
**“ANALYSIS OF SOFT TISSUE CHANGES
BEFORE AND AFTER ORTHOGNATHIC
SURGERY USING A 3-DIMENSIONAL CAMERA-
AN INTERVENTIONAL CLINICAL STUDY”**

By

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Dissertation

Submitted to

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In partial fulfilment of the requirements for the degree of

**MASTERS OF DENTAL SURGERY
IN
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ORTHOPAEDICS
(BRANCH – V)**

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ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS
KLE VISHWANATH KATTI INSTITUTE OF DENTAL SCIENCES,
KAHER, BELAGAVI, KARNATAKA.**

2021 – 2024

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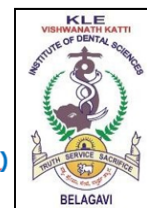
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ABSTRACT

Introduction: Orthognathic surgery is a surgical procedure employed to align the maxilla and mandible to each other and is used to correct various dentofacial anomalies and skeletal discrepancies after growth has ceased of an individual.

Orthognathic surgery alters the facial soft tissue contours by changing the underlying skeletal tissue, it is therefore used to create a more attractive face. Facial soft tissue analysis is an important step in the pre-surgical planning and evaluation of a patient. Cephalometry is usually the method used to analyse the results of orthognathic surgery, it is however predominantly useful in the analysis of hard tissue landmarks. 2-D cephalometry helps us assess lateral profile and provides little to no information regarding facial soft tissue. There are many surgical planning tools and applications available that help the dentist as well as the patient view the probable results after orthognathic surgery, but most of them are based on 2-D cephalometric data and their lateral superimpositions with 2-D photographs. 3D cameras have been in use for the analysis of facial soft tissue landmarks and have a high resolution that yields accurate and reproducible data. 3D cameras allow for analysis of frontal views that are not possible by lateral cephalometry. Moreover, 3D camera images can be zoomed, rotated and translated, providing realistic results of the effects of planned orthodontic and surgical treatment.

The purpose of this study is to utilize a 3D camera system to quantitatively analyse soft tissue changes after orthognathic surgery.

Materials and methods: 25 patients who underwent Orthognathic Surgery were considered in this study. Presurgical as well as post-surgical 3-Dimensional

photographs were taken of these patients using 3-D camera (Bellus 3D). Landmarks were marked on the 3-Dimensional images of the patient. The actual distances between soft tissue landmarks before surgery, 1 month postoperatively and 2 months postoperatively were measured. The pre-surgical and post-surgical measurements were then compared

Results: Mandibular setback surgery caused a reduction in the lower facial height, mandibular height and upper vermilion height and an increase in the bi-gonial width and lower vermilion height in these patients. Patients who underwent bi-jaw surgery showed increase in the middle third of the face, maxillary height, bi-gonial width, lip length and upper and lower vermilion heights. There was a reduction in the lower facial height, mandibular height and a slight reduction in zygomatic width.

Conclusion: The 3-D Camera used in the study can be useful as a diagnostic and predictive aid and enables an accurate evaluation of the initial and final soft tissue positions in Orthognathic surgical cases.

CONTENTS

SL NO.	PARTICULARS	PAGE NO.
1.	INTRODUCTION	1-2
2.	AIM AND OBJECTIVES	3
3.	REVIEW OF LITERATURE	4-7
4.	METHODOLOGY	8-19
5.	RESULTS	20-52
6.	DISCUSSION	53-56
7.	LIMITATIONS	57
8.	CONCLUSION	58-59
9.	SUMMARY	60
10.	BIBLIOGRAPHY	61-64
11.	ANNEXURES	65-69

LIST OF TABLES

TABLE NO.	PARTICULARS	PAGE NO.
1.	List of parameters assessed in the study	16
2.	Descriptive mean and standard deviation of the linear measurements of the upper, middle and lower thirds of patients	21
3.	Descriptive mean and standard deviation of the linear measurements of maxillary and mandibular heights of patients	23
4.	Descriptive mean and standard deviation of the linear measurements of transverse widths of patients	24
5.	Descriptive mean and standard deviation of the linear measurements of nasal landmarks of patients	25
6.	Descriptive mean and standard deviation of the linear measurements of lip landmarks of patients	26
7.	Comparison of the facial height between the time intervals	28
8.	Pairwise multiple Comparison of the lower one-third facial height of the study participants between the time intervals t_1 , t_2 and t_3	29
9.	Comparison of the maxillary and mandibular heights between the time intervals	30
10.	Pairwise multiple Comparison of the lower mandibular height of the study participants between the time intervals t_1 , t_2 and t_3	31

LIST OF TABLES

TABLE NO.	PARTICULARS	PAGE NO.
11.	Comparison of the transverse widths between the time intervals	32
12.	Pairwise multiple Comparison of the bi-gonial widths of the study participants between the time intervals t_1 , t_2 and t_3	33
13.	Comparison of the nasal landmarks between the time intervals	34
14.	Comparison of the lip landmarks between the time intervals	35
15.	Pairwise multiple comparison of the lip landmarks of the study participants between the time intervals	36
16.	Descriptive mean and standard deviation of the linear measurements of the upper, middle and lower thirds of patients	38
17.	Descriptive mean and standard deviation of the linear measurements of maxillary and mandibular heights of patients	40
18.	Descriptive mean and standard deviation of the linear measurements of transverse widths of patients	41
19.	Descriptive mean and standard deviation of the linear measurements across nasal landmarks of patients	42
20.	Descriptive mean and standard deviation of the linear measurements across lip landmarks of patients	43

LIST OF TABLES

TABLE NO.	PARTICULARS	PAGE NO.
21.	Comparison of the facial height of the study participants between the time intervals	44
22.	Pairwise multiple Comparison of the middle and lower thirds of the facial heights of the study participants between the time intervals t_1 , t_2 and t_3	45
23.	Comparison of the maxillary and mandibular height of the study participants between the time intervals	46
24.	Pairwise multiple Comparison of the maxillary and mandibular height of the study participants between the time intervals	47
25.	Comparison of the bi-zygomatic and bi-gonial widths of the study participants between the time intervals	48
26.	Pairwise multiple Comparison of the bi-zygomatic and bi-gonial widths of the study participants between t_1 , t_2 and t_3	49
27.	Comparison of the nasal landmarks of the study participants between the time intervals	50
28.	Comparison of the lip landmarks of the study participants between the time intervals	51
29.	Pairwise multiple comparison of the lip landmarks of the study participants between the time intervals.	52

LIST OF GRAPHS

GRAPH NO.	PARTICULARS	PAGE NO.
1.	Mean values of facial height of the study participants at different time intervals	16
2.	Mean values of maxillary and mandibular height of the study participants at different time intervals	21
3.	Mean values of zygomatic width and bi-gonial width of the study participants at different time intervals	23
4.	Mean values of the nasal landmarks of the study participants at different time intervals	24
5.	Mean values of lip landmarks of the study participants at different time intervals	25
6.	Mean values of facial height of the study participants at different time intervals	26
7.	Mean values of maxillary and mandibular height of the study participants at different time intervals	28
8.	Mean values of zygomatic width and bi-gonial width of the study participants at different time intervals	29
9.	Mean values of the nasal landmarks of the study participants at different time intervals	30
10.	Mean values of lip landmarks of the study participants at different time intervals	31

LIST OF ANNEXURES

ANNEXURE NO.	PARTICULARS	PAGE NO.
I	ETHICAL CLEARANCE CERTIFICATE	65
II	CONSENT FORM	66
III	PHOTOGRAPHS	67
IV	MASTER CHART (BSSO SETBACK GROUP)	68
V	MASTER CHART (BI-JAW SURGERY)	69

INTRODUCTION

Orthognathic surgery is a surgical procedure used to align the maxilla and mandible with each other and is used to correct various dentofacial anomalies and skeletal discrepancies after growth of an individual is completed.

The 2 main goals of orthognathic surgery are correcting the malocclusion of the patient and achieving pleasing facial aesthetics. Orthognathic surgery changes the contours of the facial soft tissue by changing the underlying skeleton, it is therefore used to produce more attractive facial features. Facial soft tissue analysis is an important step in the surgical planning and evaluation of a patient, surgical analyses such as COGS and Arnett's analysis are used for the evaluation of the soft tissue prior to surgical procedures. Cephalometry is routinely used to analyze the results of orthognathic surgery, however it is predominantly useful in the analysis of hard tissue landmarks and provides little to no information regarding facial soft tissue. 2-Dimensional lateral cephalometry helps us assess lateral profile but cannot help with 3-Dimensional or frontal analysis.^[1]

Various surgical planning tools and applications are available that aid the orthodontist as well as the patient to view the probable results after orthognathic surgery, but most of them are based on 2-Dimensional cephalometric data and the superimpositions with 2-Dimensional lateral profile photographs.

There are various challenges in the reconstruction of the 3-Dimensional maxillofacial form and performing 3-D maxillofacial analysis based on 2-D images. Patients usually desire to see the facial changes via 3-D images before and after orthognathic surgery, which is difficult if only 2-D data is available.^[3]

Methods employed for facial morphological analysis should have the following characteristics:

- The ability to record facial soft tissue data
- Good accuracy and precision
- Reproducibility
- Low technique sensitivity
- Safe for the patients and the operator
- Non-invasive
- Cost effective

Some methods of soft tissue analysis include –

- Direct craniofacial anthropometry
- Physioprint
- Stereophotogrammetry
- Photo cephalometry
- Video cephalometry
- Moire topography

All these approaches have limitations such as time required, poor reproducibility and/or possible errors in translations.

3D cameras have been in use for the analysis of facial soft tissue landmarks and have a high resolution that yields accurate and reproducible data. 3D cameras allow for analysis of frontal views that are not possible by lateral cephalometry. Moreover, 3D camera images can be zoomed, rotated and translated, providing realistic results of the effects of planned orthodontic and surgical treatment.

The purpose of this study is to utilize a 3D camera system to quantitatively analyze soft tissue changes after orthognathic surgery.

AIM AND OBJECTIVES

AIM:

To compare the measurements of soft tissue changes in frontal and lateral dimension following orthognathic surgery using a 3-Dimensional camera.

OBJECTIVES:

- To assess pre-surgical distances between soft tissue landmarks in orthognathic surgery patients using a 3-D camera
- To assess post-surgical distances between soft tissue landmarks in orthognathic surgery patients using a 3-D camera, 1 month post operatively and 2 months post operatively
- To measure soft tissue changes before and after orthognathic surgery in these patients

RESEARCH HYPOTHESIS

Null hypothesis – there is no comparative difference between the soft tissue changes measured using 3-D photographs before and after orthognathic surgery.

REVIEW OF LITERATURE

- **Jong Woo Choi *et al* (2013)^[1]**- In this study, the authors assessed 25 Asian patients (age range, 17-32 years) with skeletal class III malocclusion who underwent bi-jaw rotational surgery without maxillary advancement. They examined variations in facial symmetry, surface areas of the face, nose, lip shape, soft tissue cheek convexity, and vertical and horizontal landmarks using a 3D camera. They concluded that 3D cameras could potentially be utilized to analyse changes in frontal soft tissue landmarks and proportions that are not achievable with traditional cephalometry, and that they are beneficial in frontal soft tissue analysis for orthognathic surgery.
- **Minji Kim *et al* (2010)^[2]**- This study was done to analyse the 3-D changes in the soft tissue after mandibular setback surgery. 33 skeletal class III malocclusion patients treated with bilateral sagittal split ramus osteotomy were considered in this study. Lateral cephalograms and 3D facial scan images were taken before and 6 months after orthognathic surgery. Linear and angular measurements were made using Rapidform 2006. The results showed significant increase in length of upper lip and decrease in the length of the lower lip in large setback, hypodivergent, and genioplasty groups. The results also showed that mentolabial sulcus deepened less in the genioplasty group in comparison with other groups. Following a mandibular setback, the hyperdivergent group showed a greater increase in soft tissue convexity in the paranasal area compared to the hypodivergent group, even though there was no skeletal advancement of the maxilla. The conclusion stated that the extent

of setback, growth pattern and genioplasty could be used as guidelines for single jaw and bi-jaw surgeries in borderline cases.

- **B. van Loon *et al* (2014)^[4]**- This study was to evaluate the changes in the nasal region and upper lip due to orthognathic surgery using combined cone beam computed tomography and 3D stereophotogrammetry datasets. Patients undergoing Le Fort I osteotomy, with or without a mandibular bilateral sagittal split osteotomy, were included in this study. Preoperative and postoperative records of 3D stereophotogrammetry and CBCT scans were collected. The findings demonstrated that clockwise rotation of the maxilla and anterior repositioning increased both the alar width and lip volume. Three-dimensional soft tissue and hard tissue alterations in the maxilla might be analysed with the help of CBCTs and 3D stereophotogrammetry.
- **Jang Yeol Lee *et al* (2004)^[5]**- This study was conducted to determine the accuracy of a camera system for recording 3D images. A Rainbow 3D Camera Model 250 system (Genex Technologies Inc, Kensington, Md) was employed to take pictures of two distinct models: a dummy model designed to mimic a human, and a precision model that had been previously calibrated. Images of both models were taken at two different time points, one week apart. Measurements of specific distances were made, both directly on the models and from each image, repeatedly. The findings showed that substantial image distortion occurred when images at 90° were captured. Images seemed to be of highest accuracy when they were captured from the frontal perspective.

- **Min-Suk Kook *et al* (2013)^[3]**- The purpose of this study was to evaluate several methods to measure soft tissue landmarks. 15 landmarks were marked on 12 mannequin heads of different sizes and shapes and measurements were made using 5 different methods: Direct anthropometry, Digitizer, 3-D CT, 3-D scanner, and DI3D system. 10 measurement values representing the facial width, height, and depth were made twice within a one-week interval by a single examiner. Results showed that direct anthropometry, 3D CT, digitizer, 3D scanner demonstrated relatively similar values, while the DI3D system showed mildly different values. The conclusion states that 3D facial soft tissue analysis methods demonstrate adequate accuracy and reproducibility, and can be used in clinical practice and research studies.
- **Solem *et al* (2013)^[6]**- In this study, relationships between soft tissue and hard tissue changes in an orthodontically treated Asian population was evaluated. 24 adult Asian patients (mean age of 24 years), diagnosed with severe bimaxillary protrusion were considered, the extractions of all four first premolars were carried out, followed by anterior retraction with either skeletal or intraoral anchoring. Serial CBCT radiographs of the head and face region were used to assess the changes. Colour mapping and landmark displacement were used to assess the changes. The findings demonstrated that the commissures and nasolabial folds were the main locations for upper lip retraction. Lower lip retraction and soft tissue redistribution at the pogonion result from retraction of the lower anterior teeth. Soft-tissue alterations and regional facial muscle activation showed a strong correlation. They also concluded that, use of skeletal anchorage resulted in 1.5 mm greater lower lip

retraction than intraoral anchorage, and a larger retraction of the maxillary and mandibular incisor root apices.

- **Sforza et al (2007)**^[7]- Nine patients aged between 18 and 35 years with skeletal Class III malocclusion and mandibular asymmetry, were assessed by a non-invasive, landmark-based, three-dimensional system before and after mandibular setback and maxillary advancement. The three-dimensional coordinates of 50 facial soft tissue landmarks were collected, and a series of anthropometric measurements was calculated and compared with reference values from 240 healthy subjects of similar sex, age, and ethnic group. The results stated that the patients were more asymmetrical than normal subjects before the operations, particularly in the gonion region and postoperatively, total and lateral asymmetry was reduced. They concluded that the three-dimensional approach was a valuable complementary diagnostic aid that enabled quantitative evaluation of the final soft-tissue results without invasive procedures.

MATERIALS AND METHODS

SOURCE OF DATA

This study has been done on patients who underwent orthognathic surgery and were treated at KLE Academy of Higher Education & Research, KLE VK Institute of Dental Sciences, Belagavi. Surgery was conducted at KLES Dr. Prabhakar Kore Hospital & Medical Research Centre, Belagavi.

INCLUSION CRITERIA:

- Patients with Skeletal Malocclusion requiring orthognathic surgery and are willing to give their consent to participate in this study
- Patients over the age of 18yrs
- Both males and females

EXCLUSION CRITERIA:

- Patients below 18yrs of age Patients with syndromic or disease-initiating dentofacial anomalies
- Patients with systemic diseases

SAMPLE SIZE ESTIMATION

Sample size at 95% Confidence Interval and 80% Power

$$n = \frac{(z_{1-\alpha/2} + z_{1-\beta})^2 (SD_1^2 + SD_2^2)}{(x_1 - x_2)^2}$$

$$n = \frac{(1.96 + 0.85)^2 (11.34^2 + 10.68^2)}{(71.23 - 61.94)^2}$$

$$n = 22.2$$

$$n = 22$$

where, $z_{1-\alpha/2} = 1.96$

$$\bar{z}_{1-\beta} = 0.852.2$$

$$\bar{x}_1 = 71.23$$

$$x_2 = 61.94$$

$$SD_1 = 11.34$$

$$SD_2 = 10.68$$

at 10% attrition,

$$n = 22 \times 1.1$$

$$n = 24.4$$

$$n = 25$$

therefore, sample size is 25

SAMPLING TECHNIQUE- Convenience Sampling Technique

METHODOLOGY

INSTRUMENTS AND MATERIALS:

- Pre-surgical records of orthognathic patients using 3-D camera (Bellus 3D)
- post-surgical records of orthognathic patients using 3-D camera 1 month postoperatively and 2 months post operatively



BELLUS 3-D CAMERA

ASSESSING ACCURACY OF BELLUS 3-D CAMERA

- In order to assess the reliability of the images from the 3-D camera, precision and accuracy testing was done. The test included 3-Dimensional photographs of 34 subjects using the Bellus 3-D Camera, both with facial landmarks labelled and without facial landmarks labelled.
- 19 linear Measurements were made digitally using the 3-D photographs and direct measurements were also made across these landmarks.
- The Intergroup comparison of different landmarks between Direct measurement group and 3D-Photographic measurements with and without dots was performed using independent samples t-test.
- There were no statistically significant differences (p value >0.05) between the 2 groups and with and without dots.

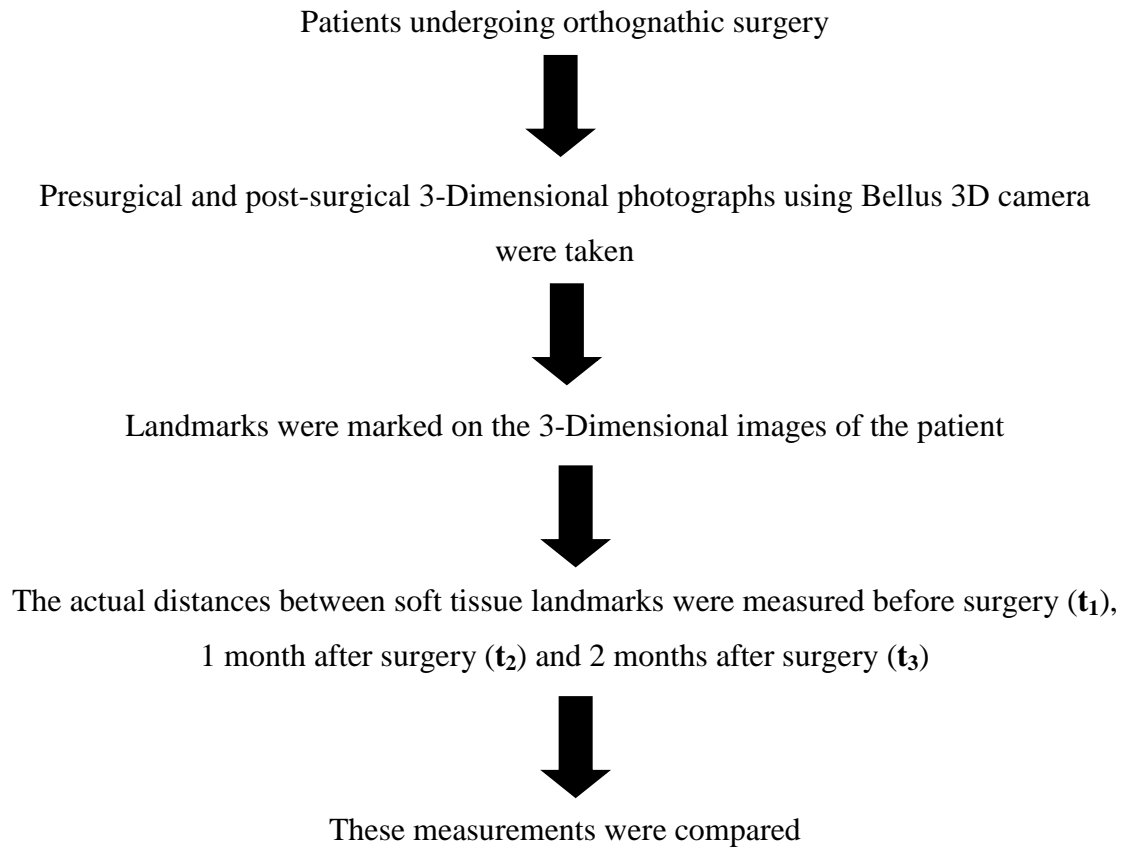
- The findings suggest that the Bellus 3D camera is able to accurately and reliably provide anthropometric linear distance measurements based on facial anatomic landmarks and can therefore be used for anthropometric measurements.

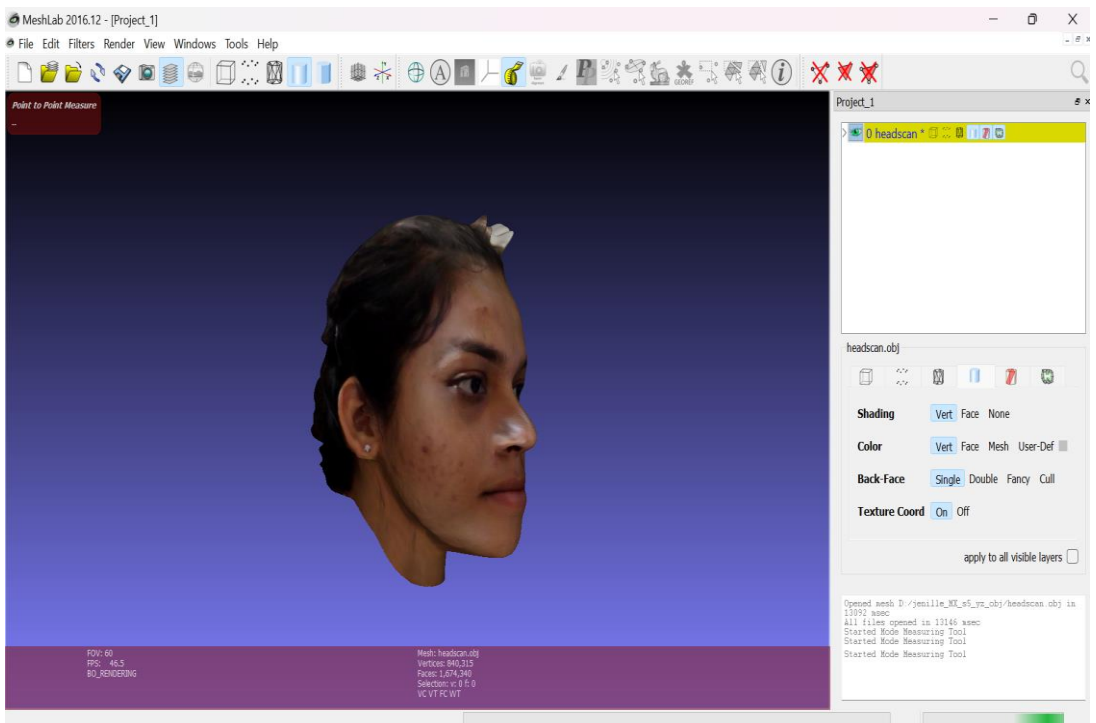
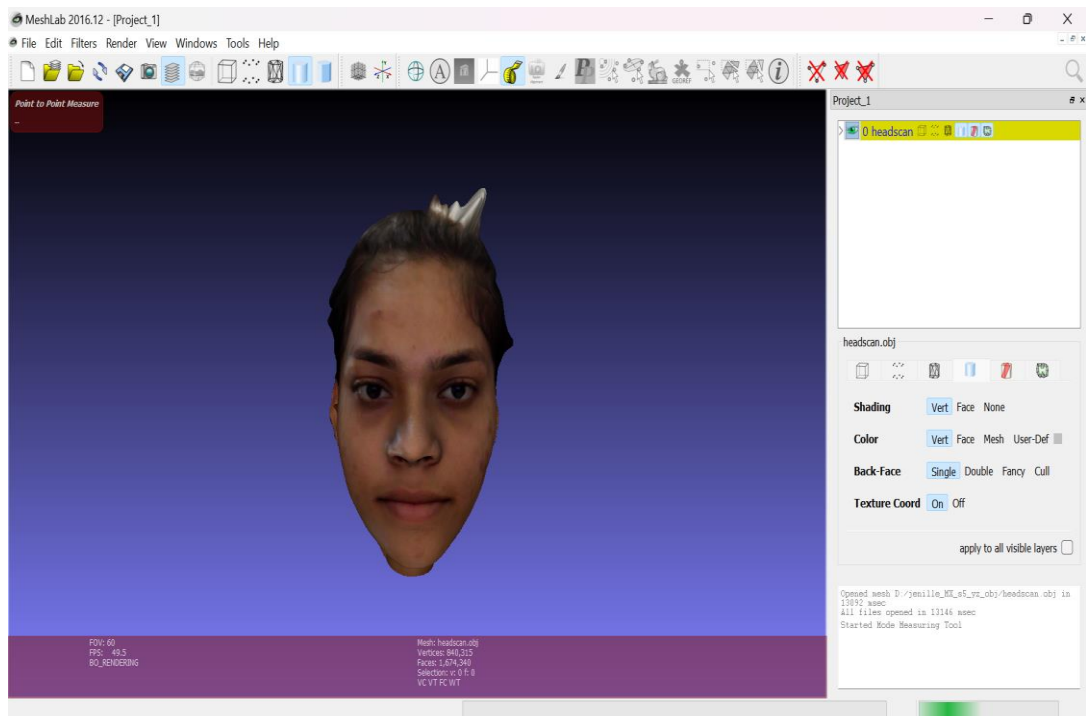
PATIENTS CONCERN: Patients were informed and the records are taken with the patient consent



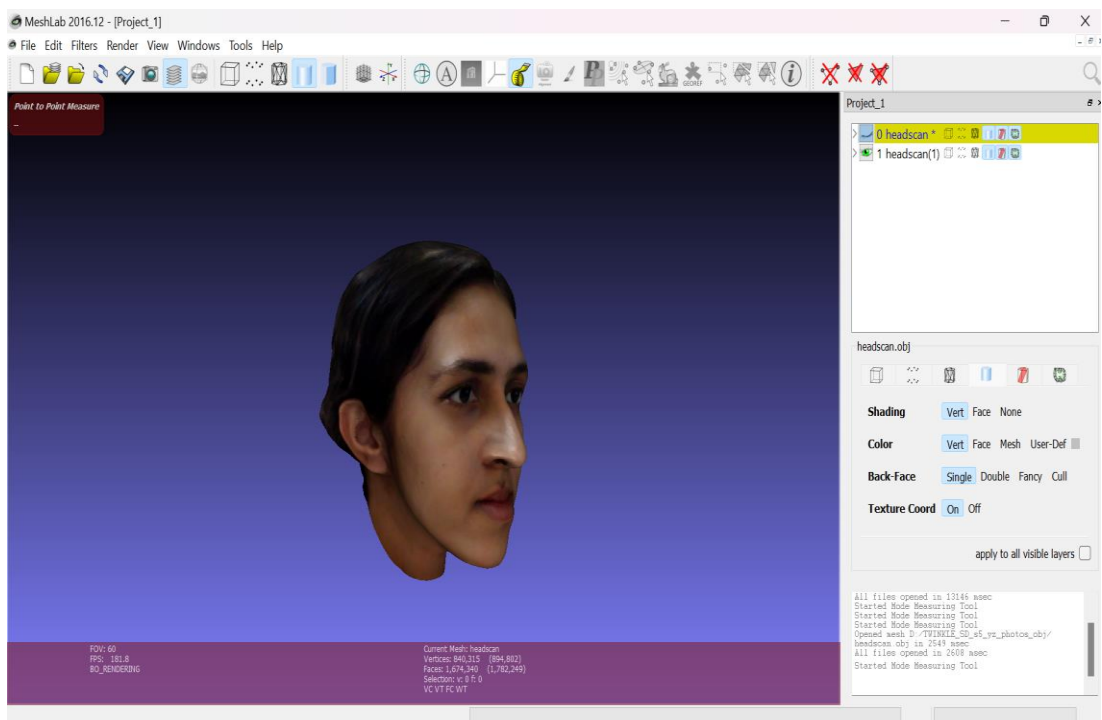
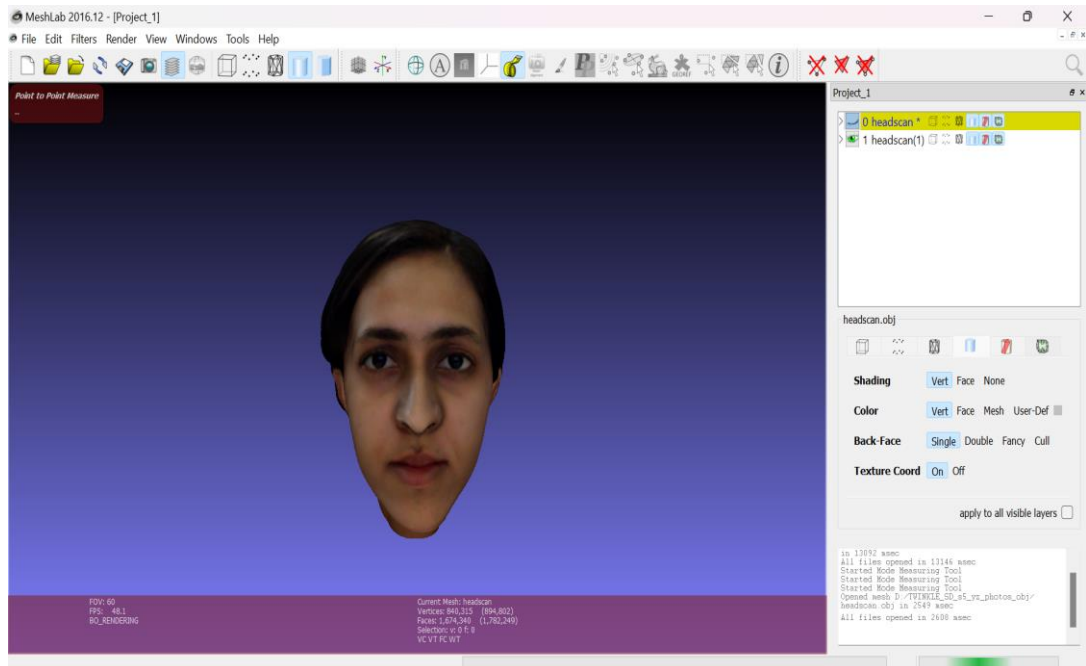
CAPTURING 3-D PHOTOGRAPH USING BELLUS 3-D CAMERA

FLOW CHART OF METHODOLOGY





PRE-SURGICAL 3-D PHOTOGRAPHS OF A PATIENT IN BSSO SETBACK GROUP



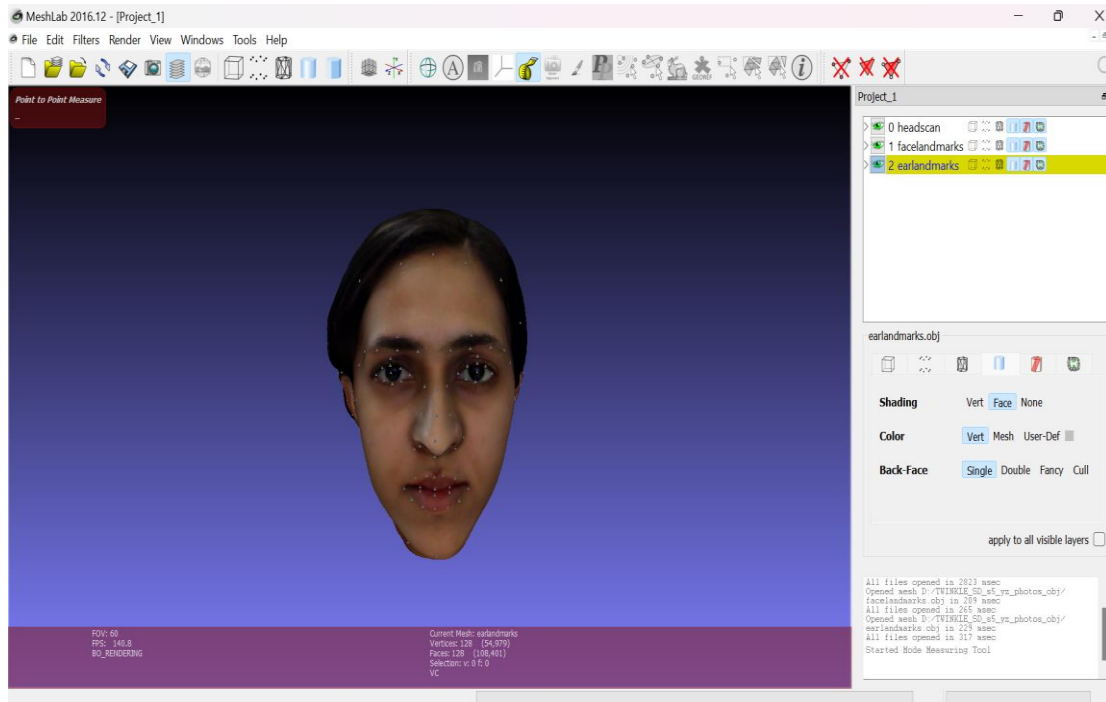
PRE-SURGICAL 3-D PHOTOGRAPHS OF A PATIENT IN BI-JAW SURGERY GROUP

Details of the procedures conducted during the research

- This study involved patients who underwent orthognathic surgery. Presurgical as well as post-surgical 3-Dimensional photographs were taken of these patients using 3-D camera (Bellus 3D).
- Landmarks were marked on the 3-Dimensional images of the patient.
- These landmarks consist of; the trichion, glabella, nasion, tip of the nose, subnasale, stomion and menton for measurement in the vertical dimension and the bi-zygomatic points, bi-gonial points, medial canthus and lateral canthus and oral commissures, bilaterally for horizontal measurements.

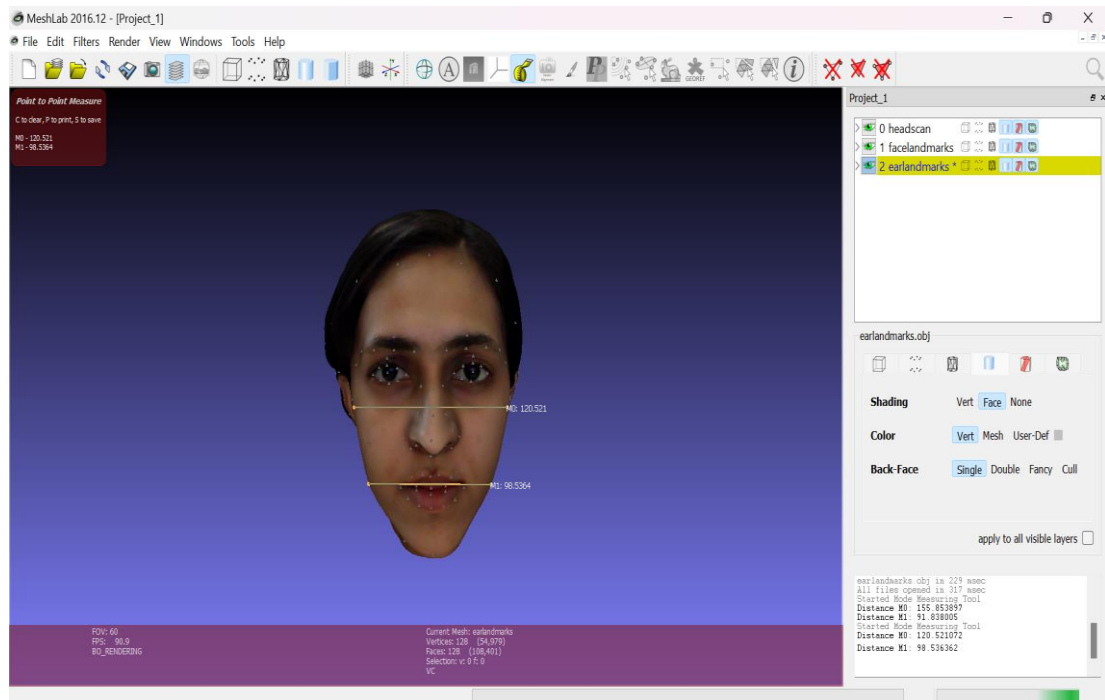
Table 1- List of parameters assessed in the study

PARAMETERS	LANDMAKRS
Facial proportions	Upper 1/3
	Middle 1/3
	Lower 1/3
Maxilla and mandible	Maxillary height
	Mandibular height
Transverse width	Zygomatic width
	Bi-gonial width
Nose	Alar width
	Nasion-nasal tip
	Nasal tip-subnasale
lips	Lip length
	Upper vermilion height
	Lower vermilion height



3-D PHOTOGRAPH DEPICTING LANDMARKS OF THE FACE

- The actual distances between soft tissue landmarks before surgery were measured (t_1)
- The actual distances between soft tissue landmarks 1 month postoperatively were measured (t_2)
- The actual distances between soft tissue landmarks 2 months postoperatively were measured (t_3)
- The pre-surgical and post-surgical measurements were then compared.



DIGITAL MEASUREMENTS OF PATIENT'S PRE-SURGICAL 3-D PHOTOGRAPH

METHOD OF STATISTICAL ANALYSIS

- Data obtained was entered and sorted in Microsoft Excel (v.2013).
- Statistical analysis was performed using Statistical package for social sciences (SPSS) software (IBM Corp) (v.21.0).
- Descriptive and inferential statistics was performed for all the different parameters assessed in the study.
- Data normality test was performed to determine normal distribution of the data.
- For ease of statistical analysis, the total study participants were divided according to the type of the surgery performed. Thus, Patients with BSSO setback surgery were 13 (n=13) and those with BIJAW surgery were 12 (n=12).

- Comparisons between different time intervals t1, t2 and t3 for all different landmarks was performed using Repeated measures ANOVA test to assess significant differences.
- All statistical tests were performed at 95% confidence intervals.
- A p value of less than 0.05 was considered as statistically significant in the study.

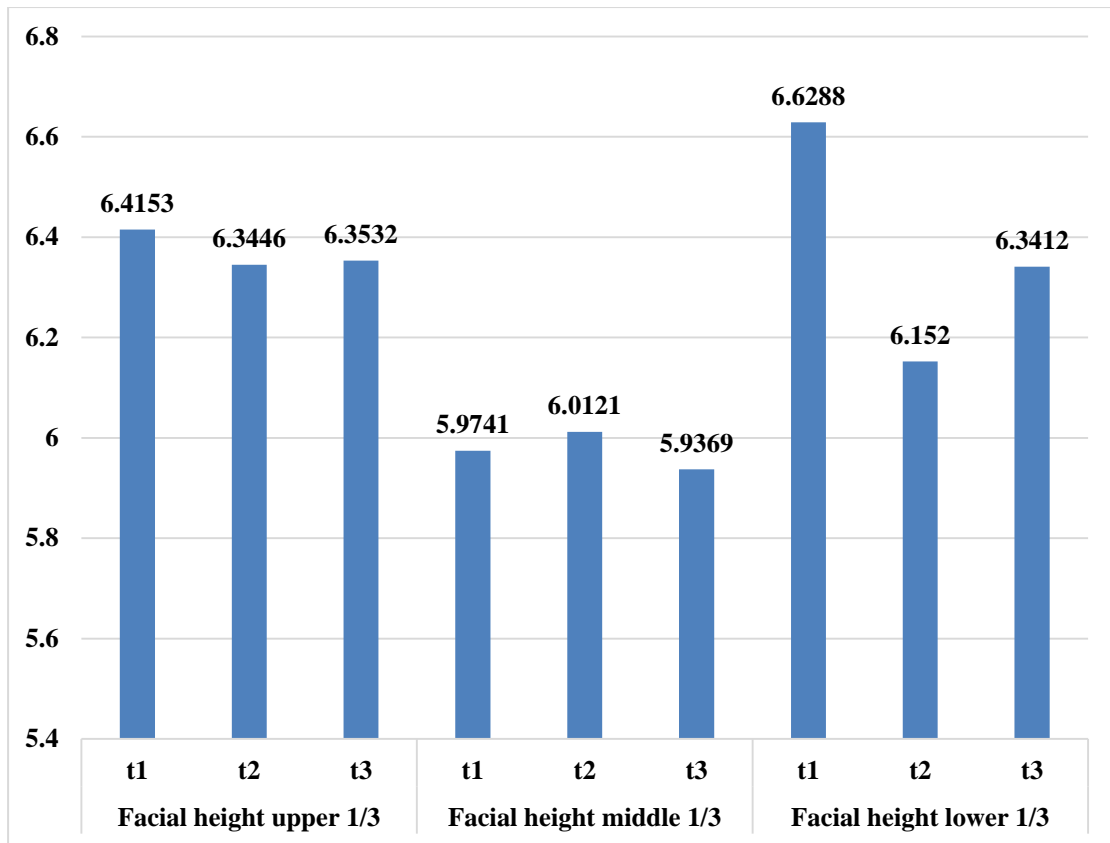
RESULTS

- This study was done to evaluate the soft tissue changes before and after orthognathic surgery using a 3-D Camera and compare the measurements 1 month after surgery with the measurements 2 months after surgery.
- A total of 25 patients who underwent orthognathic surgery and were treated at KLE Academy of Higher Education & Research, KLE VK Institute of Dental Sciences, Belagavi were considered in this study. Surgery was conducted at KLES Dr. Prabhakar Kore Hospital & Medical Research Centre, Belagavi.
- These 25 patients were divided into 2 groups based on the type of surgery performed; the mandibular BSSO setback group and Bi-jaw surgery group that involved mandibular setback and maxillary advancement.

BSSO Setback analysis**Table 2 – Descriptive statistics of the facial height of the study participants at different levels**

Parameter	Time intervals	N	Mean	Std. Deviation
Facial height upper 1/3	t1	13	6.4153	.94543
	t2	13	6.3446	.90913
	t3	13	6.3532	.81841
Facial height middle 1/3	t1	13	5.9741	.52838
	t2	13	6.0121	.44424
	t3	13	5.9369	.50359
Facial height lower 1/3	t1	13	6.6288	.43772
	t2	13	6.1520	.38346
	t3	13	6.3412	.38714

Table 2 shows descriptive mean and standard deviation of the linear measurements of the upper, middle and lower thirds of patients across the 3 different time points.

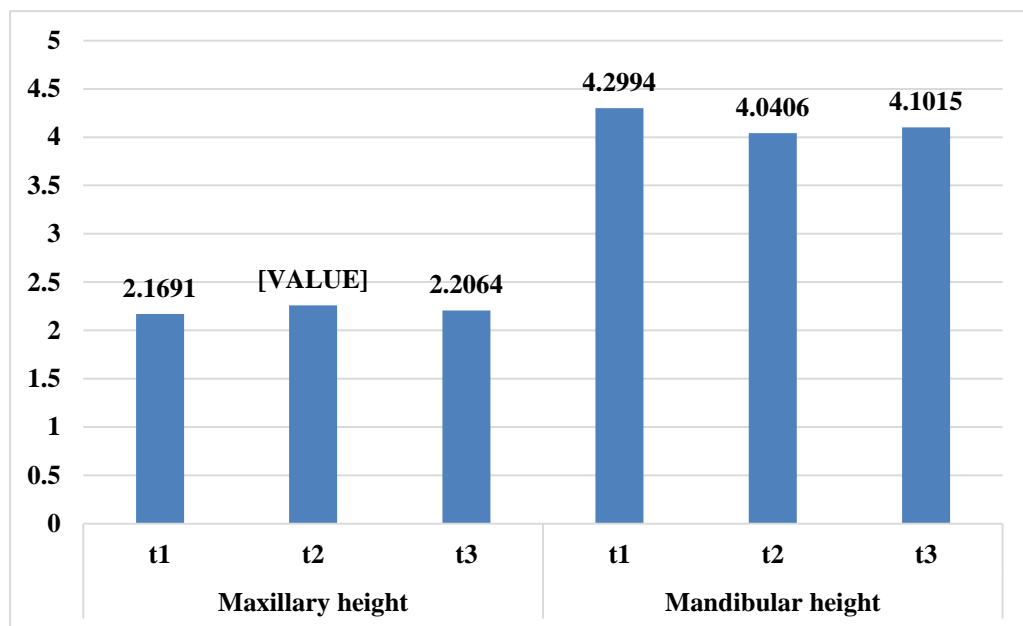


Graph 1 Mean values of facial height of the study participants at different time intervals

Table 3 – Descriptive statistics of the maxillary and mandibular height of the study participants

Parameter	Time intervals	N	Mean	Std. Deviation
Maxillary height	t1	13	2.1691	.22906
	t2	13	2.2588	.28102
	t3	13	2.2064	.28481
Mandibular height	t1	13	4.2994	.24467
	t2	13	4.0406	.16906
	t3	13	4.1015	.11870

Table 3 shows descriptive mean and standard deviation of the linear measurements of the maxillary and mandibular heights of patients across the 3 different time points.

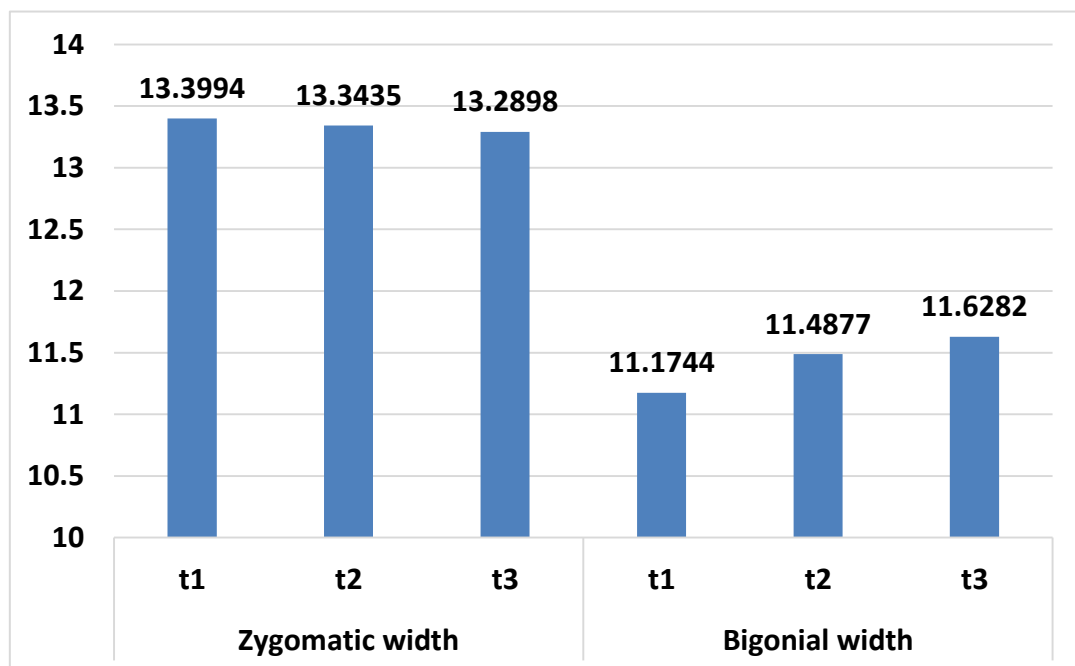


Graph 2 Mean values of maxillary and mandibular height of the study participants at different time intervals

Table 4 – Descriptive statistics of the Zygomatic width and Gonial width of the study participants

Parameter	Time intervals	N	Mean	Std. Deviation
Bi-zygomatic width	t1	13	13.3994	.99428
	t2	13	13.3435	.91570
	t3	13	13.2898	.89532
Bi-gonial width	t1	13	11.1744	.65800
	t2	13	11.4877	.55093
	t3	13	11.6282	.56747

Table 4 shows descriptive mean and standard deviation of the linear measurements of the transverse widths of patients across the 3 different time points.

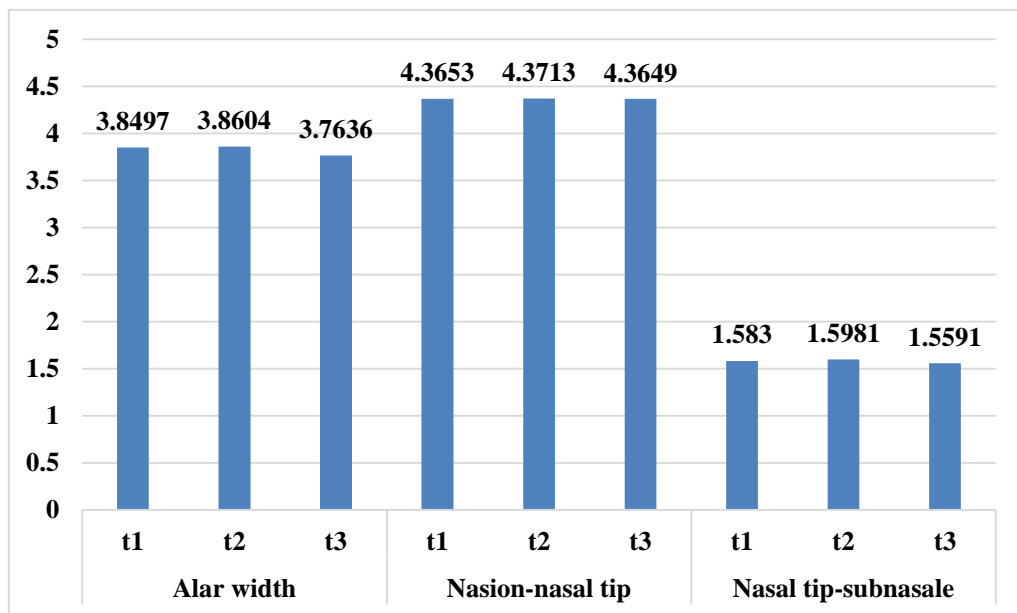


Graph 3 Mean values of zygomatic width and bigonial width of the study participants at different time intervals

Table 5 – Descriptive statistics of the nasal landmarks of the study participants

Parameter	Time intervals	N	Mean	Std. Deviation
Alar width	t1	13	3.8497	.30065
	t2	13	3.8604	.28095
	t3	13	3.7636	.32734
Nasion-nasal tip	t1	13	4.3653	.13837
	t2	13	4.3713	.11975
	t3	13	4.3649	.10092
Nasal tip-subnasale	t1	13	1.5830	.11372
	t2	13	1.5981	.11992
	t3	13	1.5591	.14343

Table 5 shows descriptive mean and standard deviation of the linear measurements across nasal landmarks at the 3 different time points.

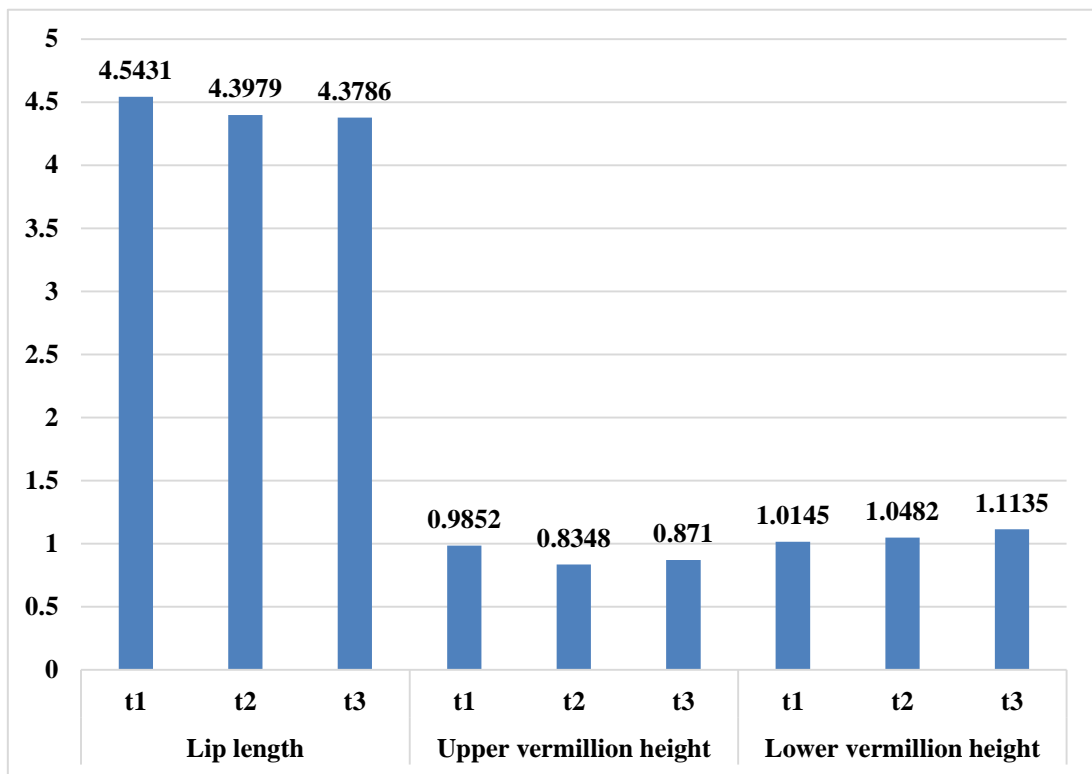


Graph 4 Mean values of the nasal landmarks of the study participants at different time intervals

Table 6 – Descriptive statistics of the lip landmarks of the study participants

Parameter	Time intervals	N	Mean	Std. Deviation
Lip length	t1	13	4.5431	.63128
	t2	13	4.3979	.48747
	t3	13	4.3786	.50463
Upper vermillion height	t1	13	.9852	.13253
	t2	13	.8348	.12571
	t3	13	.8710	.14887
Lower vermillion height	t1	13	1.0145	.24349
	t2	13	1.0482	.37307
	t3	13	1.1135	.24999

Table 6 shows descriptive mean and standard deviation of the linear measurements across landmarks around lips at the 3 different time points.



Graph 5 Mean values of lip landmarks of the study participants at different time intervals

Table 7- Comparison of the facial height of the study participants between the time intervals

Comparison between time intervals	Parameter	Sum of Squares	df	Mean Square	F value	p value
t1 vs t2 vs t3	Facial height upper 1/3	.039	2	.019	.024	.978
	Facial height middle 1/3	.037	2	.018	.076	.920
	Facial height lower 1/3	1.499	2	.749	4.602	0.017*

*p value <0.05 statistically significant, <0.01 highly significant

Table 7 shows the Comparison of the facial height of the study participants between the time intervals t_1 , t_2 and t_3 . This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the lower third of the face

Table 8- Pairwise multiple comparison of the facial height of the study participants between the time intervals

Dependent Variable	(I) Time intervals	(J) Time intervals	Mean Difference (I-J)	p value
Facial height lower 1/3	t1	t2	.47683*	.013*
		t3	.28760	.017*
	t2	t1	-.47683*	.013*
		t3	-.18923	.463
	t3	t1	-.28760	.017*
		t2	.18923	.463

*p value <0.05 statistically significant, <0.01 highly significant

Table 8 shows the Pairwise multiple Comparison of the lower one-third facial height of the study participants between the time intervals t₁, t₂ and t₃.

The Comparison of the facial height of the study participants between the time intervals was performed using Repeated measures ANOVA and pairwise comparison was also performed. This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the lower third of the face between t₁ and t₂ and t₁ and t₃ time intervals.

Table 9- Comparison of the maxillary and mandibular height of the study participants between the time intervals

Comparison between time intervals	Parameter	Sum of Squares	df	Mean Square	F	p value
t1 vs t2 vs t3	Maxillary height	.052	2	.026	.366	.674
	Mandibular height	.476	2	.238	6.959	.003*

*p value <0.05 statistically significant, <0.01 highly significant

Table 9 shows the Comparison of the maxillary and mandibular heights of the study participants between the time intervals t_1 , t_2 and t_3 . This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the mandibular heights across the time intervals.

Table 10- Pairwise multiple comparison of the maxillary and mandibular height of the study participants between the time intervals

Dependent Variable	(I) Time intervals	(J) Time intervals	Mean Difference (I-J)	p value
Mandibular height	t1	t2	.25870*	.003*
		t3	.19786*	.026*
	t2	t1	-.25870*	.003*
		t3	-.06085	.681
	t3	t1	-.19786*	.026*
		t2	.06085	.681

*p value <0.05 statistically significant, <0.01 highly significant

Table 10 shows the Pairwise multiple Comparison of the lower mandibular height of the study participants between the time intervals t₁, t₂ and t₃.

The Comparison of the maxillary and mandibular heights of the study participants between the time intervals was performed using Repeated measures ANOVA and pairwise comparison was also performed. This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the mandibular height between t₁ and t₂ and t₁ and t₃ time intervals.

Table 11- Comparison of the bi-zygomatic width and bi-gonial width of the study participants between the time intervals

Comparison between time intervals	Parameter	Sum of Squares	df	Mean Square	F value	p value
t1 vs t2 vs t3	Bi-zygomatic width	.078	2	.039	.044	.957
	Bi-gonial width	1.403	2	.701	1.988	0.05*

*p value <0.05 statistically significant, <0.01 highly significant

Table 11 shows the Comparison of the bi-zygomatic and bi-gonial widths of the study participants between the time intervals t₁, t₂ and t₃. This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the bi-gonial widths between the time intervals.

Table 12- Pairwise multiple comparison of the bi-zygomatic width and bi-gonial width of the study participants between the time intervals

Dependent Variable	(I) Time intervals	(J) Time intervals	Mean Difference (I-J)	p value
Bigonial width	t1	t2	-.31326	.038*
		t3	-.45373	.040*
	t2	t1	.31326	.038*
		t3	-.14047	.819
	t3	t1	.45373	.040*
		t2	.14047	.819

*p value <0.05 statistically significant, <0.01 highly significant

Table 12 shows the Pairwise multiple Comparison of the bi-gonial widths of the study participants between the time intervals t₁, t₂ and t₃.

The Comparison of the bi-zygomatic and bi-gonial widths of the study participants between the time intervals was performed using Repeated measures ANOVA and pairwise comparison was also performed. This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the bi-gonial width between t₁ and t₂ and t₁ and t₃ time intervals.

Table 13- Comparison of the nasal landmarks of the study participants between the time intervals

Comparison between time intervals	Parameter	Sum of Squares	df	Mean Square	F value	p value
t1 vs t2 vs t3	Alar width	.073	2	.037	.398	0.675
	Nasion-nasal tip	.000	2	.000	.012	0.989
	Nasal tip-subnasale	.010	2	.005	.314	0.733

*p value <0.05 statistically significant, <0.01 highly significant

Table 13 shows the Comparison of the nasal landmarks of the study participants between the time intervals t₁, t₂ and t₃.

The Comparison of the linear measurements around the nasal areas of the study participants between the time intervals was performed using Repeated measures ANOVA and pairwise comparison was also performed. This comparison showed no statistically significant differences (p value <0.05) for soft tissue changes between t₁ and t₂ and t₁ and t₃ time intervals.

Table 14- Comparison of the lip landmarks of the study participants between the time intervals

Comparison between time intervals	Parameter	Sum of Squares	df	Mean Square	F value	p value
t1 vs t2 vs t3	Lip length	.210	2	.105	.354	0.704
	Upper vermillion height	.160	2	.080	4.326	0.021*
	Lower vermillion height	.066	2	.033	.378	0.008*

*p value <0.05 statistically significant, <0.01 highly significant

Table 14 shows the Comparison of the lip landmarks of the study participants between the time intervals t₁, t₂ and t₃.

Table 15- Pairwise multiple comparison of the lip landmarks of the study participants between the time intervals

Dependent Variable	(I) Time intervals	(J) Time intervals	Mean Difference (I-J)	p value
Upper vermillion height	t1	t2	.15037*	.021*
		t3	.11417	.006*
	t2	t1	-.15037*	.021*
		t3	-.03620	.777
	t3	t1	-.11417	.006*
		t2	.03620	.777
Lower vermillion height	t1	t2	-.03374	.004*
		t3	-.09898	0.01*
	t2	t1	.03374	.004*
		t3	-.06524	.840
	t3	t1	.09898	0.01*
		t2	.06524	.840

*p value <0.05 statistically significant, <0.01 highly significant

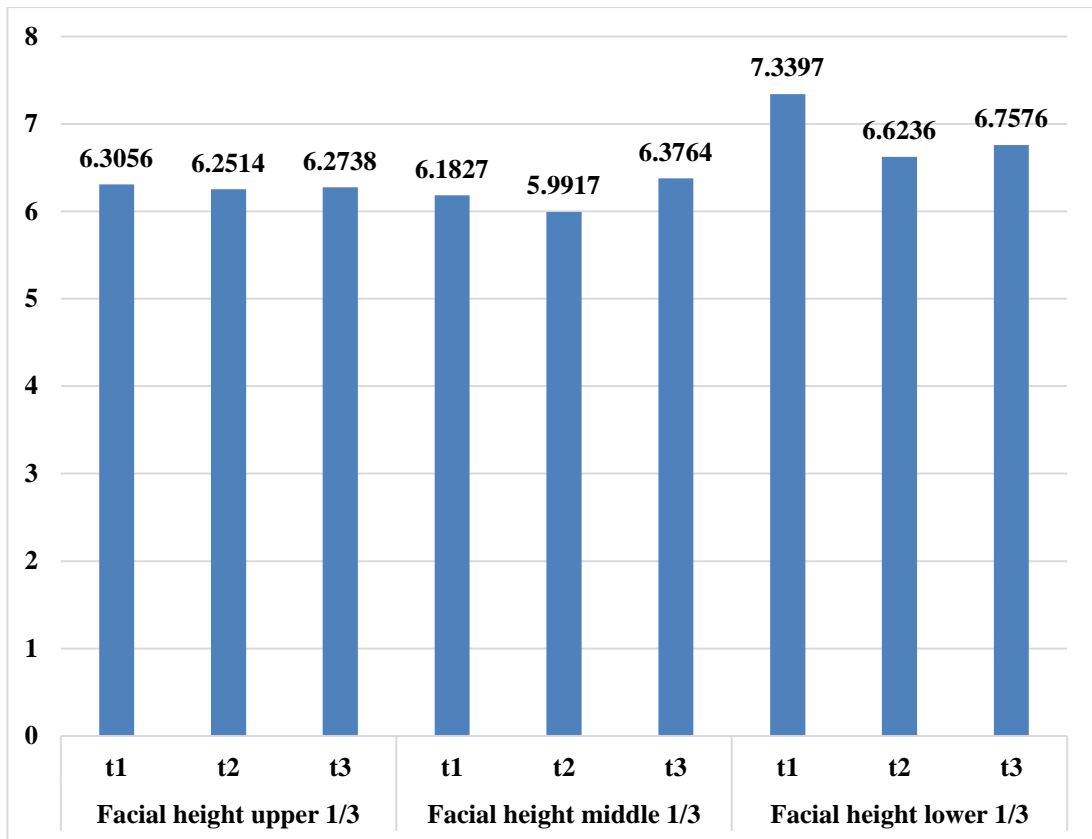
Table 15 shows the Pairwise multiple comparison of the lip landmarks of the study participants between the time intervals.

The Comparison of the lip length, upper and lower vermillion heights of the study participants between the time intervals was performed using Repeated measures ANOVA and pairwise comparison was also performed. This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the upper and lower vermillion heights between t_1 and t_2 and t_1 and t_3 time intervals.

BI-JAW SURGERY ANALYSIS**Table 16 – Descriptive statistics of the facial height of the study participants at different levels**

Parameter	Time intervals	N	Mean	Std. Deviation
Facial height upper 1/3	t1	12	6.3056	.39246
	t2	12	6.2514	.43058
	t3	12	6.2738	.42480
Facial height middle 1/3	t1	12	6.1827	.52092
	t2	12	5.9917	.37329
	t3	12	6.3764	.45429
Facial height lower 1/3	t1	12	7.3397	1.32900
	t2	12	6.6236	.63787
	t3	12	6.7576	.69029

Table 16 shows descriptive mean and standard deviation of the linear measurements of the upper, middle and lower thirds of patients across the 3 different time points.

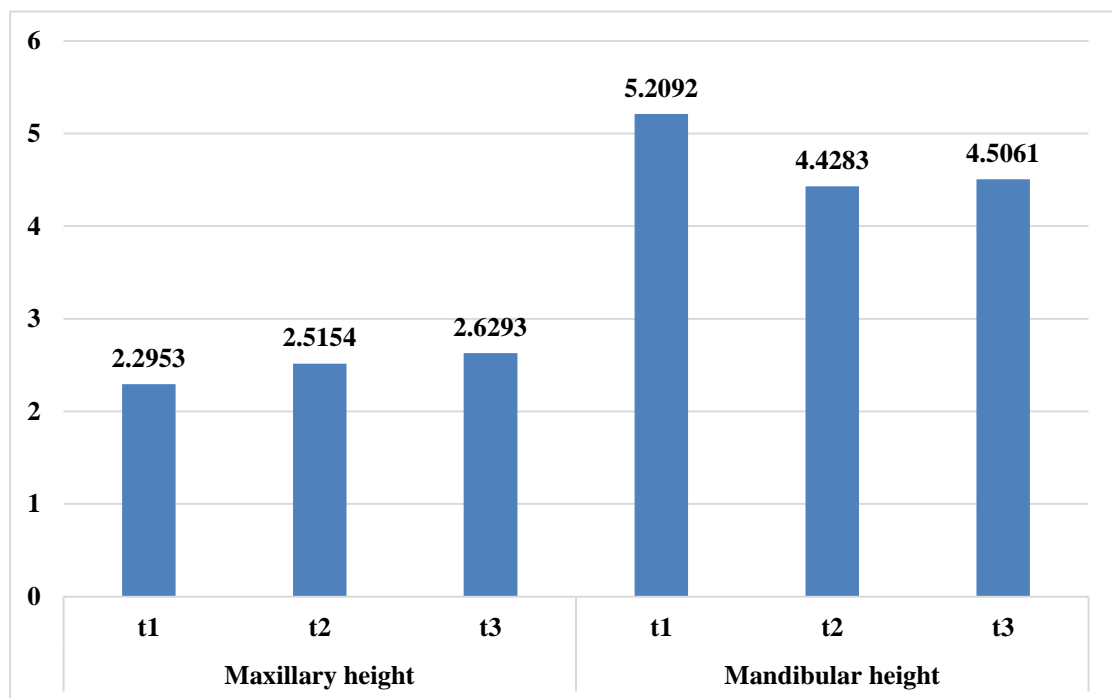


Graph 6 Mean values of facial height of the study participants at different time intervals

Table 17 – Descriptive statistics of the maxillary and mandibular height of the study participants

Parameter	Time intervals	N	Mean	Std. Deviation
Maxillary height	t1	12	2.2953	.47546
	t2	12	2.5154	.45890
	t3	12	2.6293	.52911
Mandibular height	t1	12	5.2092	.87288
	t2	12	4.4283	.43247
	t3	12	4.5061	.35985

Table 17 shows descriptive mean and standard deviation of the linear measurements of the maxillary and mandibular heights of patients across the 3 different time points.

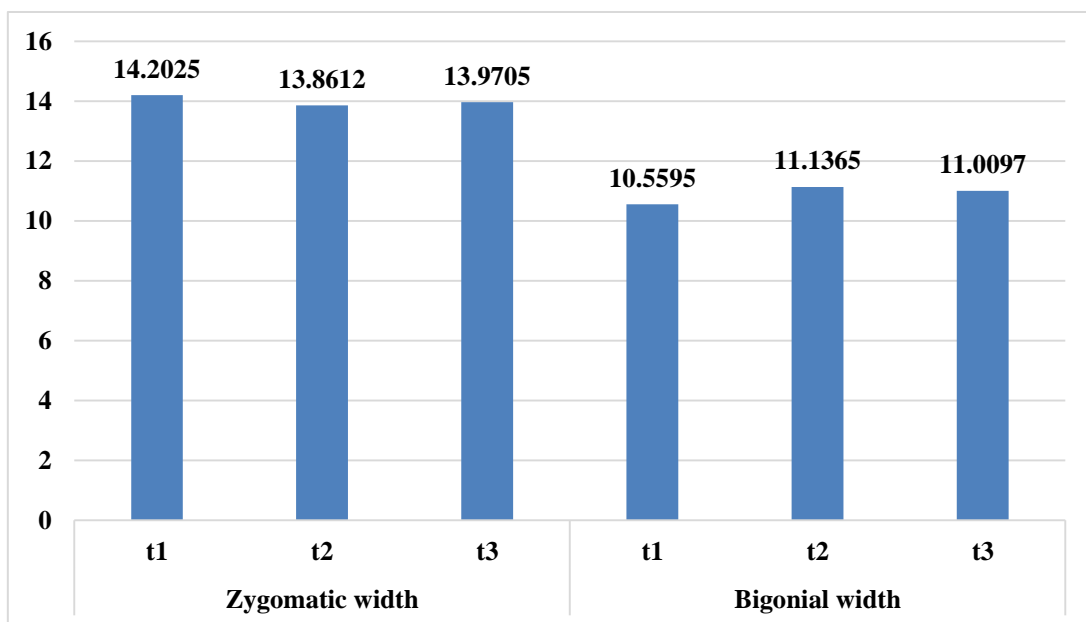


Graph 7 Mean values of maxillary and mandibular height of the study participants at different time intervals

Table 18 – Descriptive statistics of the Bi-zygomatic width and Bi-gonial width of the study participants

Parameter	Time intervals	N	Mean	Std. Deviation
Zygomatic width	t1	12	14.2025	.64473
	t2	12	13.8612	1.11773
	t3	12	13.9705	.98304
Bi-gonial width	t1	12	10.5595	.88556
	t2	12	11.1365	.82108
	t3	12	11.0097	.83848

Table 18 shows descriptive mean and standard deviation of the linear measurements of the bi-zygomatic and bi-gonial widths of patients across the 3 different time points.

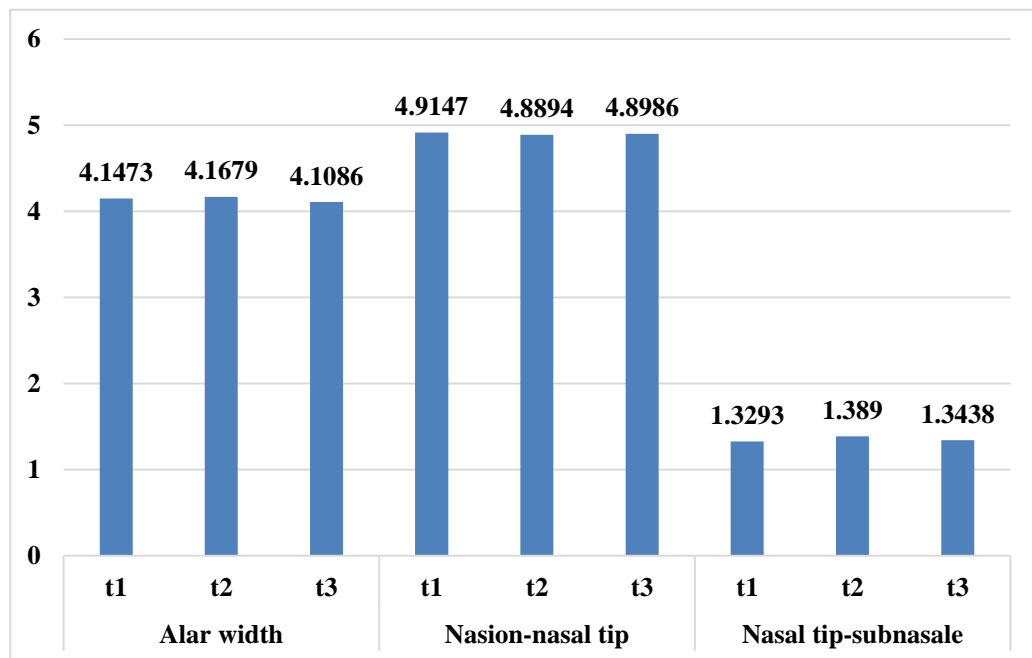


Graph 8 Mean values of zygomatic width and bigonial width of the study participants at different time intervals

Table 19 – Descriptive statistics of the nasal landmarks of the study participants

Parameter	Time intervals	N	Mean	Std. Deviation
Alar width	t1	12	4.1473	.27559
	t2	12	4.1679	.16317
	t3	12	4.1086	.24938
Nasion-nasal tip	t1	12	4.9147	.36682
	t2	12	4.8894	.47922
	t3	12	4.8986	.43664
Nasal tip-subnasale	t1	12	1.3293	.16609
	t2	12	1.3890	.10312
	t3	12	1.3438	.14531

Table 19 shows descriptive mean and standard deviation of the linear measurements across nasal landmarks of patients at the 3 different time points.

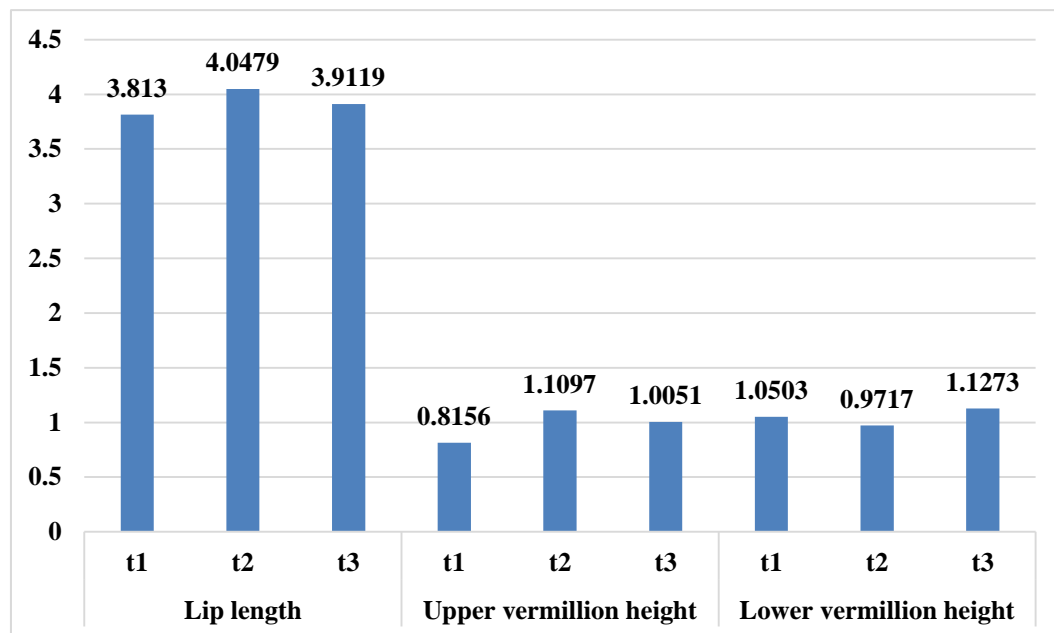


Graph 9 Mean values of the nasal landmarks of the study participants at different time intervals

Table 20 – Descriptive statistics of the lip landmarks of the study participants

Parameter	Time intervals	N	Mean	Std. Deviation
Lip length	t1	12	3.8130	.30652
	t2	12	4.0479	.30999
	t3	12	3.9119	.18783
Upper vermilion height	t1	12	.8156	.12475
	t2	12	1.1097	.16492
	t3	12	1.0051	.17968
Lower vermilion height	t1	12	1.0503	.08390
	t2	12	.9717	.09263
	t3	12	1.1273	.11570

Table 20 shows descriptive mean and standard deviation of the linear measurements across lip landmarks of patients at the 3 different time points.



Graph 10 Mean values of lip landmarks of the study participants at different time intervals

Table 21- Comparison of the facial height of the study participants between the time intervals

Comparison between time intervals	Parameter	Sum of Squares	df	Mean Square	F value	p value
t1 vs t2 vs t3	Facial height upper 1/3	.018	2	.009	.051	0.950
	Facial height middle 1/3	.888	2	.444	2.158	0.003*
	Facial height lower 1/3	3.479	2	1.739	1.970	0.010*

*p value <0.05 statistically significant, <0.01 highly significant

Table 21 shows the Comparison of the facial height of the study participants between the time intervals t_1 , t_2 and t_3 . This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the middle and lower third of the face.

Table 22- Pairwise multiple comparison of the facial height of the study participants between the time intervals

Dependent Variable	(I) Time intervals	(J) Time intervals	Mean Difference (I-J)	p value
Facial height middle 1/3	t1	t2	.19098	.03*
		t3	-.19371	.004*
	t2	t1	-.19098	.03*
		t3	-.38469	.110
	t3	t1	.19371	.004*
		t2	.38469	.110
Facial height lower 1/3	t1	t2	.71615	.014*
		t3	.58216	.006*
	t2	t1	-.71615	.014*
		t3	-.13399	.935
	t3	t1	-.58216	.006*
		t2	.13399	.935

*p value <0.05 statistically significant, <0.01 highly significant

Table 22 shows the Pairwise multiple Comparison of the middle and lower thirds of the facial heights of the study participants between the time intervals t₁, t₂ and t₃.

The Comparison of the facial height of the study participants between the time intervals was performed using Repeated measures ANOVA and pairwise comparison was also performed. This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the middle and lower thirds of the face between t₁ and t₂ and t₁ and t₃ time intervals.

Table 23- Comparison of the maxillary and mandibular height of the study participants between the time intervals

Comparison between time intervals	Parameter	Sum of Squares	df	Mean Square	F value	p value
t1 vs t2 vs t3	Maxillary height	.692	2	.346	1.449	.024*
	Mandibular height	4.441	2	2.221	6.177	.005*

*p value <0.05 statistically significant, <0.01 highly significant

Table 23 shows the Comparison of the maxillary and mandibular height of the study participants between the time intervals

This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the maxillary height and highly significant differences (p value <0.01) for the mandibular height between t₁ and t₂ and t₁ and t₃ time intervals.

Table 24- Pairwise multiple comparison of the maxillary and mandibular height of the study participants between the time intervals

Dependent Variable	(I) Time intervals	(J) Time intervals	Mean Difference (I-J)	p value
Maxillary height	t1	t2	-.22014	.019*
		t3	-.33405	.030*
	t2	t1	.22014	.019*
		t3	-.11391	.836
	t3	t1	.33405	.030*
		t2	.11391	.836
Mandibular height	t1	t2	.78096*	.009*
		t3	.70311*	.019*
	t2	t1	-.78096*	.009*
		t3	-.07785	.946
	t3	t1	-.70311*	.019*
		t2	.07785	.946

*p value <0.05 statistically significant, <0.01 highly significant

Table 24 shows the Pairwise multiple Comparison of the maxillary and mandibular height of the study participants between the time intervals t₁, t₂ and t₃.

The Comparison of the maxillary and mandibular heights of the study participants between the time intervals was performed using Repeated measures ANOVA and pairwise comparison was also performed. This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the maxillary and mandibular height between t₁ and t₂ and t₁ and t₃ time intervals.

Table 25- Comparison of the bi-zygomatic width and bi-gonial width of the study participants between the 3-time intervals

Comparison between time intervals	Parameter	Sum of Squares	df	Mean Square	F value	p value
t1 vs t2 vs t3	Zygomatic width	.729	2	.364	.416	.003*
	Bi-gonial width	2.207	2	1.103	1.531	.031*

*p value <0.05 statistically significant, <0.01 highly significant

Table 25 shows the Comparison of the bi-zygomatic and bi-gonial widths of the study participants between the time intervals t_1 , t_2 and t_3 . This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in both the bi-zygomatic and bi-gonial widths between the time intervals.

Table 26- Pairwise multiple comparison of the zygomatic width and bigonial width of the study participants between the time intervals

Dependent Variable	(I) Time intervals	(J) Time intervals	Mean Difference (I-J)	p value
Zygomatic width	t1	t2	.34128	.009*
		t3	.23202	.017*
	t2	t1	-.34128	.009*
		t3	-.10926	.956
	t3	t1	-.23202	.017*
		t2	.10926	.956
Bignonial width	t1	t2	-.57699	.034*
		t3	-.45020	.040*
	t2	t1	.57699	.034*
		t3	.12679	.929
	t3	t1	.45020	.040*
		t2	-.12679	.929

*p value <0.05 statistically significant, <0.01 highly significant

Table 26 shows the Pairwise multiple Comparison of the bi-zygomatic and bi-gonial widths of the study participants between the time intervals t₁, t₂ and t₃.

The Comparison of the bi-zygomatic and bi-gonial widths of the study participants between the time intervals was performed using Repeated measures ANOVA and pairwise comparison was also performed. This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the bi-gonial width between t₁ and t₂ and t₁ and t₃ time intervals.

Table 27- Comparison of the nasal landmarks of the study participants between the time intervals

Comparison between time intervals	Parameter	Sum of Squares	df	Mean Square	F value	p value
t1 vs t2 vs t3	Alar width	.022	2	.011	.198	.822
	Nasion-nasal tip	.004	2	.002	.011	0.989
	Nasal tip-subnasale	.023	2	.012	.589	0.561

*p value <0.05 statistically significant, <0.01 highly significant

Table 27 shows the Comparison of the nasal landmarks of the study participants between the time intervals t_1 , t_2 and t_3 .

The Comparison of the linear measurements around the nasal areas of the study participants between the time intervals was performed using Repeated measures ANOVA and pairwise comparison was also performed. This comparison showed no statistically significant differences (p value <0.05) for soft tissue changes between t_1 and t_2 and t_1 and t_3 time intervals.

Table 28- Comparison of the lip landmarks of the study participants between the time intervals

Comparison between time intervals	Parameter	Sum of Squares	df	Mean Square	F value	p value
t1 vs t2 vs t3	Lip length	.334	2	.167	2.223	.024*
	Upper vermilion height	.534	2	.267	10.665	.000*
	Lower vermilion height	.145	2	.073	7.510	.002*

*p value <0.05 statistically significant, <0.01 highly significant

Table 28 shows the Comparison of the lip landmarks of the study participants between the time intervals

The Comparison of the lip length, upper and lower vermilion heights of the study participants between the time intervals was performed using Repeated measures ANOVA and pairwise comparison was also performed.

Table 29- Pairwise multiple comparison of the lip landmarks of the study participants between the time intervals

Dependent Variable	(I) Time intervals	(J) Time intervals	Mean Difference (I-J)	p value
Lip length	t1	t2	-.23496	.005*
		t3	-.09894	.004*
	t2	t1	.23496	.005*
		t3	.13601	.453
	t3	t1	.09894	.004*
		t2	-.13601	.453
Upper vermilion height	t1	t2	-.29416*	.000*
		t3	-.18952*	.016*
	t2	t1	.29416*	.000*
		t3	.10465	.251
	t3	t1	.18952*	.016*
		t2	-.10465	.251
Lower vermilion height	t1	t2	.07862	.001*
		t3	-.07695	.015*
	t2	t1	-.07862	.001*
		t3	-.15557*	.391
	t3	t1	.07695	.015*
		t2	.15557*	.391

*p value <0.05 statistically significant, <0.01 highly significant

Table 29 shows the Pairwise multiple comparison of the lip landmarks of the study participants between the time intervals.

This comparison showed statistically significant differences (p value <0.05) for soft tissue changes in the lip length as well as the upper and lower vermilion heights between t₁ and t₂ and t₁ and t₃ time intervals.

DISCUSSION

One of the main goals of orthodontic treatment is to achieve facial harmony, this is accomplished by orthopedic, orthodontic or surgical therapy.

Changes in the soft tissue thickness and shape after orthognathic surgery are influenced by the initial soft tissue thickness of the corresponding area ^[9] and are also related to the magnitude and direction of the movement of the underlying hard tissue during the surgery ^[14].

In orthognathic surgical cases, changes are usually evaluated in the lateral and frontal views. The reason being, majority of surgical simulation applications available rely on 2-D modalities for orthognathic surgical treatment planning. Up and coming 3-D surgical simulation tools are slowly becoming integrated into surgical treatment planning.

The purpose of this study was to evaluate the soft tissue changes before and after orthognathic surgery and compare the measurements 1 month after surgery as well as 2 months after surgery using 3-D photographs.

The 3-D camera used by us provided sufficient quantitative data about the changes in various soft tissue landmarks and facial proportions after orthognathic surgery.

BSSO SETBACK GROUP-

With the help of the images obtained from the 3-D Camera, it was noticed that in the group of individuals who underwent a mandibular setback surgery there were

significant changes in their lower facial height, mandibular height, bi-gonial width, and the upper and lower vermillion heights.

It was also noted that the surgery did not alter the vertical dimension of the face in the upper and middle third regions, the nose profile or the lip length in these patients.

Mandibular setback surgery caused a reduction in the lower facial height, mandibular height and upper vermillion height in patients. There was a slight increase in the bi-gonial width and lower vermillion height in these patients.

Pairwise comparison showed that there was a sharp decrease in the lower facial height, mandibular height and upper vermillion height at t_2 with an increase at t_3 with the measurement at t_3 being lesser than the measurement at t_1 . Similarly, the bi-gonial width and lower vermillion height showed an increase at t_2 followed by a slight decrease at t_3 ; the value at t_3 was larger than the one at t_1 .

These findings are in line with a previous study conducted by Minji Kim *et al.* that there was a reduction in the lower facial height and lower vermillion lengths and heights after mandibular setback surgery.^[2] It was also noted that there was a significant increase on the upper lip length in patients who underwent mandibular setback surgery.

BI-JAW SUGERY GROUP-

Group of patients who underwent bi-jaw surgery were also analyzed using the images obtained using the Bellus 3-D Camera. This group has significant changes in the middle and lower facial 1/3rd height, bi-zygomatic width, bi-gonial width, lip length as well as the upper and lower vermillion heights.

There were, however, no statistically significant differences for soft tissue changes in the upper facial height and nasal proportions between t_1 and t_2 and t_1 and t_3 time intervals.

Patients who underwent Le-Fort 1 maxillary advancement and mandibular setback by bilateral sagittal split osteotomy showed an increase in the middle third of the face, maxillary height, bi-gonial width, lip length and upper and lower vermilion heights. There was a reduction in the lower facial height, mandibular height and a slight reduction in zygomatic width.

In a study on the soft tissue changes among bi-jaw surgical patients conducted by Sforza *et al.* there was a significant reduction in lower facial height and bi-gonial width with an increase in the lower lip height, overall lip length and midface depth and height.^[7]

Pairwise comparison showed that there were statistically significant differences for soft tissue changes of the face between t_1 and t_2 and t_1 and t_3 time intervals for most linear measurements in our study.

There was a sharp decrease in the lower facial height, mandibular height and a slight reduction in zygomatic width at t_2 with an increase at t_3 , with the value at t_3 being lesser than t_1 . Similarly, the midface height lower vermilion height initially decreased at t_2 , showing a sharp increase at t_3 , with the value at t_3 being more than the value at t_1 . The maxillary height, bi-gonial width, lip length and upper vermilion height showed an increase at t_2 followed by a slight decrease at t_3 ; the value at t_3 was larger than the one at t_1 .

These changes in both groups can be correlated with the presence of post surgical swelling and possible relapse of the orthognathic surgical procedure.

These findings are congruent with our findings with regards to most anatomical landmarks and linear measurements, however in contrast to these studies showing a reduction in gonial widths, ours showed an increase in the same.

In the studies by Kim *et al.* and Choi *et al.* on the evaluation of mandibular width after mandibular setback surgery, it was noted that there was an increase in the bi-gonial width after mandibular setback. The increase can be attributed to the amount of overlap between the distal and proximal segments causing a relative increase in the bi-gonial width. ^[17]

LIMITATIONS OF THE STUDY

Despite some valuable findings in our study, there are certain limitations to be taken into consideration.

- This was a 2-month follow up study, therefore, in order to obtain more accurate results after complete stabilization post Orthognathic surgery, long-term follow up studies are required.
- Since this study included smaller groups of patients undergoing either bi-jaw surgeries or mandibular setback surgery, it cannot be set as a standard method for all types of orthognathic surgical procedures.
- The marking of landmarks was done manually which could lead to possible human errors, therefore, the use of a software could produce more accurate results.

A multi-center study with a larger sample size can be considered for a more extensive study in order to overcome these limitations.

CONCLUSION

This study was done to evaluate the soft tissue changes before and after orthognathic surgery using 3-D photographs and compare the measurements 1 month after surgery as well as 2 months after surgery.

The following conclusions can be drawn from the present study:

- 1) Mandibular setback surgery caused a reduction in the lower facial height, mandibular height and upper vermilion height and an increase in the bi-gonial width and lower vermilion height in these patients.
- 2) Patients who underwent Le-Fort 1 maxillary advancement and mandibular setback by bilateral sagittal split osteotomy showed an increase in the middle third of the face, maxillary height, bi-gonial width, lip length and upper and lower vermilion heights. There was a reduction in the lower facial height, mandibular height and a slight reduction in zygomatic width.

3-D cameras permit quantitative measurements of soft tissue changes after orthognathic surgical procedures in patients with skeletal and dentofacial deformities. This is especially advantageous in the frontal view, which is not possible with conventional 2-D cephalometry.

Although cephalometry is an important tool for evaluation of skeletal discrepancies prior to orthognathic surgery, 3-D technology may provide more valuable information by giving a 360° view of the anatomical landmarks in surgical patients. This information may be particularly useful regarding the soft tissue landmarks on the face.

With the advent of 3-D surgical simulation tools such Dolphin's 3-D Surgery module, Planmeca Romexis, Nemoceph, etc. the use of CBCTs and 3-D Photography is slowly increasing. 3-D photographs are superimposed onto CBCTs in a similar manner as 2-D cephalometric superimpositions onto 2-D lateral photographs for Orthognathic surgery treatment planning.

The three-dimensional approach used in the study can be useful as a diagnostic and predictive aid while enabling accurate evaluation of the initial and final soft tissue positions in Orthognathic surgical cases.

SUMMARY

The goal of the study was to assess the soft tissue changes before and after orthognathic surgery using a 3-D Camera and compare the measurements 1 month after surgery as well as 2 months after surgery.

A total of 25 patients who underwent orthognathic surgery were considered in this study.

These 25 patients were divided into 2 groups based on the type of surgery performed; the mandibular BSSO setback group and Bi-jaw surgery group that involved mandibular setback and maxillary advancement.

Comparisons between different time intervals t₁, t₂ and t₃ for all different landmarks was performed using Repeated measures ANOVA test to assess significant differences.

Mandibular setback surgery caused a reduction in the lower facial height, mandibular height and upper vermilion height and an increase in the bi-gonial width and lower vermilion height in these patients.

Patients who underwent Le-Fort 1 maxillary advancement and mandibular setback by bilateral sagittal split osteotomy showed an increase in the middle third of the face, maxillary height, bi-gonial width, lip length and upper and lower vermilion heights. There was a reduction in the lower facial height, mandibular height and a slight reduction in zygomatic width.

Pairwise comparison showed that there were statistically significant differences for soft tissue changes of the face between t₁ and t₂ as well as t₁ and t₃ time intervals for most linear measurements in our study.

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ANNEXURE-I-ETHICAL CLEARANCE CERTIFICATE

Research and Ethics Committee
KLE VK INSTITUTE OF DENTAL SCIENCES

A Constituent Unit of KLE Academy of Higher Education & Research
 Accredited 'A' Grade by AACSB Placed In Category 'A' by MHRD (Govt)

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CERTIFICATE

Sl. No. : **1605**

EC/IND/INST/2021/2435
 Research & Ethics Committee

This is to Certify that the synopsis titled

*Evaluation of soft tissue changes before and after
 Orthognathic surgery using a 3-Dimensional camera -
 An interventional clinical study* Submitted by
 Dr. REG. NO. II0221003 _____ P. G. Student /
 Staff, Guided by _____ -from Department of
 Orthodontics and Dentofacial Orthopaedics has been critically evaluated by
 committee members and granted ethical clearance to conduct the above
 mentioned study

Date : 21/4/24

[Signature]
Member Secretary
 Research and Ethical Committee
 KLEVK Institute of Dental Sciences
 BELAGAVI

[Signature]
Chairman
 Research and Ethical Committee
 KLEVK Institute of Dental Sciences
 Belagavi
 BELAGAVI

ANNEXURE II-CONSENT FORM

KLE VK INSTITUTE OF DENTAL SCIENCES, BELAGAVI –590010

CONSENT FORM

TITLE: FRONTAL AND LATERAL SOFT TISSUE ANALYSIS USING A 3-DIMENSIONAL CAMERA FOLLOWING ORTHOGNATHIC SURGERY AND ITS COMPARISON WITH SIMULATION DONE ON DOLPHIN IMAGING SYSTEM

OPERATOR: -

NEED FOR THE STUDY: The purpose of this study is to utilize a 3D camera system to analyze soft tissue changes after orthognathic surgery.

I, _____ aged _____ have been informed about my involvement in the study:

- I agree to give my personal details like name, age, sex, address and the details required for the study to the best of my knowledge.
- I am informed about the procedure and I agree and give my consent to the orthodontist for procedure.
- I permit the dentist to utilize the information given by me and results obtained from this study for presentation and publication purpose.
- I will not claim any returns for my cooperation in the study, even if it is being sponsored by any agency. I am participating with my own will and wish.
- I will follow the instructions given by the doctor.
- During the study, if I wish to resign from the study, I am free to do so and my treatment will still be completed in the department.
- In my full consciousness and presence of mind, after understanding all the procedure in my vernacular language, I am willing and give my consent to participate in this study.

Date:

Place:

Signature of witness

Signature

ANNEXURE III- PHOTOGRAPH



ANNEXURE IV- MASTER CHARTS FOR BSSO SETBACK

GROUP

facial height upper 1/3				facial height middle 1/3				facial height lower 1/3			
PATIENT	t1	t2	t3	PATIENT	t1	t2	t3	PATIENT	t1	t2	t3
1	6.90681	7.02931	6.95337	1	5.53009	5.45878	5.43223	1	6.63077	6.38727	6.45427
2	5.75884	5.80823	5.75903	2	6.55255	6.45263	6.40981	2	6.6551	6.08114	6.12413
3	6.42418	6.40184	6.50031	3	5.94025	6.02405	5.99684	3	6.52688	6.14588	6.32868
4	7.50164	7.49641	7.50238	4	6.00224	6.20423	6.21459	4	6.70561	6.56174	6.61098
5	4.97343	5.0086	5.01052	5	5.17835	5.20726	5.09268	5	5.43598	5.27601	5.32972
6	5.66884	5.91723	5.65121	6	6.79215	6.21263	6.5189	6	6.7915	6.34115	6.31427
7	6.42418	6.40184	6.50031	7	5.92125	6.02405	5.99684	7	6.89189	6.38134	6.41868
8	7.87114	7.41261	7.20828	8	6.00224	6.20423	6.21459	8	6.70917	6.38727	6.45427
9	4.87143	5.1761	5.6115	9	5.17835	5.24326	5.13268	9	7.15251	6.18916	6.02113
10	5.9184	5.19823	5.43903	10	6.55255	6.45263	6.40981	10	6.52688	6.14588	6.32868
11	6.67118	6.01184	6.79031	11	5.51909	5.8791	5.42921	11	6.9011	6.56174	6.61098
12	7.50164	7.49641	7.50238	12	6.55255	6.45263	6.40981	12	5.33198	5.71601	5.42972
13	6.90681	7.12131	6.1633	13	5.94125	6.34213	5.92184	13	6.91561	6.76174	6.81018
Mean values	6.415271	6.344612	6.353225	5.97407	6.012124	5.93691		6.551922	6.225872	6.248899	

maxillary height			mandibular height			zygomatic width			bigonial width				
PATIENT	t1	t2	t3	PATIENT	t1	t2	t3	PATIENT	t1	t2	t3		
1	2.46432	2.46853	2.48034	1	4.2303	3.85473	4.01546	1	13.3744	13.359	13.2944		
2	2.34608	2.43008	2.39814	2	4.468	4.10643	4.04329	2	13.6838	13.5018	13.6018		
3	2.14482	2.20021	2.15681	3	4.31281	4.05429	4.10123	3	12.9349	12.9402	12.9531		
4	2.24879	2.250104	2.250614	4	4.2624	4.1041	4.20056	4	14.5	14.49	14.501		
5	1.57838	1.60846	1.60451	5	3.91073	3.86677	3.90082	5	11.9877	11.9482	11.9754		
6	2.16208	2.43008	2.32111	6	4.7191	4.29043	4.0832	6	13.8238	13.6421	13.5938		
7	2.14482	2.31921	2.15681	7	4.20281	4.05429	4.10123	7	12.8419	12.8212	12.8131		
8	2.24879	2.410104	2.250614	8	4.2624	4.1041	4.20056	8	14.7823	14.8712	14.512		
9	1.92838	1.71746	1.62451	9	3.9813	3.71677	3.90082	9	12.8819	12.9762	12.311		
10	2.19608	2.21008	2.36548	10	4.2168	4.21943	4.11329	10	14.98	14.413	14.411		
11	2.46432	2.46853	2.48034	11	4.2303	3.85473	4.13546	11	11.623	11.7212	11.8751		
12	2.12608	2.43108	2.40181	12	4.7818	4.21106	4.31229	12	13.2541	13.359	13.2144		
13	2.14482	2.41021	2.1918	13	4.31281	4.09129	4.21123	13	13.5238	13.4218	13.7118		
Mean values	2.169058	2.258011	2.206376	4.299351	4.040648	4.101495		13.39935	13.34345	13.28984	11.36135	11.48769	11.43856

alar width			nasion-nasal tip			nasal tip-subnasale					
PATIENT	t1	t2	t3	PATIENT	t1	t2	t3	PATIENT	t1	t2	t3
1	3.94004	3.95207	3.8415	1	4.2886	4.19771	4.2795	1	1.51552	1.55674	1.56526
2	4.14946	4.1468	4.1396	2	4.4631	4.45901	4.46292	2	1.76751	1.75993	1.76638
3	3.59314	3.60011	3.59842	3	4.48833	4.490581	4.488358	3	1.5054	1.51441	1.4995
4	4.07199	4.09934	4.090917	4	4.33642	4.40428	4.336681	4	1.55557	1.58278	1.58367
5	3.33071	3.35376	3.382105	5	4.26245	4.19776	4.26904	5	1.4643	1.43995	1.45102
6	3.61314	3.81211	3.51842	6	4.12631	4.28771	4.2795	6	1.61751	1.77993	1.76638
7	4.12199	4.0874	4.1009	7	4.4631	4.45901	4.46292	7	1.5054	1.51441	1.3995
8	3.82004	3.89207	3.8325	8	4.51833	4.481581	4.418358	8	1.67557	1.58278	1.58367
9	4.14946	4.1468	4.1396	9	4.47133	4.490581	4.488358	9	1.5312	1.55674	1.56526
10	3.81314	3.71011	3.48842	10	4.41642	4.40428	4.336681	10	1.79751	1.75993	1.7638
11	4.19199	4.08934	4.10017	11	4.26245	4.19776	4.26904	11	1.6154	1.59241	1.3195
12	3.34071	3.35376	3.382105	12	4.1386	4.28771	4.1995	12	1.61557	1.71278	1.58367
13	3.9104	3.94207	3.3121	13	4.5131	4.46901	4.45292	13	1.4123	1.42195	1.42112
Mean values	3.849708	3.860442	3.763597	4.365272	4.371306	4.364906		1.582982	1.598057	1.559133	

lip length			upper vermillion height			lower vermillion height					
PATIENT	t1	t2	t3	PATIENT	t1	t2	t3	PATIENT	t1	t2	t3
1	5.57973	4.92859	4.92062	1	0.893225	0.728444	0.757686	1	0.835652	0.863413	0.90464
2	4.34254	4.29541	4.27903	2	0.81602	0.902745	0.899661	2	1.82053	1.45368	1.38431
3	4.07701	4.10068	3.96899	3	0.895476	0.81779	0.896592	3	0.854348	0.933997	0.890058
4	5.24181	5.18145	5.19779	4	1.08106	0.91327	1.04783	4	1.05013	1.10014	1.06412
5	3.9381	3.83447	3.92587	5	0.596032	0.60603	0.58515	5	0.83344	8.8209	0.90058
6	4.12254	4.2451	4.19903	6	0.966027	0.912745	0.78661	6	1.34053	1.45368	1.38431
7	4.07701	4.10068	3.96899	7	0.99647	0.90779	0.792592	7	0.9413	0.9439	0.91
8	5.57973	4.92859	4.92062	8	0.893225	0.728444	0.757686	8	1.22053	1.45368	1.38431
9	4.32154	4.18541	4.28103	9	0.81602	0.812745	0.88166	9	0.794348	0.9439	0.99
10	4.16701	4.11068	3.7989	10	0.88147	0.90779	0.896592	10	1.05013	1.2014	1.03412
11	5.1801	5.19145	5.20779	11	1.191	0.91327	1.05783	11	0.91344	8.8209	0.9158
12	3.8181	3.78447	3.9618	12	0.895476	0.9187	0.81592	12	1.22053	1.55368	1.58431
13	4.6154	4.28541	4.2913	13	1.20112	0.98327	1.12783	13	0.91352	0.96143	0.91264
Mean values	4.543125	4.397876	4.378597	0.932509	0.850233	0.869511		1.060648	2.346515	1.096861	

ANNEXURE V- MASTER CHARTS FOR BI-JAW SURGERY GROUP

facial height upper 1/3				facial height middle 1/3				facial height lower 1/3			
PATIENT	t1	t2	t3	PATIENT	t1	t2	t3	PATIENT	t1	t2	t3
14	6.20748	6.23972	6.29723	14	6.04724	6.13774	6.14073	14	6.57936	6.32094	6.35125
15	5.82486	5.70094	5.72547	15	5.57983	5.6718	5.7733	15	9.5023	7.6366	7.8492
16	6.64586	6.61119	6.59853	16	6.92918	5.79801	6.92206	16	6.88263	6.44278	6.61206
17	6.6847	6.64465	6.69775	17	6.36378	6.03781	6.78	17	6.15053	5.9195	6.02051
18	5.82486	5.70094	5.72547	18	5.57983	5.70815	5.7733	18	6.57936	6.32094	6.35125
19	6.64586	6.61119	6.59853	19	6.92918	6.68711	6.92206	19	9.5023	7.6366	7.8492
20	6.20748	6.23972	6.29723	20	6.14724	5.91789	6.14073	20	6.88263	6.44278	6.61206
21	5.82486	5.70094	5.72547	21	5.57983	5.50815	6.6671	21	6.88263	6.44278	6.61206
22	6.64586	6.61119	6.59853	22	6.72918	6.68711	7.0123	22	6.15053	5.9195	6.02051
23	6.6847	6.64465	6.69775	23	6.36378	6.03781	6.13129	23	6.57936	6.32094	6.35125
24	5.82486	5.70094	5.72547	24	6.36378	6.0012	6.13129	24	9.5023	7.6366	7.8492
25	6.64586	6.61119	6.59853	25	5.57983	5.70815	6.123	25	6.88263	6.44278	6.61206
Mean values	6.305603	6.251438	6.27383	6.182723	5.991744	6.37643		7.339713	6.623562	6.757551	

maxillary height			mandibular height			zygomatic width			bigonial width		
PATIENT	t1	t2	t3	PATIENT	t1	t2	t3	PATIENT	t1	t2	t3
14	2.86884	2.97454	3.19454	14	4.46275	3.78544	3.68997	14	15.4594	16.0921	16.0029
15	2.85182	2.79973	3.29815	15	6.38515	4.9746	4.90979	15	14.0848	13.4245	13.4374
16	1.91244	2.03584	2.14506	16	4.70032	4.2873	4.4217	16	13.4399	12.8614	13.3626
17	1.562928	1.99746	1.84511	17	4.5029	4.00942	4.3179	17	14.2316	13.9561	14.0002
18	2.65182	2.79973	2.98159	18	6.38515	4.9746	4.90979	18	13.7848	13.4245	13.4374
19	1.91244	2.03584	2.34506	19	4.70032	4.2873	4.4217	19	13.8699	12.8614	13.3626
20	2.56884	2.77454	2.98454	20	4.70032	4.2873	4.4217	20	15.4594	16.0921	16.0029
21	2.45182	2.99973	2.99159	21	4.5029	4.00942	4.3179	21	14.0198	13.4245	13.3374
22	1.91244	2.13584	2.14506	22	6.38515	4.9746	4.90979	22	13.5399	12.8614	13.3626
23	1.62928	1.83746	1.84511	23	6.38515	4.9746	4.90979	23	14.2356	13.9561	13.9012
24	2.56884	2.99454	2.79454	24	4.70032	4.2873	4.4217	24	14.31511	13.9561	14.0012
25	2.65182	2.79973	2.98159	25	4.70032	4.2873	4.4217	25	13.9898	13.4245	13.4374
mean values	2.295277	2.515415	2.629328	5.209229	4.428265	4.506119		14.2025	13.86123	13.97048	
									10.55946	11.13645	11.00966

alar width			nasion-nasal tip			nasal tip-subnasale					
PATIENT	t1	t2	t3	PATIENT	t1	t2	t3	PATIENT	t1	t2	t3
14	3.97098	4.17996	4.01102	14	4.65069	4.236274	4.346274	14	1.11708	1.3507	1.2919
15	3.84468	4.04215	3.81608	15	4.700403	4.748891	4.761137	15	1.38894	1.38178	1.379587
16	4.40661	4.12154	4.30477	16	5.409732	5.491276	5.45647	16	1.23328	1.31001	1.20146
17	4.40997	4.5001	4.39915	17	4.617363	4.62009	4.60996	17	1.61414	1.5998	1.60904
18	3.84468	4.04215	3.81608	18	4.700403	4.748891	4.761137	18	1.38894	1.38178	1.379587
19	4.40661	4.12154	4.30477	19	5.409732	5.491276	5.45647	19	1.23328	1.31001	1.20146
20	4.40661	4.12154	4.30477	20	4.65069	4.236274	4.346274	20	1.11708	1.3507	1.2919
21	4.40997	4.5001	4.39915	21	4.700403	4.748891	4.761137	21	1.38894	1.38178	1.379587
22	3.84468	4.04215	3.81608	22	5.409732	5.491276	5.45647	22	1.23328	1.31001	1.20146
23	3.97098	4.17996	4.01102	23	4.617363	4.62009	4.60996	23	1.61414	1.5998	1.60904
24	3.84468	4.04215	3.81608	24	4.700403	4.748891	4.761137	24	1.38894	1.38178	1.379587
25	4.40661	4.12154	4.30477	25	5.409732	5.491276	5.45647	25	1.23328	1.31001	1.20146
Mean values	4.147255	4.167907	4.108645	4.914721	4.88945	4.898575		1.329277	1.389013	1.343839	

lip length			upper vermillion height			lower vermillion height					
PATIENT	t1	t2	t3	PATIENT	t1	t2	t3	PATIENT	t1	t2	t3
14	4.18596	3.8973	3.9174	14	0.931984	1.06691	1.00823	14	1.17947	0.93348	0.90321
15	3.41623	3.69061	3.67039	15	0.805455	1.21749	1.2385	15	1.01371	0.864644	1.18463
16	3.9279	4.34818	4.05656	16	0.634126	0.8189	0.70387	16	0.953514	1.032623	1.22918
17	4.00373	4.3128	4.10031	17	0.902141	1.2906	1.04652	17	1.10977	1.07891	1.09818
18	3.41623	3.69061	3.67039	18	0.891984	1.06691	1.00823	18	1.01371	0.864644	1.18463
19	3.9279	4.34818	4.05656	19	0.795455	0.921749	1.2385	19	0.953514	1.032623	1.22918
20	4.18596	3.8973	3.9174	20	0.634126	0.99188	0.70387	20	1.17947	0.93348	0.90321
21	3.41623	3.69061	3.67039	21	0.59412	0.9718	0.89387	21	1.01371	0.864644	1.18463
22	3.9279	4.34818	4.05656	22	0.882141	1.1262	1.04652	22	0.953514	1.032623	1.22918
23	4.00373	4.3128	4.10031	23	0.89198	1.26691	1.00823	23	1.10977	1.07891	1.09818
24	3.41623	3.69061	3.67039	24	0.90241	1.22062	0.94652	24	1.10977	1.07891	1.09818
25	3.9279	4.34818	4.05656	25	0.92098	1.35691	1.21823	25	1.01371	0.864644	1.18463
Mean values	3.812992	4.047947	3.911935	0.815575	1.10974	1.005091		1.050303	0.971678	1.127252	