

Prediction of Soft-Tissue Changes Following Single and Bi-Jaw Surgery: An Evaluative Study

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Abstract

Introduction: Orthognathic surgery is carried out in the hard tissues; however, the patient perceives change in the soft tissue. It is important to accurately predict postoperative facial changes associated with each surgical procedure. This study aims to evaluate the changes in the soft tissues resulting from the movement of the hard tissue following single and bi-jaw surgeries. **Materials and Methods:** An evaluative clinical study was carried out on a total of 34 subjects which consisted of 52 jaw surgeries. Maxilla and mandible were considered as a separate entity even in bi-jaw cases for evaluation. Surgical procedures performed were either bilateral sagittal split osteotomy, Le Fort I osteotomy or both. Pre- and post-surgical lateral cephalograms were compared to assess the soft-tissue change at various soft-tissue points and were labeled T1 and T2, respectively. The points on maxilla were Point A and PrS on upper lip. The points on mandible were PrI and Point B on lower lip and Pog and Gn on chin. **Results:** All the points on the maxilla and mandible had a strong correlation between the hard and soft-tissue points except point PrS on upper lip. **Discussion:** Facial appearance is an important parameter in the present times which influences the social and psychological development of an individual. What patient sees is the external soft-tissue drape whereas orthognathic surgery is carried out on bony components of the face. Thus prediction of soft-tissue changes following surgery is an important part of treatment planning.

Keywords: Bilateral sagittal split osteotomy, cephalometry, Le Fort osteotomy, orthognathic surgery

INTRODUCTION

In the present times, facial esthetics is considered as a prime factor influencing psychosocial development and possibly playing an important role in an individual's work and social status. It has long been said that beauty lies in the eye of the beholder however our perception of physical beauty is hard-wired into our being and based on how closely the features of one's face reflect phi in their proportions. There is no beauty without proportions. The clinical ability to alter dentofacial form, whether through orthodontics, facial growth modification or surgery, requires an understanding of proportions and symmetry.^[1]

Orthognathic surgery comprises of surgical procedures carried out in bony components of the maxillomandibular region; however, what patients perceive is the change in their soft tissue. It is important to understand of postoperative facial changes associated with each surgical procedure. Hence, the objective of the present study was to evaluate the changes in the soft-tissue resulting from hard tissue movement following orthognathic surgery.

MATERIALS AND METHODS

An evaluative clinical study was carried out on a total of 34 subjects consisting of 52 jaw surgeries. Maxilla and mandible were considered a separate entity even in bi-jaw cases for evaluation purpose. The study was performed on a Goan population from November 2014 to November 2018 and the study group comprised of 18 females and 16 males. The subjects were in the age range from 17 to 30 years, with a mean age of 21.3 years. Ethical approval was obtained from the Institutional Review Board prior to the start of the study and followed the Declaration of Helsinki. Consent for surgery as well for the publication of article was taken from the patients

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at the time of enrolling them for the study. All the data obtained were analyzed by a biomedical statistician.

Inclusion criteria

- Patients requiring orthognathic surgery for the correction of skeletal deformities and have undergone presurgical orthodontic decompensation
- Patients within 17–30 years of age
- The American Society of Anaesthesiologists (ASA) Class I and Class II.

Exclusion criteria

- Prior surgical procedures including esthetic surgery and craniomaxillofacial surgery
- Post traumatic defects
- Underlying pathological conditions
- ASA III and IV
- Temporomandibular joint dysfunction.

Method

A total of 34 subjects were included in the study based on the inclusion and exclusion criteria. In the pre surgical phase, cephalometric tracings and mock surgery was performed, followed by the fabrication of surgical guides. Surgical procedures performed were Le Fort I osteotomy for maxilla and bilateral sagittal split osteotomy (BSSO) for mandible or both.

Cephalometric analysis

Presurgical lateral cephalogram (T1) was taken 1 week prior to the surgery and postsurgical lateral cephalogram (T2) 6 months after the surgery. Lateral cephalogram was taken in the natural head position. All the radiographs were digitized and processed using Adobe Acrobat Pro Dc Software version 11 (Adobe Inc. Released 2012. Version 11.0. California) by a single investigator. Hard-tissue landmarks of the cephalograms were traced using a modified version of the analysis of

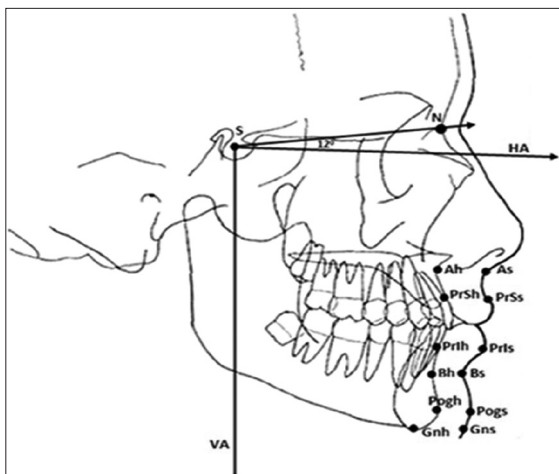


Figure 1: Markings for Hard tissue points: Point A (Ah), Prosthion superior (PrSh), Prosthion inferior (PrIh), Point B (Bh), Pogonion (Pogh), Gnathion (GnH) and corresponding Soft tissue points: Point A (As), Prosthion superior (PrSs), Prosthion inferior (PrIs), Point B (Bs), Pogonion (Pogs), Gnathion (Gns). Points Nasion (N) and Sella (S) for obtaining reference lines

Legan and Burstone^[2] and Lew *et al.*^[3] Hard and soft-tissue points were marked as illustrated in Figure 1. The distance between the hard and soft tissue points and the vertical reference line in pre- and post-surgical radiographs were recorded^[4] [Figures 2a, b and 3a, b respectively]. Data obtained from analysis of presurgical and postsurgical cephalogram were recorded using Statistical Package for Social Sciences version 18 (SPSS Inc. Released 2009. PASW Statistics for Windows, Version 18.0. Chicago: SPSS Inc.).

Observations

The relationship between the changes in soft tissue and those of hard tissue was determined by Pearson correlation coefficient. It was observed that, the correlation coefficient between points Ah and As for maxillary advancement and setback surgeries was statistically highly significant ($P = 0.003$ and $P = 0.000$, respectively). This indicates a very strong correlation between the hard and soft tissues of the maxilla on advancement as well as setback surgeries.

The graph demonstrated that with every unit advancement in maxilla, the upper lip will advance by 1.23 units [Figure 4a] and move back by 0.97 units on every unit of setback [Figure 4b]. The correlation coefficient between Points PrSh and PrSs was statistically not significant. The correlation coefficient between the hard and soft tissue points on the mandible in relation to the lower lip was found to be highly significant ($P = 0.000$) for advancement as well as setback surgeries thus proving a strong correlation between tissues.

The graph further demonstrates that the lower lip will advance by 0.66 units and the soft tissue of mentolabial sulcus will advance by 1.109 units with every unit of advancement [Figure 5a]. The lower lip recedes by 0.794 units and the mentolabial sulcus by 0.731 units with every unit setback of mandible [Figure 5b]. On advancement of mandible, soft-tissue drape in the chin region will advance by 0.859 and 0.71 units in relation to Pogonion and Gnathion respectively [Figure 5a] and will move back

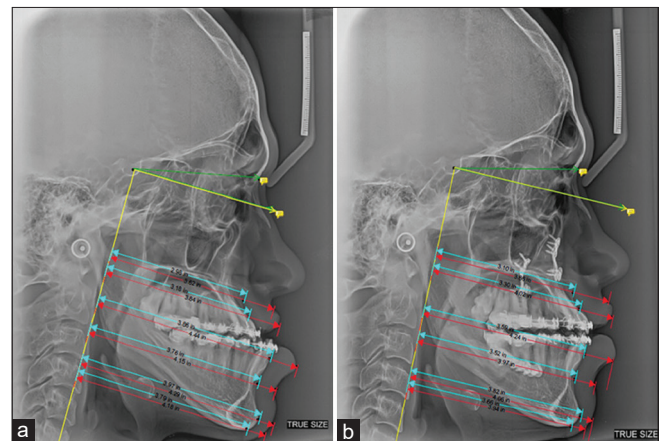


Figure 2: (a) Presurgical Lateral Cephalogram (Case 1) with hard and soft-tissue marking Green line: Sella-Nasion; Yellow lines: Vertical and Horizontal reference lines; Blue lines: Distance of hard tissue points; Red lines: Distance of soft-tissue points (b) Postsurgical Lateral Cephalogram (Case 1)

by 0.965 and 0.859 units respectively on mandibular setback surgeries [Figure 5b].

DISCUSSION

Facial skeleton and its soft tissue drape are the determinants of facial harmony and balance. The foundation on which the aesthetics of the face is based, is formed by the architecture and topographic relationships of the facial skeleton. However, the visual impact of the face totally depends on the form and proportion of the soft tissues.^[5] Changes in the soft tissue form after the surgery depends on various factors such as

lip morphology, wound closure, and postoperative swelling. The assessment of these changes requires around 6 months to 12 months of duration.^[6]

In the present study, 34 patients were assessed for changes occurring in soft tissues with hard tissue movement following orthognathic surgery. A total of 52 jaws were evaluated considering each jaw as a separate entity even in bi-jaw cases. The surgeries performed were Le Fort I for maxillae and/or BSSO for mandibles. The linear horizontal soft-tissue changes in relation to the hard tissue change were recorded and analyzed.

Changes in the lower lip and chin region were evaluated at four points on the mandible namely: PrI, B, Pog, Gn. Points evaluated were same as used by Ribeiro *et al.*^[4] Storms *et al.*^[7] used soft-tissue points namely: Li (Labrale inferius), B', Pog', Gn' and Me' (soft tissue Menton) which involved hard tissue points on dental structures as well. Authors have investigated the changes in soft tissue with some variations in the landmarks such as SNB angle, N-B distance^[8] to determine the vertical parameters in the past. However, the present study was limited to osseous structures to eliminate changes occurring due to dental movements and only linear horizontal changes were evaluated as the changes occurring due to autorotation are negated.

After performing mandibular advancement surgeries on 15 jaws following BSSO, it was noted that the ratio of soft

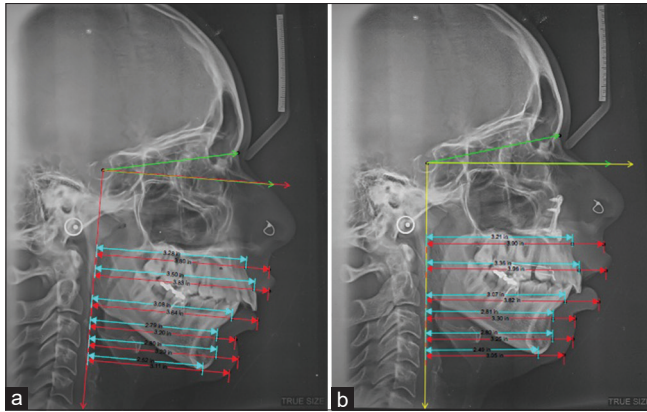


Figure 3: (a) Pre surgical Lateral Cephalogram (Case 2) (b) Postsurgical Lateral Cephalogram (Case 2)

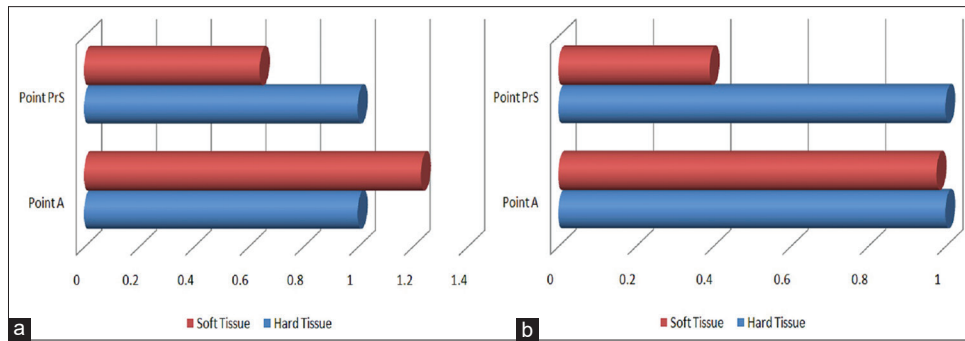


Figure 4: (a) Graph showing movement of soft tissues with respect to hard tissues in the region of Points A and PrS in maxillary advancement cases. (b) Graph showing movement of soft tissues with respect to hard tissues in the region of Points A and PrS in maxillary setback cases

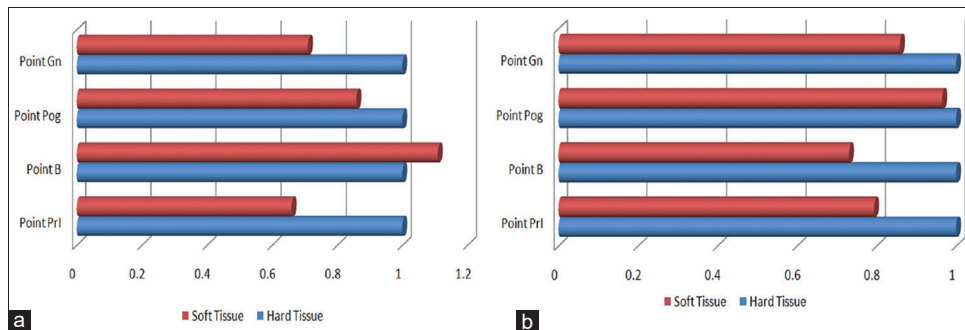


Figure 5: (a) Graph showing movement of soft tissues with respect to hard tissues in the region of Points Gn, Pog, Point B and PrI in mandibular advancement cases. (b) Graph showing movement of soft tissues with respect to hard tissues in the region of Points Gn, Pog, Point B and PrI in mandibular setback cases

tissue to hard tissue change after surgery at lower lip was 0.66:1 (PrIs: Prlh), mentolabial sulcus was 1.1:1 (Bs: Bh), area of chin was 0.85:1 (Pogs: Pogh) and 0.71:1 (Gns: Gnh). These were similar to the ratios obtained in studies by Lines and Steinhauer^[9] and Quast^[10] which stated that although the soft and hard tissue chins predictably advanced in a 1:1 ratio, the lower lip changes were more variable with soft/hard tissue ratios ranging from 0.38:1 to 0.75:1^[11] Talbott^[12] stated that in cases of mandibular advancement, ratio at lower lip was 0.85:1 and at chin was 1.04:1. Proffit and Epker^[13] showed a mean change of 0.75:1 at lower lip and 1:1 at chin. Mommaerts and Marxer^[14] stated a change of 0.56:1 at lower lip and 1.03:1 at the area of chin.

Changes in soft-tissue following surgery were first reported in mandibular setback procedures. An attempt was made to quantify the noticeable changes that occurred in lower lip and chin.^[15] The present study revealed that with every 1 unit setback of mandible, lower lip moved back by, 0.7 units whereas chin area moved back by 0.8–0.9 units. This was in accordance with the previous studies which stated that for every 1 mm of posterior mandibular skeletal movement, the soft tissue lip receded by 0.6–0.75 mm while the soft tissue chin receded by 0.9–1 mm.^[9,16]

The results obtained from the present study showed a strong correlation between hard and soft-tissue points at Pog and Gn with $r = 0.96$ and $r = 0.85$ respectively which were in concurrence with the study conducted by Lin and Kerr^[17] and Rupperti *et al.*^[18] This indicates accurate prediction of soft-tissue points on the chin. Points PrI and point B showed moderate correlation with $r = 0.79$ and $r = 0.73$ respectively which makes them less predictable. This is in accordance with the study performed by Do and Lam.^[19]

Le Fort I surgery was performed on 21 maxillae which comprised of 8 advancements and 13 setbacks. Various authors have used variables such as pronasale, columella, subnasale, nasolabial angle, nasal tip angle to evaluate the changes in nasal tip projection.^[20] However, the points that were monitored for the soft-tissue change in the present study were Point A and PrS.

In this study, upper lip followed Point A with a ratio of 1.23:1. The study of Ribeiro *et al.*^[4] gave a ratio of 0.85:1 between As and Ah which was lower in comparison. However, the results from this study are proven to be true by Landes *et al.*^[21] who said that maxillary advancement had an 84% impact when applying anthropometry whereas using roentgenocephalometry an advancement had a 105% response, which was seen in our study. Soft-to-hard ratios have ranged from 0.32:1 to 0.93:1 as stated by San Miguel Moragas *et al.*^[22] When v-y and cinch were performed together, the ratios ranged from 0.78:1 to 0.93:1.

The ratio obtained at base of upper lip (PrSs: PrSh) in the study was 0.64:1. This was in similar lines with the study done by Willmar;^[23] where he obtained a ratio that ranged from 0.4:1

and 0.80:1 (mean: 0.57:1) in cases where nasal cinch suture and V-Y lip plasty were not performed. In contrast, the ratio ranged from 0.56:1 to 0.78:1 (mean: 0.66:1) if only V-Y was performed.^[24] Naini *et al.*^[25] in 2017, found that nasal cinch suture along with V-Y plasty led to lip lengthening. It showed higher ratios which ranged from 0.9:1 to 0.95:1.^[26]

The ratio obtained for upper lip at Point A after setback of maxilla was 0.97:1 which revealed that the upper lip receded by 0.97 units with every unit setback of maxilla. Whereas the ratio at base of upper lip (PrSs: PrSh) was found to be 0.85:1 which was higher than 0.67:1 as given by Lines and Steinhauer^[9] in 1974. In 1992, Jensen *et al.*^[11] noted that the upper lip moved back by the ratio ranging from 0.33:1 to 0.76:1 in cases of maxillary setback.

As per the correlation coefficients described by Lin and Kerr,^[17] there was a strong correlation between As and Ah in advancement and setback surgeries and is proven true in the present study ($r = 0.89$ and $r = 0.87$ respectively). Whereas weak correlation exists between PrSs and PrSh in advancement and setback of maxilla ($r = 0.49$ and $r = 0.48$). This implies that other factors contribute more than 55% to soft tissue response at this point.

It was observed that the soft to hard tissue ratios of the maxilla obtained in this study were higher than previous studies. Regardless of the type of maxillary surgery whether advancement or setback, there were changes in the nasal tip, nasal width, and upward nasal rotation.^[27] These changes may be attributed to the modifications done in the soft tissues of upper lip and a new positioning of the anterior nasal spine during the surgery.

In case of bi-jaw surgeries, the thickness of the soft-tissue Pog may increase slightly after surgery in patients with skeletal Class III malocclusion with a higher preoperative mandibular plane angle.^[28] The predictions of soft-tissue changes were found to be less accurate for bi-jaw surgeries than those for single jaw surgeries.^[29] Non specificity and large variability in the ratios obtained is the drawback of the study as movement of soft tissues in vertical direction was not considered.

Confounding factors to the study included:

- Selective case analysis
- Patient compliance
- Error associated with surgical planning
- Splint fabrication
- Anatomical variation in prediction tracing.

Results of this study could have been positively influenced by:

- Larger sample size
- Longer follow up period.

Variation in the values as compared to other studies in the soft-tissue changes in the maxillary procedures could be attributed to the vertical movement of the maxilla which was not been factored.

CONCLUSION

The cephalometric prediction of orthognathic surgery is considered as a gold standard for surgical planning and patient counseling. With the help of this, accurate description of the orthodontic and surgical outcome should be done prior to the treatment. This aids in evaluation of treatment feasibility, to optimize case management, to increase patients' understanding and acceptance of the recommended treatment.

To improve the outcome of the surgical procedure, changes in the soft tissue must be incorporated in treatment planning. This necessitates certain norms to be established for the changes occurring in soft-tissues following orthognathic surgery among the native population. Some factors which affect the soft-tissue response are inevitable or sometimes difficult to control and predict. Patients should be informed prior to the surgery that predictions are only a guide and may not represent the actual surgical outcome.

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Conflicts of interest

There are no conflicts of interest.

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