Original Article - Prospective Study

Soft tissue changes and its stability as a sequlae to mandibular advancement

Access this article online
Website:
www.amsjournal.com
DOI:
10.4103/2231-0746.147095
Quick Response Code:

Uday Kiran Uppada, Ramen Sinha, D. Sreenatha Reddy, Dushyanth Paul

Department of Oral and Maxillofacial Surgery, Sri Sai College of Dental Surgery, Vikarabad, Andhra Pradesh, India

Address for correspondence:
Dr. Uday Kiran Uppada, Sri Sai College of Dental Surgery, Vikarabad, Andhra Pradesh, India.
E-mail: udaymaxfax@gmail.com

ABSTRACT

Purpose of the Study: To predict the changes and evaluate the stability that occurs in the soft tissues following the skeletal movement subsequent to surgical advancement of the mandible through bilateral sagittal split osteotomy and to provide the patient reliable information with regard to esthetic changes that can be expected following the treatment. **Materials and Methods:** Twenty adult patients diagnosed with skeletal class II malocclusion and underwent bilateral sagittal split osteotomy for mandibular advancement by a mean of 8 mm using rigid fixation were included in the study. Soft tissue changes brought about by the surgical procedure and their stability over a period of time were evaluated prospectively using 12 linear (4 vertical and 8 horizontal) and 4 angular measurements on profile cephalograms which were taken preoperatively after the pre-surgical orthodontics (T1) and postoperatively with duration of 1 month (T2) and 6 months (T3) respectively. **Results:** It was observed that compared to the linear measurements, the angular measurements showed significant changes. The improvement in the esthetic outcome is a direct reflection of the angular changes whereas the linear changes played a contributing role. Following mandibular advancement surgery the profiles of the patients was perceived to have improved with reduction in the facial convexity, an increase in the lower facial height, decrease in the depth of the mentolabial sulcus and improvement in the lip competency with lengthening, straightening and thinning of the lower lip. **Conclusion:** The soft tissue response and its stability depends on the stability of the surgical procedure itself, postsurgical growth and remodeling of the hard tissues and soft tissue changes as a result of maturation and aging.

Keywords: Bilateral sagittal split ramus osteotomy, orthognathic maxilla, profile cephalogram, retrognathic mandible

INTRODUCTION

Facial esthetics is a critical factor in human interrelationship. Some patients have a unique constellation of dentofacial features that neither growth modification nor the camouflage would offer a possible solution. Combined surgical and orthodontic procedure to correct major dentofacial deformities and malocclusion usually requires bi-jaw surgery. Lower third of the face constitutes the lips and the chin throat region and has a unique impact on the facial dynamics. Surgeries performed on the lower jaw have a direct bearing on the effect of the face and in general and greatly influence lip-chin-throat relationship. Surgical procedures to correct the skeletal deformities results in changes in the shape and position of the overlying soft tissues. These changes in the relationship of hard tissue to soft tissue were first reported by McNeill *et al*.[1] Predictions of profile changes after orthognathic surgery remains a problem because of the variability in the nature of soft tissue and difference in soft tissue displacement compared with osseous translation.

When long-term treatment outcome is to be predicted, it is of particular importance to determine the time interval at which postoperative changes related to surgical intervention cease or are reduced to clinically insignificant levels and hence that the likelihood of further noticeable discrepancies in the prediction is reduced. Thus, it becomes an important factor in determining soft tissue changes after orthognathic surgery.

Patients seeking orthognathic surgery needs precise information about the facial changes that will appear after the treatment. Regardless of the method, the accuracy of the prediction is highly dependent on the clinician's knowledge of the soft tissue response to skeletal repositioning.[2] Therefore, an accurate prediction of the postoperative facial profile is an essential part of diagnosis and treatment planning procedure in combined surgical-orthodontic therapy.[3] This study is intended to predict the changes and evaluate the stability that occurs in the soft tissues following the skeletal movement subsequent to surgical advancement of the mandible through bilateral sagittal split osteotomy and to provide the patient reliable information with regard to esthetic changes that can be expected following the treatment.

MATERIALS AND METHODS

Twenty patients diagnosed with skeletal class II malocclusion and underwent mandibular advancement surgery by a mean of 8 mm (range of 7–10 mm) using rigid fixation were included in the study. Non growing healthy adult patients having natural dentition supporting the lips with orthognathic maxilla and retrognathic mandible who underwent only bilateral sagittal split osteotomy for correction of retrognathic mandible were included. Patients who underwent combined maxillary and mandibular procedures and those who had undergone prior TMJ surgery are excluded.

Soft tissue changes brought about by the surgical procedure and their stability over a period of time were evaluated prospectively using 12 linear (4 vertical and 8 horizontal) and 4 angular measurements on profile cephalograms, which were taken preoperatively after the presurgical orthodontics (T1) and postoperatively with duration of 1 month (T2) and 6 months (T3) respectively.

Linear parameters [Figure 1]

- Mandibular retrognathism: (G–Pg′//HP):[4] Distance measured by drawing a line perpendicular to glabella and parallel to HP
- Vertical height ratio: (G–Sn/Sn–Me′$^{\perp lr}$ HP):[4] Ratio of middle third facial height to lower third facial height measured perpendicular to HP
- Lower vertical height-depth ratio: (Sn–Gn′/C–Gn′):[4] Ratio of distances from subnasale to gnathion and cervical point to gnathion
- Lower lip protrusion: (Li–[Sn–Pg]):[5] Distance measured from subnasale to soft tissue pogonion and measured perpendicular to the most prominent point of the lower lip
- Mento labial sulcus depth: Si (Li–Pg′):[5] Distance measured from the depth of the sulcus perpendicular to Li–Pg line
- E-Line: (Pn–Pg′):[4] A line drawn from the tip of the nose to the soft tissue pogonion. It evaluates the position of upper lip and lower lip
- Soft tissue thickness of the chin at pogonion (Pg–Pg′):[6] Distance measured from a line drawn from hard tissue pogonion to soft tissue pogonion
- Soft tissue thickness of the chin at menton (Me–Me′):[6] Distance measured from a line drawn from hard tissue menton to soft tissue menton
- Soft tissue thickness of the chin at gnathion (Gn–Gn′):[6] Distance measured from hard tissue gnathion to soft tissue gnathion
- Lip competency: (Si–Ss):[4] Vertical distance from stomion inferius to stomion superius
- Soft tissue thickness of upper lip: (Point A – Sn): Distance measured from Point A to subnasale
- Soft tissue thickness of lower lip: (Point B–Si): Distance measured from Point B to mentolabial sulcus.

Angular parameters [Figure 2]

- Angle of facial convexity: (G–Sn–Pg′):[4] Angle formed by the line joined from Glabella to Subnasale to soft tissue Pogonion
- Lower lip-chin throat angle: (Sn–Gn′–C):[4] Angle formed by intersection of lines from labrae inferioris to soft tissue Pogonion and from soft tissue Pogonion to cervical point
- Naso labial angle: (Cm–Sn–Ls):[4] Angle formed by intersection of columella of the nose, subnasale and labrale superius
- Lip curl angle: (Li–Si–Pg′):[6] Angle of mentolabial sulcus.

RESULTS

A total of 20 patients (10 males and 10 females) of age ranging from 18 to 25 years, with a mean age of 21.1 years who underwent mandibular advancement surgery are included. It was observed that compared with the linear measurements, the angular measurements showed significant changes. The improvement in the esthetic outcome is a direct reflection of the angular changes while the linear changes played a contributing role [Figures 3-6].

Compared with the preoperative phase (T1) during the immediate postoperative phase (T2) there was a statistically significant difference observed in the reduction in the mandibular retrognathism, increase in the vertical height ratio, improvement in the angle of facial convexity and lower lip-chin throat angle and achievement of lip competency ($P < 0.05$). It was observed that most of these changes were stable during the late postoperative phase (T3).

The changes in the upper lip caused due to the surgical edema subsided from the T2 during T3 showing that mandibular advancement surgery had no effect on the soft tissues of the upper lip ($P < 0.05$). Overall compared to T1 and T3 the profiles of the patients was perceived to have improved with a statistically significant difference observed in the reduction in the mandibular retrognathism, increase in the vertical height ratio, reduction in the mentolabial sulcus depth, improvement in the angle of facial convexity and lower lip-chin throat angle and achievement of lip competency ($P < 0.05$).

The results are summarized as shown in Tables 1 and 2.

DISCUSSION

Literature is replete with articles describing changes in soft tissue with respect to bony movements. It is commonly accepted that soft tissue pogonion and soft tissue B point move on a 1:1 ratio, with hard tissue changes and lower lip changes at a 0.5:1 ratio.[7] Given that both soft and hard tissue remodels as we age, one would expect time to be a factor in predicting soft tissue change. Keeling *et al*. reported that over time, the hard tissue surgical change is a weak predictor of the soft tissue projection.[8] Consequently, this study focused on soft tissue changes over time apart from skeletal changes.

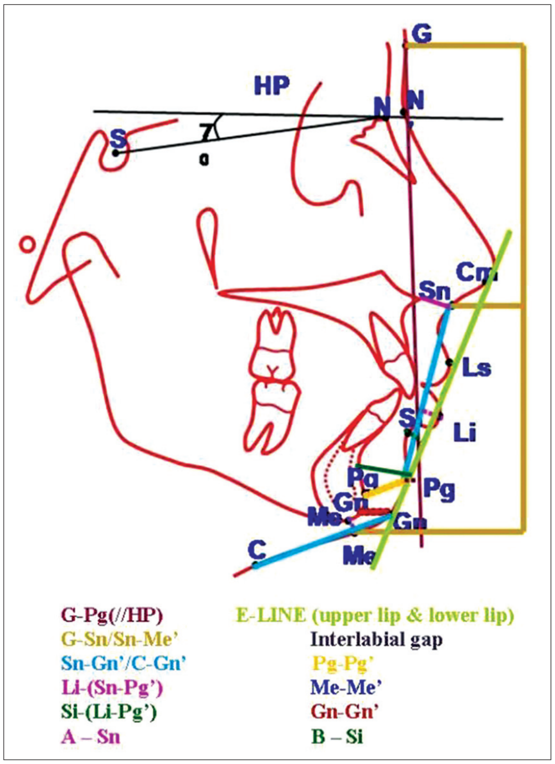

Figure 1: Linear parameters for soft tissue evaluation

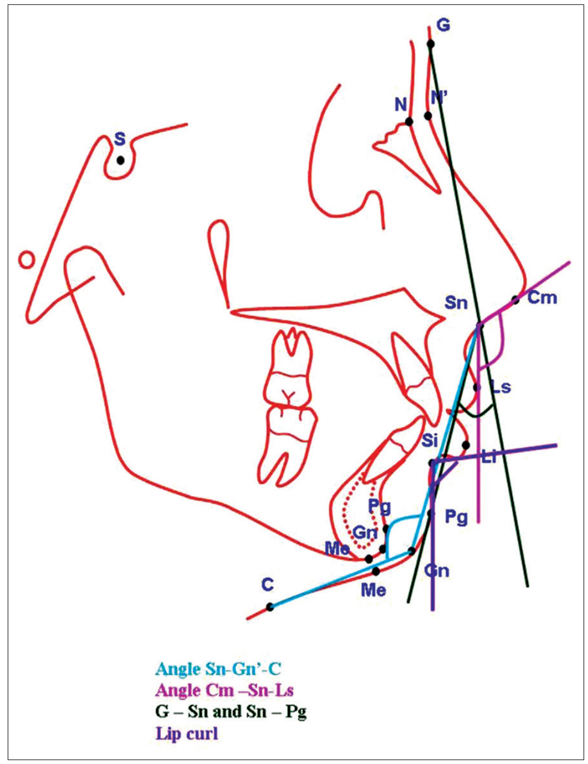

Figure 2: Angular parameters for soft tissue evaluation

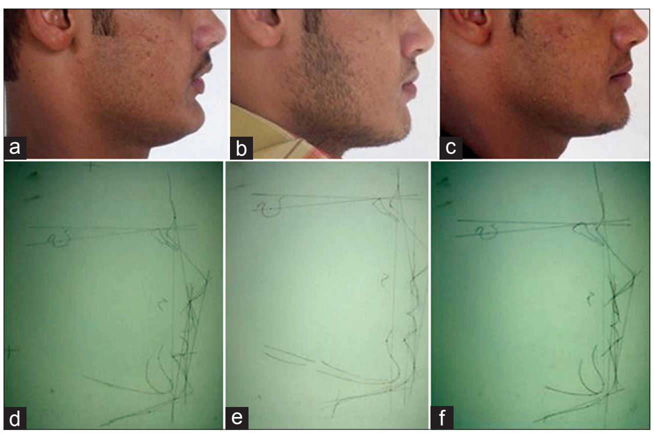

Figure 3: Case 1 - (a) Pre surgical phase, (b) Immediate postsurgical phase, (c) Late postsurgical phase, (d) Cephalometric tracing in the presurgical phase, (e) Cephalometric tracing in the immediate postsurgical phase, (f) Cephalometric tracing in the late postsurgical phase

With regard to facial convexity, Tsang *et al*. recommended mandibular advancement surgery in borderline patients with profile angles of 160° necessary for profile to be consistently perceived as improved after surgery and to minimize the incidence of profile worsening after treatment.[9] In our group of patient, the pre-surgical profile angles are in the range of 150–160° (mean of 150°). In T2, there were significant changes in the angle of facial convexity and lower lip chin-throat angle. The former tended to become more obtuse by a mean of 10°, while the latter became acuter by a mean of 8°. These changes were found to be stable in the long term which was in accordance with previous studies.[5,10]

Table 1: Measurements of the linear parameters

Parameter	Mean difference (mm)	
	T1-T2	T2-T3
Mandibular retrognathism	6.0	0.1
Vertical height ratio	0.05	0.01
Lower vertical height-depth ratio	0.03	0.03
Lower lip protrusion	0.8	0.3
Mento labial sulcus depth	1.2	0.4
E - line	0.0	0.1
Soft tissue thickness of the chin at pogonion	0.7	0.6
Soft tissue thickness of the chin at menton	0.5	0.1
Soft tissue thickness of the chin at gnathion	0.2	0.2
Lip competency	3.0	0.5
Soft tissue thickness of upper lip	0.9	0.1
Soft tissue thickness of lower lip	0.4	0.0

Table 2: Measurements of the angular parameters

Parameter	Mean difference (degree)	
	T1-T2	T2-T3
Angle of facial convexity	6	0
Lower lip - chin throat angle	8	1
Naso labial angle	3	2
Lip curl angle	17	1

About the changes in the upper lip, there was an initial anterior movement by a mean of 0.4 mm, which was probably related to postoperative edema that gradually faded. In T3, it was observed

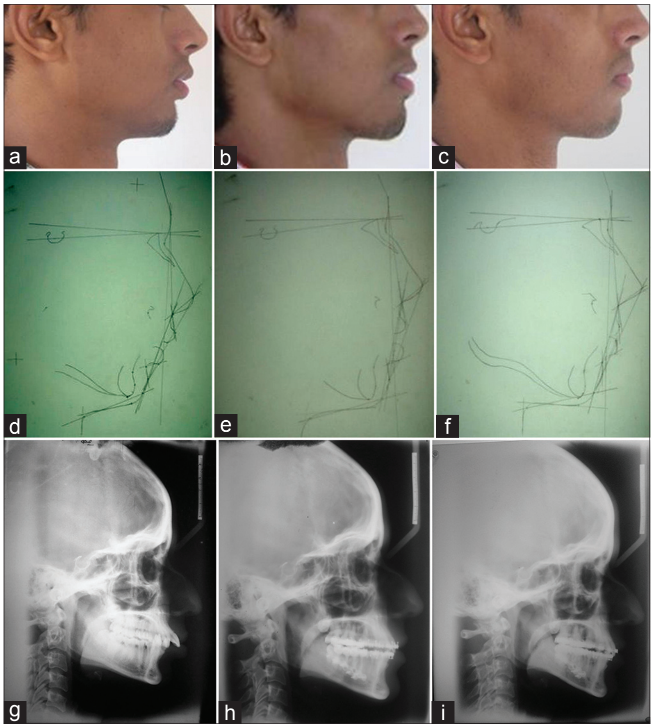

Figure 4: Case – 2 (a) Pre surgical phase, (b) Immediate postsurgical phase, (c) Late postsurgical phase, (d) Cephalometric tracing in the pre surgical phase, (e) Cephalometric tracing in the immediate postsurgical phase, (f) Cephalometric tracing in the late postsurgical phase, (g) Pre surgical cephalogram, (h) Immediate postsurgical cephalogram, (i) Late postsurgical cephalogram

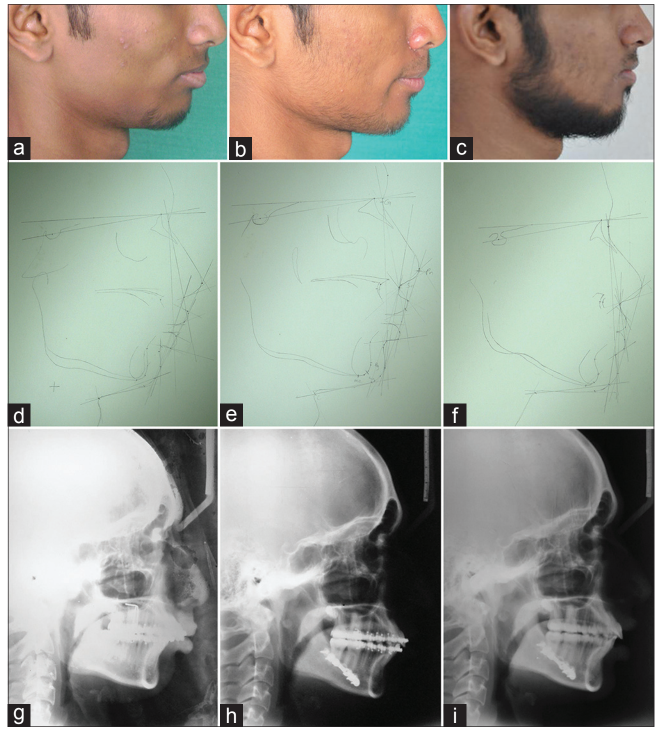

Figure 5: Case – 3 (a) Pre surgical phase, (b) Immediate postsurgical phase, (c) Late postsurgical phase, (d) Cephalometric tracing in the pre surgical phase, (e) Cephalometric tracing in the immediate postsurgical phase, (f) Cephalometric tracing in the late postsurgical phase, (g) Pre surgical cephalogram, (h): Immediate postsurgical cephalogram, (i) Late postsurgical cephalogram

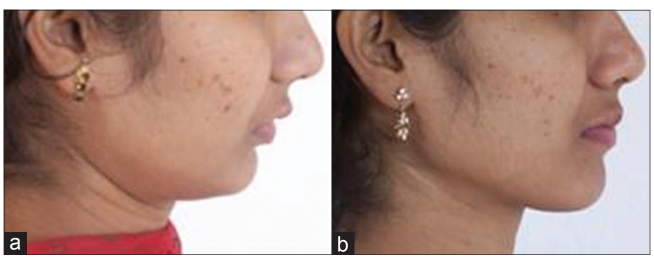

Figure 6: Case – 4 (a) Presurgical phase, (b) Late postsurgical phase

that a mild posterior movement of the upper lip beyond its preoperative position by a mean of 0.8 mm.

We found a reduction in the nasolabial angle in T2 by a mean of 3° related to the postoperative edema, but then in T3, an increase in the nasolabial angle, approaching close to the T1 were most noticeable. However, it is seen that the effects of surgery on the upper lip position are of little clinical significance after mandibular advancement.[7,8,10-12]

Several authors commented on the high variability in the lower lip position after mandibular advancement surgery. In this study, it was observed that the lower lip thickness was reduced by a mean of 0.4 mm in T2 and the thickness remained stable in T3. Change in the lower lip thickness actually represents an unrolling and stretching of the lip as the tooth-bearing segment is advanced and rotated clockwise. Decrease in thickness apparently accounts for the reduced anterior repositioning of the lower lip compared with the mentolabial sulcus and chin. The differential anterior relocation of the lower lip and chin results in straightening of the lower lip and the mentolabial sulcus becoming shallower.

Quast DC stated that there is a tendency for the lower lip length to increase following mandibular advancement.[13] Ewing and Ross felt that the behavior of the lower lip after mandibular advancement is very inconsistent.[14] A difference of 2–3 mm in either direction from the predicted movement could be expected and an accurate prediction of the structural changes that occur when the often everted lower lip is allowed to unfurl as the jaw relationship is normalized is difficult. Many factors, such as the preoperative thickness of the lower lip, positional changes of the lower incisors by the postoperative orthodontic treatment and difficulty in reproducing a relaxed lip position when the cephalometric radiographs are repeatedly taken may influence the lower lip profile.

In respect to E-line to upper lip, the variable showed a significant increase in the value in T2 by a mean of 1.6 mm in contrary the lower lip showed no significant changes following mandibular advancement. With regards to the E-line, the point Pg′ moved forward due to surgical advancement of the mandible. Furthermore, the lower lip is brought forward while there is no change in the sagittal position of the upper lip. This could explain the differences in the changes of upper and lower lip. However, in T3, these changes were found to be adequately stable.[10]

Of the 20 patients in our group, 18 patients had lip incompetency by a mean of 3.5 mm in T1. We achieved lip competency in 18 out of the 18 patients in T2 that was also stable in T3.

We found that in the case of chin, depth of the mentolabial sulcus reduced by a mean of 1.2 mm, lip curl angle increased by a mean of 17°, the thickness of the soft tissue chin in the regions of pogonion, gnathion and menton reduced by a mean of 0.7 mm, 0.4 mm and 0.2 mm respectively in T2. It is felt that this could probably be due to the stretch of the soft tissues to compensate for the advanced mandible, in spite of the existing postoperative edema.

In T3, lip curl angle was stable along with the soft tissue thickness of the chin in the regions of gnathion, pogonion and menton. The we can collaborate our findings in this study to Mommaerts and Marxer who reported that the soft tissue thickness of the chin at the region of menton remained unchanged and mentolabial sulcus depth decreased but the behavior of the lower lip at labrale inferius was noted to be variable in the postsurgical phase.[15] Iizuka *et al*. also reported that the soft tissue pogonion and the mentolabial sulcus were less affected by the postoperative edema and showed minimal changes between the short term and long term periods.[11] In contrast, the inferior labrae is strongly affected by the postoperative edema and there is no consensus concerning the effect of mandibular advancement surgery on the lower lip position. Similarly, this study reveals that the soft tissue pogonion and mentolabial sulcus are less affected by postoperative edema while the upper and lower lips were strongly affected.

Hamada *et al*. reported that the tendency of changes in the soft tissue was different in the lower lip area from the chin area in both the horizontal and vertical dimensions.[16] Different anatomical structures, as well as the relations between the soft tissue and the underlying hard tissue, are directly linked to a different mobility and flexibility in the soft tissue of the lip and chin areas. It is thus speculated that the accurate prediction of changes in the profile following surgery is more difficult for the lower lip compared to the chin due to its ability of transformation. In contrast this study reveals that both the lower lip and the soft tissue thickness at the chin region are more or less stable in the late postsurgical phase.

Gjorup and Athanasiou claimed that operative changes in the position of the upper and lower lips and the soft tissue at the chin are influenced by the initial preoperative thickness of the area.[7] Hu *et al*. investigated the soft tissue profile changes after surgical correction of mandibular prognathism in Chinese patients and the sex differences in the ratios of soft tissue to hard tissue change.[17] His study showed that greater thickness of soft tissue in men resulted in a smaller ratio of soft to hard tissue change after surgery.

Few authors reported that soft tissue movement was greater in women compared with men for the upper lip and the chin.[2,5,18] Our study did not reveal any significant differences related to males and females in the soft tissue responses following surgery. Hence, the soft tissue response and its stability depends on the severity of the dentofacial deformity in the presurgical phase, stability of the surgical procedure itself and postsurgical growth and remodeling of the hard tissues and soft tissue changes as a result of maturation and aging but not solely on the presurgical soft tissue thickness.[18,19]

Keeling *et al*. reported that the soft tissue response measured at immediate postoperative phase decreased rapidly between 2 and 6 months, but thereafter the soft tissue relapse remained significantly small or nearly unchanged.[8] Chou *et al*. showed that the swelling caused by mandibular advancement began to resolve by 8 weeks and was fully resolved by 6 months after which the soft tissue changes were stable.[18] Hence, the use of 6 months postsurgical follow-up period in this study to predict and gauge the soft tissue changes and their stability following mandibular advancement is justified.

CONCLUSION

Following mandibular advancement surgery it was observed that the profiles of the patients was perceived to be improved with reduction in the facial convexity, an increase in the lower facial height, decrease in the depth of the mentolabial sulcus and improvement in the lip competency. However, postsurgical growth and remodeling of the hard tissues and soft tissue changes as a result of maturation and aging should be taken into account while planning for an orthognathic surgery.

REFERENCES

1. McNeill RW, Proffit WR, White RP. Cephalometric prediction for orthodontic surgery. Angle Orthod 1972;42:154-64.
2. Joss CU, Joss-Vassalli IM, Kiliaridis S, Kuijpers-Jagtman AM. Soft tissue profile changes after bilateral sagittal split osteotomy for mandibular advancement: A systematic review. J Oral Maxillofac Surg 2010;68:1260-9.
3. Joss CU, Vassalli IM, Thüer UW. Stability of soft tissue profile after mandibular setback in sagittal split osteotomies: A longitudinal and long-term follow-up study. J Oral Maxillofac Surg 2008;66:1610-6.
4. Reyneke JP. Text Book on the Essentials of Orthognathic Surgery. Ch. 2. Quintessence Publisher:UK; 2003. p. 34-6.
5. Mobarak KA, Espeland L, Krogstad O, Lyberg T. Soft tissue profile changes following mandibular advancement surgery: Predictability and long-term outcome. Am J Orthod Dentofacial Orthop 2001;119:353-67.
6. Kneafsey LC, Cunningham SJ, Petrie A, Hutton TJ. Prediction of soft-tissue changes after mandibular advancement surgery with an equation developed with multivariable regression. Am J Orthod Dentofacial Orthop 2008;134:657-64.
7. Gjørup H, Athanasiou AE. Soft-tissue and dentoskeletal profile changes associated with mandibular setback osteotomy. Am J Orthod Dentofacial Orthop 1991;100:312-23.
8. Keeling SD, LaBanc JP, Van Sickels JE, Bays RA, Cavalieros C, Rugh JD. Skeletal change at surgery as a predictor of long-term soft tissue profile change after mandibular advancement. J Oral Maxillofac Surg 1996;54:134-44.
9. Tsang ST, McFadden LR, Wiltshire WA, Pershad N, Baker AB. Profile changes in orthodontic patients treated with mandibular advancement surgery. Am J Orthod Dentofacial Orthop 2009;135:66-72.
10. Mihalik CA, Proffit WR, Phillips C. Long-term follow-up of Class II adults treated with orthodontic camouflage: A comparison with orthognathic surgery outcomes. Am J Orthod Dentofacial Orthop 2003;123:266-78.
11. Iizuka T, Eggensperger N, Smolka W, Thüer U. Analysis of soft tissue profile changes after mandibular advancement surgery. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2004;98:16-22.
12. Eggensperger NM, Lieger O, Thüer U, Iizuka T. Soft tissue profile changes following mandibular advancement and setback surgery an average of

12 years postoperatively. J Oral Maxillofac Surg 2007;65:2301-10.
13. Quast DC, Biggerstaff RH, Haley JV. The short-term and long-term soft-tissue profile changes accompanying mandibular advancement surgery. Am J Orthod 1983;84:29-36.
14. Ewing M, Ross RB. Soft tissue response to mandibular advancement and genioplasty. Am J Orthod Dentofacial Orthop 1992;101:550-5.
15. Mommaerts MY, Marxer H. A cephalometric analysis of the long-term, soft tissue profile changes which accompany the advancement of the mandible by sagittal split ramus osteotomies. J Craniomaxillofac Surg 1987;15:127-31.
16. Hamada T, Motohashi N, Kawamoto T, Ono T, Kato Y, Kuroda T. Two-dimensional changes in soft tissue profile following surgical mandibular advancement in Japanese retrognathic adults. Int J Adult Orthodon Orthognath Surg 2001;16:272-9.
17. Hu J, Wang D, Luo S, Chen Y. Differences in soft tissue profile changes following mandibular setback in Chinese men and women. J Oral Maxillofac Surg 1999;57:1182-6.
18. Chou JI, Fong HJ, Kuang SH, Gi LY, Hwang FY, Lai YC, *et al.* A retrospective analysis of the stability and relapse of soft and hard tissue change after bilateral sagittal split osteotomy for mandibular setback of 64 Taiwanese patients. J Oral Maxillofac Surg 2005;63:355-61.
19. Forsberg CM. Facial morphology and ageing: A longitudinal cephalometric investigation of young adults. Eur J Orthod 1979;1:15-23.

Cite this article as: Uppada UK, Sinha R, Reddy DS, Paul D. Soft tissue changes and its stability as a sequlae to mandibular advancement. Ann Maxillofac Surg 2014;4:132-7.

Source of Support: Nil, **Conflict of Interest**: None declared.