deformity is the result of mandibular prognathism, maxillary deficiency, or a combination. Treatment frequently requires a combination of orthodontics and orthognathic surgical procedures to improve facial esthetics and harmonize facial profile. **Objectives:** The objective of the study is to assess and quantify, by means of cephalometric analysis, the pre- and postoperative soft-tissue and airway changes following bi-jaw surgery and mandibular setback surgery after the correction of skeletal Class III deformities using surgery-first approach. **Materials and Methods:** Patients with skeletal Class III malocclusion were classified based on the A point–nasion–B point, beta angle, and Witt's appraisal. The cases were divided based on the type of surgery-first orthognathic approach they received. Group A (20 patients) comprised patients who underwent bi-jaw surgery (Le Fort I + bilateral sagittal split osteotomy [BSSO]) and Group B (20 patients) who underwent BSSO alone. After the lateral cephalograms were digitized, the cephalograms were evaluated for soft-tissue changes and airway changes. **Results:** The soft-tissue response to simultaneous two-jaw surgery was superior to those seen in mandibular setback procedures with the exception of the changes seen in the facial contour angle and soft-tissue facial angle. There was a significant decrease in lower airway in cases treated with mandibular setback alone. **Conclusion:** Cases treated with bi-jaw surgeries had a significant soft-tissue improvement in the long term compared to mandibular setback surgeries. Since there was a significant reduction in the lower airway in cases treated with isolated mandibular surgeries, bi-jaw surgeries maybe preferred over mandibular setback surgeries.

**Keywords:** Airway changes, bi-jaw surgery, Class III skeletal deformity, mandibular setback surgery, soft tissue, surgery-first approach

## Introduction

The combined surgical and orthodontic approach for treatment of patients with severe mandibular prognathism has produced normal function and acceptable esthetic results in many patients who were formerly considered to be permanently physically challenged.[1] The analysis of the soft tissues of the face has been an important part of orthodontic treatment planning since the 1950s. In modern orthodontic practice, orthognathic surgery is quite frequently used to maximize function and facial esthetics. It is not surprising then that the behavior of soft-tissue facial structures after these procedures is of great interest.[2]

Surgical correction of Class III dentofacial deformities may be accomplished by maxillary advancement, mandibular setback, or bimaxillary procedures. In some instances, the choice between these procedures is not straightforward. While any of these approaches is usually equally effective in correcting the dental malocclusion, each procedure affects the patient's appearance differently, with only one resulting in the most esthetically pleasing profile.[3] Most studies assessing stability after orthognathic surgery have reported

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on the positions of the hard tissues though several have attempted to quantify the relationships between the hard and soft tissues.[4] Cephalometric norms are used to guide clinicians during diagnosis and treatment planning. However, the ultimate goal of treatment is not only to achieve ideal cephalometric values but also a balanced soft-tissue profile.[5] The surgical procedures that reposition the facial skeleton alter the soft tissues that are attached to the bone to affect the facial changes. One aspect of this surgery, which has gained prominence over the last two decades, is the effect of the skeletal movements on the posterior airway space (PAS). The soft palate, tongue, hyoid bone, and associated muscles are attached directly or indirectly to the maxilla and the mandible. This means that movement of the jaws will result in positional changes of the structures directly attached to the bone and changes in the tension of the attached soft tissue and muscle. This will result in an alteration in the volume of the nasal and oral cavities and PAS dimensions depending on the direction and magnitude of the skeletal movements.[6] Historically, the surgical correction of Class III deformities was achieved by mandibular setback surgery alone. With advances in knowledge and techniques, corrective surgery progressed to include bimaxillary procedures. Several studies attempted to investigate the effect of orthognathic surgery on the PAS in patients with Class III skeletal deformities. However, most of these investigated only the effects of mandibular setback surgery for the correcting mandibular prognathism.[6] Changes in airway dimensions have been demonstrated after surgical repositioning of the maxilla or mandible, and case reports of mandibular setback surgery inducing sleep-related breathing disorders, such as obstructive sleep apnea (OSA), have been associated with airway narrowing.[7]

The effects of bimaxillary surgery for correcting Class III deformities have not been sufficiently explored, and therefore, a study of changes in soft-tissue and upper airway measurements to examine the effects of bimaxillary surgery is needed.[6]

## Materials and Methods

A sample of 40 patients aged between 18 and 35 years was divided into two groups based on the type of orthognathic surgery-first approach they have received. Group A comprised patients who underwent bi-jaw surgery, where a combination of maxillary Le Fort I osteotomy and mandibular setback procedure was done, while Group B comprised patients who underwent mandibular setback alone. The lateral cephalograms were taken preoperatively (T0), immediately after surgery (T1), and 3 to 12 months after surgery (T2). These were assessed and compared for soft-tissue changes including airway analysis. The pre- and postsurgical cephalograms were digitized using the Nemotec Dental Server NX 2006 (nemotec SL, madrid, Spain) program by a single examiner.

### Inclusion criteria

The inclusion criteria of this study were as follows:

1. Classified as Class III malocclusion with
    - A point–nasion–B point (ANB) angle $\leq 0^{o}$ [Figure 1]
    - Witt's appraisal = BO ahead of AO by 3 mm [Figure 2]
    - Beta angle $\geq 34^{o}$ [Figure 3]
2. Patients treated with surgery-first orthognathic approach
3. No surgical intervention other than bilateral sagittal split osteotomy (BSSO) and/or Le Fort 1 osteotomy
4. Lateral cephalograms taken before surgery, immediately after surgery, and 3 to 12 months after surgery
5. No syndromes and no cleft lip or palate.

### Exclusion criteria

The exclusion criteria of this study were as follows:

1. Previous orthognathic surgery
2. Marked mandibular bone asymmetry
3. Patients with OSA.

### Standardization of the lateral cephalograms

The digitized lateral cephalograms were calibrated using the Nemotec 2006 software to eliminate the errors caused due to radiographic magnification and resolution and errors occurring during the linear measurements. The patients were classified as skeletal Class III malocclusion based on the following parameters.

### Criteria for classifying the malocclusion

The patients categorized as skeletal Class III malocclusion were further divided into Group A and Group B and measured for the following parameters.

### Soft tissue

1. Nasolabial angle: Angle measured between the columella of the nose and upper lip (Sn-Ls).
2. Chin–throat angle: Angle formed between the line drawn from Li-Pog and a submental tangent
3. Chin–throat length: Length measured from the angle of the throat to $Me^{I}$
4. E-line to Ls: Distance measured from the E-line to Ls
5. E-line to Li: Distance measured from the E-line to Li
6. Nose tip to true vertical line: Distance measured from the nose tip to a line placed through subnasale perpendicular to the natural horizontal head position
7. Merrifield's Z-angle: Angle formed by intersection of FH and a line connecting $Pog^{I}$ and the most protrusive lip point (upper or lower)
8. Facial contour angle: Formed by lines drawn from GI to Sn and from Sn to $Pog^{i}$
9. Soft-tissue facial angle: Angle formed between sellanasion ($SN^{I}$) and nasion–pogonion ($N^{I}$ – $Pog^{I}$)
10. S-line: Distance measured from the S-line to Ls and Li.

### *Airway measurements*

1. Upper pharynx: Distance measured from a point on the posterior outline of the soft palate to the closest point on pharyngeal wall

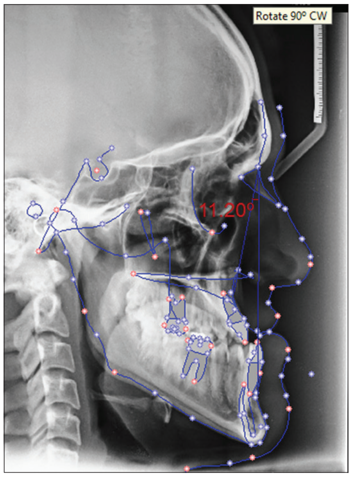



**Figure 1:** A point–nasion–B point angle: This angle represents the difference between the SNA and SNB and defines the mutual relationship of maxillary to mandibular bases in sagittal plane

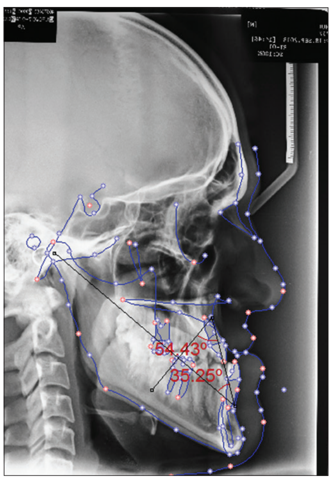



**Figure 2:** Beta angle: Angle formed by a point drawn from condylion to Point B and perpendicular drawn from Point A

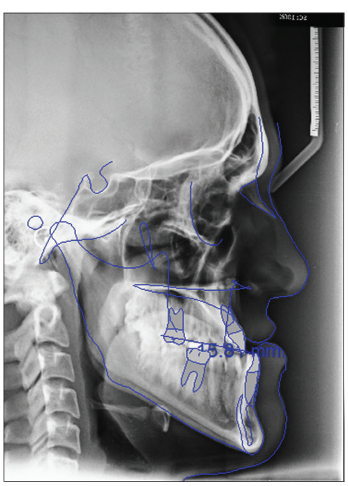


**Figure 3:** Witt's Appraisal: Distance between Point A and Point B

2. Lower pharynx: Distance measured from the point of intersection of the posterior border of the tongue and inferior border of the mandible to the closest point on the posterior pharyngeal wall
3. Soft palate length: Length measured from posterior nasal spine to tip of soft palate
4. Soft palate thickness: Soft palate thickest dimension from nasal surface to oral surface
5. Palatal angle: Angle formed between maxillary plane and soft palate length.

## Results

The study included 40 patients; out of which, 20 patients, Group A, had undergone bi-jaw surgery, while the remaining 20 patients, Group B, underwent only isolated mandibular setback procedure using the surgery-first orthognathic approach. Variables were measured at each interval in both the groups. Statistically significant differences were found in each group from T0 to T1, while T1 to T2 remained statistically insignificant. Changes of variables before and after treatment are shown in the tables.

There was a significant difference between Group A (bi-jaw) and Group B (mandibular setback alone) for ANB angle at T1 ($P = 0.04$) and T2 ($P = 0.018$). The ANB angle increased more in bi-jaw compared to mandibular setback group.

There was a significant difference between Group A (bi-jaw) and Group B (mandibular setback) for beta angle at T2 ($P = 0.02$). Beta angle decreased more in bi-jaw group compared to mandibular setback group [Graph 1].

There was no significant difference between Group A (bi-jaw) and Group B (mandibular setback) for Witt's appraisal at T1 ($P = 0.78$) and T2 ($P = 0.13$) [Graph 2].

There was a significant difference between Group A (bi-jaw) and Group B (mandibular setback) for nasolabial angle at T2 ($P = 0.007$). The nose turned upward significantly in cases treated with bi-jaw (Le Fort I + mandibular setback) compared to mandibular setback procedure [Graph 3].

There was a significant difference between Group A (bi-jaw) and Group B (mandibular setback) for chin–throat angle at T0 ($P = 0.03$) and T2 ($P = 0.05$). This angle is more acute in patients with mandibular anteroposterior excess while obtuse in cases with mandibular anteroposterior deficiency [Graph 4].

There was no significant difference between Group A (bi-jaw) and Group B (mandibular setback) for Merrifield's Z angle. The Z angle reflects the combined value of Frankfurt-mandibular plane angle (FMA),Frankfurt-mandibular incisal angle (FMIA), Incisor-mandibular plane angle (IMPA), and soft-tissue thickness because all have a direct bearing on facial balance ($P > 0.05$).

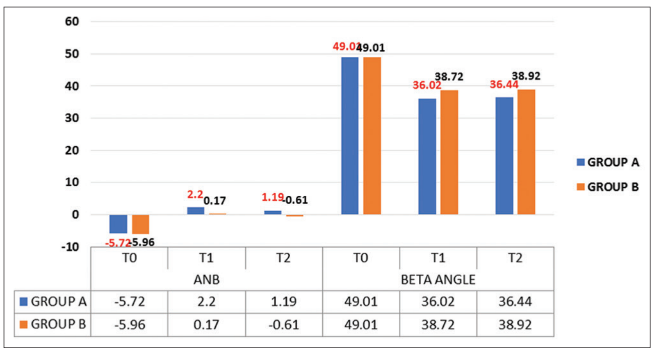
There was a significant difference between Group A (bi-jaw) and Group B (mandibular setback) for E-line to Ls at T1 ($P = 0.009$). The upper lip moved more anteriorly toward the E-line in bi-jaw cases compared to mandibular setback cases.

There was no significant difference between Group A (bi-jaw) and Group B (mandibular setback) for E-line to Li ($P > 0.05$). The lower lip moved equally posteriorly from E-line in both the groups [Graph 5].

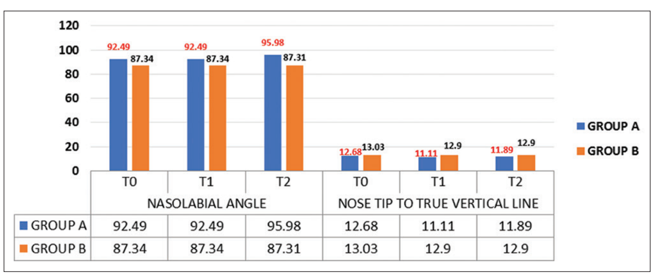
There was no significant difference between Group A (bi-jaw) and Group B (mandibular setback) for the upper airway. The upper airway changed insignificantly in both the study groups ($P > 0.05$).

There was a significant difference between Group A (bi-jaw) and Group B (mandibular setback) for lower airway at T2 ($P = 0.01$). The lower airway reduced significantly in cases treated with mandibular setback alone compared to bi-jaw cases [Graph 6].

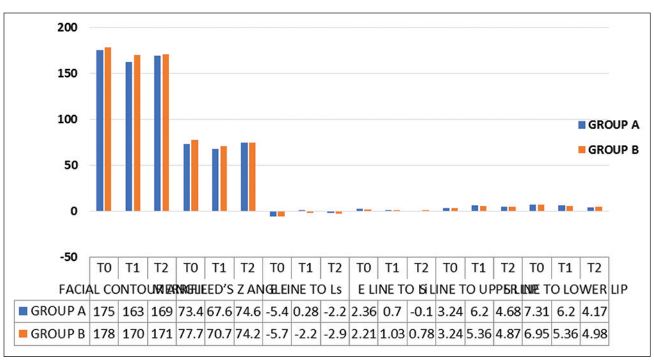
The position of the soft palate (palatal angle) changed significantly in both the surgical groups ($P = 0.04$). This represents adaptive postural changes of the soft palate to maintain adequate palatal function and an oropharyngeal seal [Graphs 7 and 8].




**Graph 1:** Classifying criteria for Class III malocclusion




**Graph 3:** Changes associated with middle third of the face



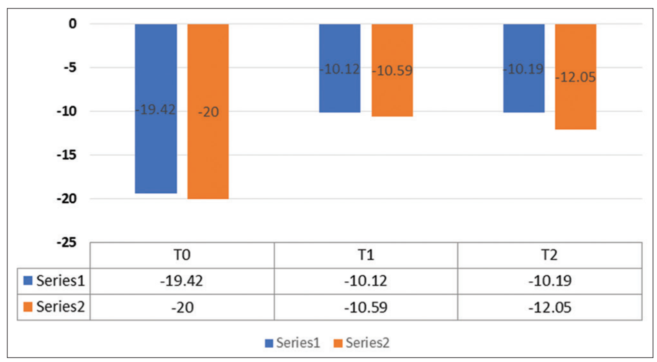

**Graph 5:** Variables associated with overall soft-tissue changes

## Esthetic outcome evaluation

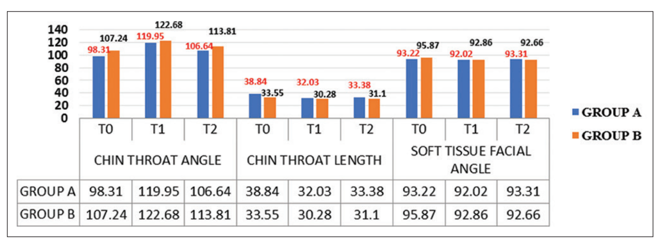
The nasolabial angle increased significantly in cases treated with bi-jaw (Le Fort I + mandibular setback) compared to mandibular setback procedure. The chin–throat angle was more acute, and the chin–throat length decreased significantly in cases treated with mandibular setback alone. When the variables affecting the overall harmony of the face were assessed, the E-line to upper lip and the Steiner's line approached the normal values with bi-jaw surgery compared to mandibular setback surgery. However, the soft-tissue facial angle and facial contour angle showed insignificant changes with both the procedures when the subjects were evaluated 3 to 12 months after the surgery.

## Functional outcome evaluation

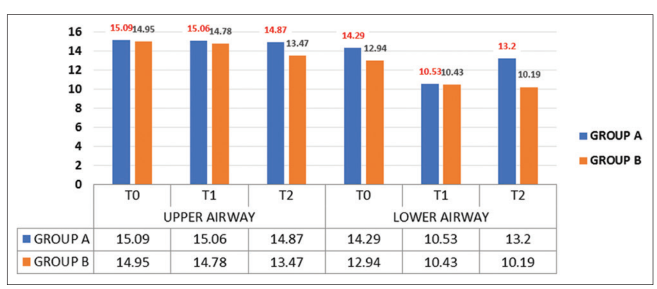
When the variables affecting functional changes (upper airway, lower airway, soft palate thickness, and tongue thickness) were quantified, the subjects who underwent surgery-first approach with BSSO alone had a significant reduction in the lower airway, whereas the subjects who underwent BSSO combined with Le Fort I osteotomy had an insignificant change in the airway.



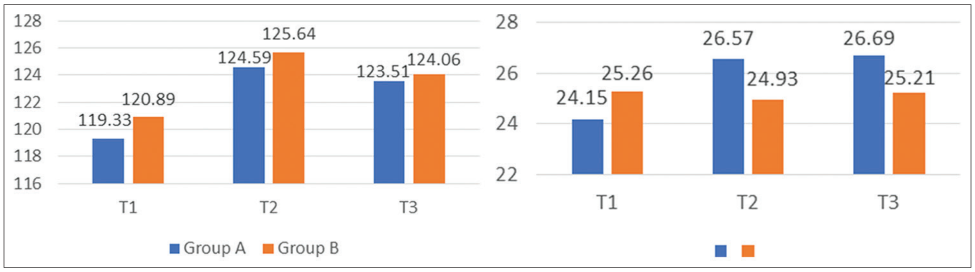

**Graph 2:** Witt's appraisal



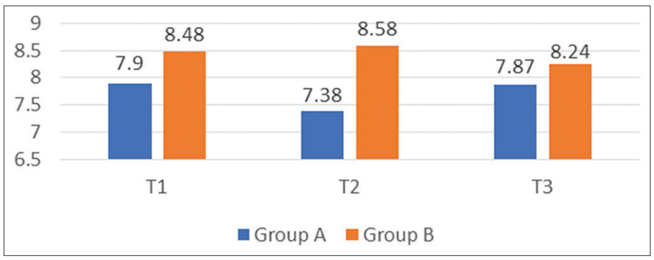

**Graph 4:** Changes associated with lower third of the face




**Graph 6:** Airway changes




**Graph 7:** Tongue thickness and soft palate thickness




**Graph 8:** Palatal angle

## Discussion

One of the main purposes of this investigation was to determine the soft-tissue and airway changes following bi-jaw surgery versus mandibular setback surgery in the correction of skeletal Class III malocclusion using surgery-first orthognathic approach. Precise sample selection was very important to achieve the most reliable and meaningful results. All patients selected had skeletal Class III malocclusion and were nongrowing adults. Almost all the patients were treated by the same surgeon and orthodontist to keep operator variability to a minimum. Record collection was very consistent among those patients selected although the data were collected retrospectively. Lateral cephalometric radiographs of the patients in both the groups taken preoperatively (T0), immediately after surgery (T1), and 3 to 12 months after surgery (T2) were used to assess and compare long-term changes in the soft tissue and airway between the two groups. These radiographs were further digitized and calibrated to eliminate linear measurement errors. In Group A and Group B, mean values were calculated for each variable at T0, T1, and T2. Statistically significant difference was found from T0 to T1 for each variable in both the groups, whereas the values at T1 and T2 remained statistically insignificant. When each variable between the groups was compared, there was a significant difference for ANB angle and beta angle (variables that classified the malocclusion) from T0 to T1 in both the groups, indicating that the skeletal deformity has been corrected to Class I malocclusion. The ANB angle changed significantly at T1 and T2, while beta angle changed significantly at T2. The angles approached the normal values significantly in bi-jaw group compared to mandibular setback group. Frequently, a bimaxillary surgical approach is necessary in patients with severe skeletal discrepancies to achieve facial profile harmony and occlusal objectives. Surgical limitations and higher relapse risks may also determine the need for a bimaxillary approach in these cases.[8]

In this study, the postsurgical values showed normalization of both the ANB and beta angle as a result of the two-jaw surgery. In a similar study by Lin and Kerr[9] on Caucasian Class III patients treated by bimaxillary surgery, the mean ANB value was 3.65° which showed normalization toward skeletal Class I. Soft-tissue profile changes were significantly altered because of the surgery. All participants presented presurgically with a concave profile and a protrusive lower lip. The orthognathic surgery improved the facial convexity, nasolabial angle, and upper and lower lip protrusion and the overall harmony of the face. The study by Enacar *et al.*[10] suggested that the soft-tissue responses to two-jaw surgery were similar to those seen in mandibular setback surgery alone, with the exception of the changes seen in the nasal tip projection and the upper lip area. In our study, statistically significant difference was found for nasolabial angle, between the groups at T2. The nasolabial angle increased in the bi-jaw group suggesting that the nose tip turned upward following the maxillary advancement or impaction. According to a study done by Jensen *et al*.,[9] with an average 2-mm advancement and 3.4-mm impaction of the maxilla, there was a tendency for the base of the nose (subnasale and nasal tip) to advance about two-thirds of the amount of anterior movement of A point, whereas the free end of the upper lip showed a change that averaged about 90% of the maxillary advancement. There was a significant difference for chin–throat angle at T0 and T2 in both the groups. When the variables measuring the overall harmony of the face were assessed, there was no statistically significant difference between them at T2. Although the bi-jaw cases showed better improvement in the soft-tissue changes compared to mandibular setback cases due to the scope for overcorrection, the differences were not statistically significant. Comparing the findings of bimaxillary surgery with those of isolated mandibular setback surgery only, the effects of bimaxillary surgery on the mandibular soft-tissue profile in the current subjects were, on the whole, found to be similar. Recently, a paradigm shift has occurred from hard tissue to soft tissue known as the soft-tissue paradigm. According to this reverse approach, the key determinant is soft-tissue positions, necessitating evaluating the effects of various surgical orthodontic treatments and their effect on the face. In the presurgical workup of any potential orthognathic case, one of the prime concerns of both the orthodontist and the oral surgeon must be the final soft-tissue profile and the esthetic appearance of the patient. The relative anteroposterior positions of the nose, lips, and chin must be evaluated, as must the vertical proportions of the soft tissue as well as the soft-tissue contours, to produce the optimum postoperative profile. In our study, there was a significant reduction in the lower airway in patients who underwent isolated mandibular setback alone. The position of the soft palate (palatal angle) changed significantly in both the surgical groups ($P$ = 0.04). This represents adaptive postural changes of the soft palate to maintain adequate palatal function and an oropharyngeal seal. In a study by Turnbull and Battagel,[7] there was a significant decrease in lingual airway subsequent to mandibular setback. Therefore, it is reasonable to assume that, as the mandible is surgically retruded, the size of the oral cavity and the relative tongue proportion increases. The tongue may then be displaced superiorly and posteriorly reducing the lingual airway dimension. This finding is concurrent with the present study where there was a significant reduction in the lower airway in cases who underwent mandibular setback alone. It is possible that the reduction in retrolingual airway and intermaxillary space found after the correction of Class III cases may predispose to sleep apnea in some individuals. Evidence for this is provided by studies comparing oropharyngeal morphology in sleep apnea participants with healthy controls. Guileminault *et al*., 1985, and Riley *et al*., 1987, presented two case reports that highlighted the development of sleep apnea in two previously healthy nonobese females following cosmetic mandibular retrusion surgery. Isolated mandibular prognathism occurs in only 20% to 25% of all Class III patients, while 75% have some degree of maxillary skeletal deficiency. The increase in bimaxillary surgery is due to refinements in the Le Fort I down fracture (Epker and Wolford, 1975) but also as a result of increased diagnostic awareness of maxillary hypoplasia as an important component in Class III dysgnathias (Ellis and Mc Namara, 1984). Thus, in view of the results found in this investigation and keeping in mind the anatomic limitations, risk of OSA, limited movements that follow the envelope of discrepancy, severity of malocclusion, and the similar soft-tissue changes seen in both the groups, we can conclude that when treating patients with skeletal Class III pattern, a bi-jaw surgical approach (maxillary advancement and mandibular setback) could be preferred over an isolated mandibular setback procedure.

## Conclusion

The bi-jaw surgery provided better scope for overcorrection and better soft-tissue response as compared to the mandibular setback surgery. Soft-tissue changes were limited only to the area of the lower lip and chin in cases treated with isolated mandibular setback. The chin–throat length decreased significantly, while the chin–throat angle was more acute. There was a significant reduction in the lower airway in cases treated with isolated mandibular setback alone. However, better overall soft-tissue changes were seen in bi-jaw surgery group compared to mandibular setback surgery group. Owing to anatomic limitations, risk of OSA, severity of malocclusion, and limited movements that follow the envelope of discrepancy in isolated mandibular setback surgery, bi-jaw surgeries could be preferred over isolated mandibular setback procedures for the correction of skeletal Class III deformities. However, a larger sample size is needed to substantiate the results obtained from this study.

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Nil.

### Conflicts of interest

There are no conflicts of interest.

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