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Original Research Paper

Surgery

A STUDY OF SOFT TISSUE PROFILE CHANGES FOLLOWING MAXILLARY OSTEOTOMIES

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ABSTRACT

PURPOSE OF THE STUDY: This study was done to investigate the two dimensional changes in the bone and the ratio of movements of overlying soft tissues in the upper lip region of the facial complex following maxillary osteotomies.

MATERIALS AND METHODS: Preoperative and postoperative lateral cephalograms of patients who underwent maxillary osteotomy were taken. Soft tissue points (VB,SLS,Sn)were compared with the underlying hard tissue points (I &A)using constructed horizontal plane as the reference line.

RESULTS: Soft tissue changes in relation to hard tissue changes noted in various lip regions were 0.801, 0.801&0.343 when points VB to I, SLS to A ,and Sn to A were compared respectively.

CONCLUSION: The predictability and significance of changes of soft tissue in relation to hard tissue is variable as it reaches towards the nose. These ratios can be used for treatment planning to obtain predictable results

KEYWORDS :

INTRODUCTION

In the 13th century Thomas Aquinas states a fundamental truth of esthetics:" The senses delight in things duly proportioned". St.Thomas was expressing the direct and often measurable relationship that exists between beauty and mathematics , a relationship that applies to both natural beauty and art.

The human face is a complex mosaic of lines, angles, planes, shapes, textures and colors. The inter play of these elements produces an infinite variety of facial forms from near perfect symmetry to extreme disproportion. An esthetically pleasing face is regarded as one in which the facial features are well proportioned and balanced and relate well to each other.

To establish a concept of facial balance or proportions ,imaginary lines are drawn through various facial landmarks,and the various features are measured in relation to the rest of the face. This type of study is known as "Cephalometric study"

Severe maxillary protrusion is a common dentofacial deformity causing functional and aesthetic problems. A thorough clinical examination and understanding of this dentofacial deformity is important to choose the best treatment modality.

Orthognathic surgery isconsidered to be the principal tool for correcting severe dentofacial skeletal discrepancies. The major goal of orthognathic procedures is not only of establishing balanced and stable dentoskeletofacial complex,but also the achievement of aesthetically pleasing overlying soft tissue envelope . Lefort1 osteotomy with set back and anterior subapical osteotomy with extraction of premolars was successfully used by several others for correction of maxillary protrusion.

The muscles of facial expression originate from the underlying facial bones that are repositioned during orthognathic surgery. Similarly these muscles are often incised ,and elevated during surgery. It is hypothesized that the disruption of these muscles, their origins, vectors of movement and their length would have an effect on the soft tissue movement.

Although some authors have studied the soft tissue changes following orthognathic surgery, the soft tissue profile changes resulting from maxillary osteotomies in severe cases are still debatable. The objective of this study was to evaluate the changes in the hard tissue and changes in the soft tissue profile after maxillary ostetomy using cephalometric analysis.

AIM OF THE STUDY

To assess the two dimensional changes in the bone and the ratio of movements of the overlying soft tissue in the upper lip region following maxillary osteotomy.

MATERIALS AND METHODS

This is a retrospective study on 20 pateints who had undergone maxillary osteotomy (Lefort1, anterior maxillary osteotomy, or Lefort1+ anterior maxillary osteotomy)in a teaching hospital in south India.

Criteria for selection of patients:

1. Patients were non growing adults.(age group ranging from22-35)
2. They had a natural dentition supporting the lips.
3. Patients demonstrated a maxillary prognathism or retrognathism for which surgical intervention was necessary.
4. The criteria applied included an average follow up of 6 post operative months.
5. Patients upon whom Lefort1osteotomy, anterior maxillary osteotomy, or Lefort1+ anterior maxillary osteotomy performed were studied.
6. Records consisting of standardized lateral cephalograms that met the following criteria were available on all patients.

a. A pre operative radiograph taken within one week of surgery (T1)

b. A postoperative radiograph taken 6 months after surgery (T2)

The radiographs were taken at an average of six months post operatively to avoid the period of post operative edema and to ensure soft tissue stability

c.All radiographs were taken in centric relation with lips in repose

CEPHALOMETRIC ANALYSIS

Before tracing the radiograph three orientation crosses were drawn on the radiograph, two within the cranium and one over the area of the cervical vertebrae. Then the three orientation crosses were traced into the acetate paper. After this, the soft tissue and hard tissue outline were traced and the cephalometric landmarks were identified in the soft tissue and hard tissue.

Here in this study the preoperative and post operative tracing records were compared to analyse the soft tissue profile changes in relation to hard tissue changes in the upper lip after maxillary osteotomy. Only horizontal changes were analysed for which an X-Ycoordinate system was used. The X axis was determined as a line rotated 7 degree upwards from SN line through N. This line is called "Constructed horizontal plane "which was used as the reference line for this study.

STUDY 1

Shift I and **Shift VB** were developed to describe the stability of surgical treatment and to relate the movement of underlying skeletal structure with resultant soft tissue profile changes.

Shift I – Millimeter movement of the incisal edge of the maxillary incisor along the x axis at 90^0 to x axis.

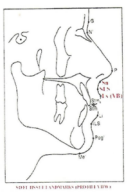
Shift VB - Millimeter movement of the upper lip to that of maxillary incisor.

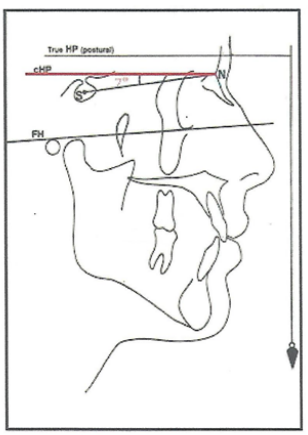
Hard Tissue Landmarks :

Sella (S)
Nasion (N)
Anterior nasal spine (ANS)
Posterior nasal spine (PNS)
Maxillary molar
Mandibular molar
Point A
Maxillary incisor
Point B
Pogomon (pg)
Gnathion (Gn)
Gonion (Go)

Soft Tissue Landmarks :

Soft tissue nasion (Ns)
Pronasale (Prn)
Subnasale (Sn)
Superior labial sulcus (SLS)
Labrale superius (LS)
Labrale inferius (LI)
Inferior labial sulcus (ILS)
Soft tissue pogonion (Pgs)
Soft tissue gnathion (Gns)
Stomion (Sto)

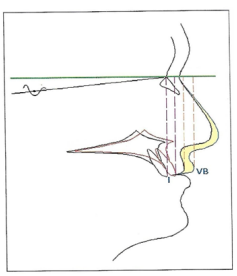




CEPHALOMETRIC PLANE OF REFERENCE

Point VB-(Vermillion border/Ls-labrale superius) most superior anterior point on the outline of the upper lip and corresponds closely to the vermillion border

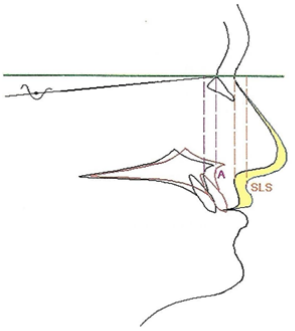
Point I- Most inferior position of upper central incisor



COMPARISON OF SHIFT VB AND SHIFT I

STUDY II

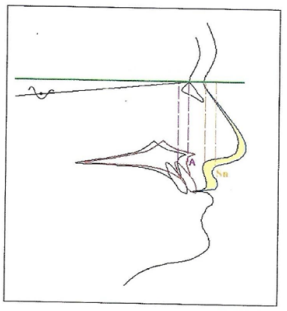
Shift A and **Shift SLS** were compared in the same way
Shift SLS-Millimeter change in superior labial sulcus
Shift A- Millimeter change in subspinale
Point A (SubSpinale): The most concave portion of anterior maxilla, below anterior nasal spine
Point SLS(Superior labial sulcus): The Point of greatest concavity in the midline of upper lip between subnasale and labrale superius



COMPARISON OF SHIFT SLS AND SHIFT A

STUDY III

Shift A and **Shift Sn** (Subnasale) were compared
Shift Sn- Millimeter change in Subnasale
Shift A- Millimeter change in Subspinale
PointSn(Subnasale) -The point at which the columella (nasal septum) merges with the upper lip in the mid sagittal plane



COMPARISON OF SHIFT Sn and SHIFT A

Soft tissue change –Analysis

Analysis of the relationship of soft tissue change to hard tissue change (surgically produced) were accomplished by calculating the ratios of

1.Shift VB/Shift 1
2. Shift SLS/Shift A
3. ShiftSn/Shift A

The values obtained were statistically analysed and compared

RESULTS

TABLE I
COMPARISON OF SHIFT VB WITH SHIFT I

No.	Shift I	Shift VB	Shift VB/Shift I
1.	8	7	.86
2.	7.5	5	.67
3.	7	5	.71
4.	9.5	8	.84
5.	9.5	8	.84
.6.	7.5	6	.80
7.	8.5	6	.71
8.	8.5	7	.82
9.	5.5	5.5	1.00
10.	6.5	5	.78
11.	7	6	.86
12.	9	7	.78
13.	10	8	.80
14.	11	8	.73
15	8	6	.75
16.	8	6	.75
17.	11	8.5	.77
18.	11	10	.91
19.	7	6.5	.93
20.	7	5	.71

Mean= 0.801
I - Maxillary Incisor tip (Hard tissue)
VB - Vermillion border (Soft tissue)

TABLE II

COMPARISON OF SHIFT SLS WITH SHIFT A

No.	Shift A	Shift SLS	Shift SLS/ Shift A
1.	7	6	.86
2.	7	5	.71
3.	7	5	.71
4.	9	7	.78
5.	8.5	7	.82
6.	7	5	.71
7.	7.5	6	.80
8.	7.5	6	.80
9.	5.5	5	.90
10.	6	5	.83
11.	6.5	6	.78
12.	9	7.5	.83
13.	9	7	.78
14.	10	8.5	.85
15.	7.5	6	.80
16.	7.5	6	.80
17.	10	8.5	.85
18.	10	8.5	.85
19.	6.5	5	.78
20.	6.5	5	.78

Mean= 0.801
A- Point A (Subspinale) (hard tissue)
SLS - Superior labial sulcus (Soft tissue)

TABLE III

COMPARISON OF SHIFT Sn WITH SHIFT A

No.	Shift A	Shift Sn	ShiftSn/ ShiftA
1.	7	2.5	.36
2.	7	2.5	.36
3.	7	3	.43
4.	9	4	.44
5.	8.5	3.5	.41
6.	7	3	.43
7.	7.5	3	.4
8.	7.5	2.5	.34
9.	5.5	1.5	.27
10.	6	2	.33
11.	6.5	2	.31
12.	9	3.5	.39
13.	9	3	.33
14.	10	3.5	.35
15.	7.5	2	.27
16.	7.5	2	.27
17.	10	3	.30
18.	10	2.5	.25
19.	6.5	2	.31
20.	6.5	2	.31

Mean = 0.343
A- Point A (Subspinale) (hard tissue)
Sn - Submanale (Soft tissue)

TABLE IV

COMPARISON OF MEAN ± STANDARD DEVIATION OF SHIFT VB WITH SHIFT I

Group	Mean ± SD	't' value	'p' valve
Shift I	8.35 ±1.58	3.5531	p<0.001
Shift VB	6.68 ±1.39		

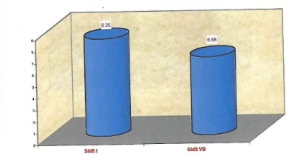


TABLE V

COMPARISON OF MEAN ± STANDARD DEVIATION OF SHIFT SLS WITH SHIFT A

Group	Mean ± SD	't' value	'p' value
Shift A	7.73±1.37	3.741	p<0.001
Shift SLS	6.25 ± 1.25		

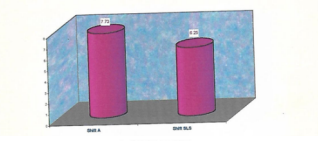


TABLE VI

COMPARISON OF MEAN ± STANDARD DEVIATION OF SHIFT Sn WITH SHIFT A

Group	Mean ± S.D	't' value	'p'- value
Shift A	7.73±1.37	14.89	p<0.0001
Shift Sn	2.65 ±0.67		

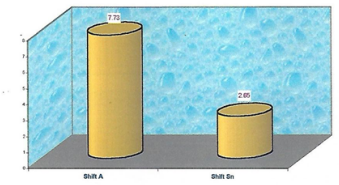
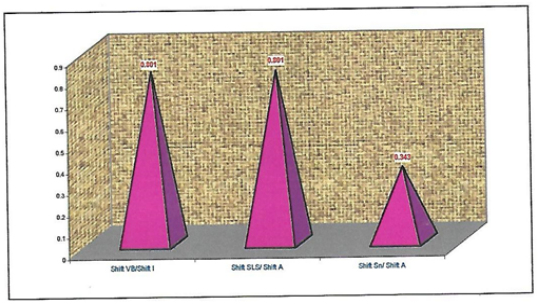


TABLE VII

COMPARISON OF CHANGE IN RATIOS

Group	Mean ± S.D of ratios	't' value of change	'p' value
Shift VB / Shift I	0.801± 0.084	---	---
Shift SLS / Shift A	0.801 ± 0.051	0	---
Shift Sn / Shift A	0.343 ± 0.06	7.89	P<0.001



From Table 7 it is observed that the ratio of Shift VB to Shift 1was 0.801 +_0.084 which is exactly the same even in the case of Shift SLS to Shift A. At the same time Shift Sn to Shift A is computed as 0.34+_0.06 which has shown a remarkable reduction. The difference in the mean ratios of Shift Sn to Shift A has been compared with Shift VB to Shift 1 as well as Shift SLS to Shift A and was found highly statistically significant (t=7.89,df=38.p<0.001).Since the ratio of mean Shift VB to Shift 1 and Shift SLS to Shift A happened to be the same, no further statistical analysis is found necessary.

DISCUSSION

This study was done to compare and analyse the soft tissue profile changes in relation to underlying hard tissue changes after maxillary osteotomy. Though maxillary osteotomies produce changes in the various regions of the facial complex, these changes are more predominant in the upper lip region. Both horizontal and vertical changes after maxillary osteotomies can be studied by cephalometric analysis. But this study was aimed at analyse the horizontal (anteroposterior)changes as they were more productive according to various authors. From the results of the study done by Arja Heliovaara et al[7] in 2000, the horizontal mean change in the upper lip profile was 80%of the skeletal change whereas the vertical mean soft tissue change was lesser 40%. Same type of study done by Hui.et al[8] in 1994 showed that upper lip movement with the underlying hard tissue was with a ratio of one half horizontally and one third vertically.

In this study preoperative and postoperative lateral cephalograms were taken and certain hard tissue and soft tissue land marks were compared and statistically analysed. The results showed a mean change of 0.801 for Shift VB/ShiftI which concludes a soft tissue change of 0.801 mm for every 1mm change of hard tissue . In 1974 Lines et al [1] concluded ,a soft tissue change of 0.67mm per1 mm of underlying hard tissue change while comparing the points I&VB. William.H.Bell and John J Dain proved a relationship of .73 :1.Park et al [2] in his study found that the ratio of upper lip to maxillary incisor was 0.67:1.A similar study done by Carlotti et al[3] in 1986 showed a mean change of 0.9:1 which closely approximates the result of this study. According to Fonseca [4],the difference between the studies of Lines et al and Carolotti

was because of the use of alar cinch suture and V-Y closure during the surgical procedure. Morgas et al [5] reported that the upper lip tends to follow the skeletal movement more closely if both alar cinch suture and V-Yclosure are performed. In his study he found that a ratio of 0.6:1 could be used in Le Fort I advancement surgery if alar base cinch suture is not performed, and a ratio of 0.9:1 if it is performed. The study conducted by Parades deSousa Gil[6] states that the alar cinch suture and v-y closure technique seemed to have little effect in counter acting the undesirable post operative nasolabial changes.

A mean change of .801:1 was also seen when points A and SLS were compared. A similar study done by Bundgaard et al [9] showed a mean change of 0.8:1 which is very supportive with this study. The ratio obtained for Wen-Ching Koe et al[10]was 0.96:1.

The ratio obtained while comparing the points Sn and A was 0.343:1 which was very much inferior to the values obtained while comparing the other two parameters. Rosen [11] in 1988 also conducted the same study and concluded from his studies a mean soft tissue to hard tissue change of 0.5:1 while comparing the same landmarks. Simliar studies done by Stella etal [12](1989) and Freihofer [13] (1976)showed a mean change of 0.46:1 and 0.57:1 respectively.

These studies by Freihofer and Rosen were done only on thin lipped patients which is more predictable than thick lips. It may be because the actual bulk of a thick lip may have a tendency to absorb a large amount of bony advancement without a predictable change in soft tissue. Dead space under the lip may absorb the first portion of a bony advancement before the soft tissue is affected and becomes clinically apparent. The upper lip is attached to the nose and this prevents a 1:1 soft tissue to hard tissue change. The area where the lip is attached to the nose ,the soft tissue change will be comparatively less than the lower areas of upper lip which is supported mainly by underlying tooth. Burstone et al [14] suggested that a direct relationship between hard and soft tissue changes may always exist because of variation in the thickness of the soft tissue covering the face. M.MShawky et al [15](2012) has found that the hard and soft tissue changes were only observed in the maxillary region ,upper lip area and nasal tip. Soft tissue mean change included 53%of backward displacement of theLabrale Superius in relation to bone displacement and 18.7%mean increase in the naso labial angle. The highest correlation coefficient was obtained between the hard and soft tissue changes in the upper lip region[16]

Analysis of soft tissue changes associated with maxillary osteotomies in this study reveals a highly significant correlation of bone changes and soft tissue changes. The data suggest good predictability of profile changes relative to the surgically produced hard tissue changes. Dr.William.H.Bell suggests use of the figure 0.7+/0.1 for clinical use in predicting upper lip position after anterior maxillary osteo tomies.

CONCLUSION

Under the conditions of the study the following conclusions were drawn.

1. The upper lip responded variably to the direction and amount of maxillary repositioning
2. Simple regression equations and ratios were satisfactory for the analysis of selected soft tissue points
3. The upper lip is attached to the nose, which prevents a 1:1 soft tissue change
4. The predictability and the significance of changes of soft tissue in relation to hard tissue is variable as it reaches the nose.

To conclude, a better understanding of the relationship between skeletal movement and the response of the overlying soft tissue is essential to improve the predictability of aesthetic soft tissue result after maxillary surgery. If we know the ratios of movements of soft tissue in relation to hard tissue, maxillofacial surgeons can plan the bony movement to be undertaken during surgery for a better soft tissue profile. The main drawback of this study is that it is a two dimensional analysis of three dimensional picture. Nevertheless it is the most popularized and simplest method for the study of soft tissue changes.

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