ASSESSMENT OF SOFTWARE ASSISTED TREATMENT PLANNING IN SOFT TISSUE PREDICTION FOLLOWING FIXED ORTHODONTIC TREATMENT.

THESIS

Submitted to

BABU BANARASI DAS UNIVERSITY,

LUCKNOW, UTTAR PRADESH

In the partial fulfilment of the requirements for the degree

of

MASTER OF DENTAL SURGERY

In

ORTHODONTICS AND DENTOFACIAL ORTHOPAEDICS

By

Dr. Rigzing O.Lepcha

Under the guidance of

DR. TRIPTI TIKKU

Professor

Department of Orthodontics and Dentofacial Orthopaedics

BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES, LUCKNOW

(Faculty of Babu Banarasi Das University)

YEAR OF SUBMISSION: 2022 **BATCH: 2019-2022**

DECLARATION BY THE CANDIDATE

I hereby declare that this dissertation entitled **"ASSESSMENT OF SOFTWARE ASSISTED TREATMENT PLANNING IN SOFT TISSUE PREDICTION FOLLOWING FIXED ORTHODONTIC TREATMENT"** is a bonafide and genuine research work carried out by me under the guidance of Proffessor ***Dr.Tripti Tikku,*** as a Guide and Professor and Head ***Dr.Rohit Khanna,*** as Co-Guide in Department of Orthodontics and Dentofacial Orthopaedics of the Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

Date: 30/March/2022

Place: Lucknow

Dr. Rigzing O.Lepcha

CERTIFICATE BY THE GUIDE

This is to certify that the dissertation entitled **"ASSESSMENT OF SOFTWARE ASSISTED TREATMENT PLANNING IN SOFT TISSUE PREDICTION FOLLOWING FIXED ORTHODONTIC TREATMENT"** is a bonafide work done by **Dr.Rigzing O. Lepcha**, under my direct supervision and guidance in partial fulfilment of the requirement for the degree of MDS in Orthodontics and Dentofacial Orthopaedics.

Tripti Tikku

Dr. Tripti Tikku
Professor
Department of Orthodontics &
Dentofacial Orthopaedics
BBDCODS, BBDU
Lucknow

Date: 30/march/2022.

CERTIFICATE BY THE Co-GUIDE

This is to certify that the dissertation entitled **"ASSESSMENT OF SOFTWARE ASSISTED TREATMENT PLANNING IN SOFT TISSUE PREDICTION FOLLOWING FIXED ORTHODONTIC TREATMENT"** is a bonafide work done by **Dr.Rigzing O. Lepcha**, under my direct supervision and guidance as a Co-Guide in partial fulfilment of the requirement for the degree of MDS in Orthodontics and Dentofacial Orthopaedics.

Date : 30/March/2022

Dr. Rohit Khanna
Professor and Head
Department of Orthodontics &
Dentofacial Orthopaedics
BBDCODS, BBDU
Lucknow

ENDORSEMENT BY THE HOD / HEAD OF THE INSTITUTION

This is to certify that the dissertation entitled **"ASSESSMENT OF SOFTWARE ASSISTED TREATMENT PLANNING IN SOFT TISSUE PREDICTION FOLLOWING FIXED ORTHODONTIC TREATMENT"**is a bonafide work done by **Dr. Rigzing O.Lepcha** under the supervision of **Dr. Rohit Khanna**, Professor & Head, Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College Of Dental Sciences, Babu Banarasi Das University, Lucknow, Uttar Pradesh.

Dr. Rohit Khanna
Professor & Head
Department of Orthodontics &
Dentofacial Orthopaedics
BBDCODS, BBDU
Lucknow

Dr. Puneet Ahuja
Principal
BBDCODS, BBDU
Lucknow

PRINCIPAL
Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow-226028

COPYRIGHT

DECLARATION BY THE CANDIDATE

I hereby declare that the **Babu Banarasi Das University** shall have the rights to preserve, use and disseminate this dissertation in print or electronic format for academic / research purpose.

Date: 30/March/2022

Place: Lucknow

Dr. Rigzing O.Lepcha

Acknowledgement

The satisfaction and euphoria that accompany the successful completion of a task could be incomplete without the mention of the people who made it possible. I owe my immense respect to almighty God for living in my heart, inspiring me for noble values in life and for his divine blessings.

It is my privilege and honour to express my most sincere and heartful thanks to my head, ***Dr. Rohit Khanna,*** *MDS, Professor & Head, Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow, for his co-operation and continuous help rendered during preparation of this dissertation. His unflinching courage and conviction will always inspire me, and I hope to continue to work with his noble thoughts. I can only say a proper thanks to him through my future work. It is to him, that I dedicate this work.*

I take this opportunity to express my profound gratitude and heartful thanks to my guide ***Dr. Tripti Tikku****, MDS, Professor, Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow, for her expert guidance, personal attention and encouragement in preparing the dissertation.I can't say thank enough for her tremendous support and help.Her patience and support helped me overcome many crisis situations and finish this dissertations.*

I am also thankful to ***Dr. Rana Pratap Maurya,*** *MDS, Reader,* ***Dr. Sneh Lata Verma,*** *MDS, Reader,* ***Dr Kamna Srivastava,*** *MDS, Reader,all my Senior Lecturers* ***Dr.Sweata,Dr.Srishti Aditi,Dr.Abhimanyu,Dr.Prateek*** *MDS, Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das College of Dental Sciences, Lucknow, for their valuable suggestions, time to time guidance, encouragement and constant moral support during the period of my study. Without their support nothing would have been possible for me. It was their understanding, valuable suggestions, unstinted help and personal attention that have provided good and smooth basis for this work.I feel motivated and encouraged by their mere presence.It's honour to have to have such teachers and shall forever be indebted to them.*

I am really thankful to my late grandother ***Dawa Doma*** *parents* ***Mr. Kazi Lepcha , Mrs. Lachu Maya, Mr.,Arun Kr. Basnett, Mrs Devika Basnett*** *for their love and constant support throughout my life. Thank you for giving me sincere encouragement and inspiration throughout my research work and for giving me strength to reach for the star and chase my dreams. I owe you everything guys. Without your blessings it would never have been possible.*

I would also like to thank my brother ***Tshering Wangchuk*** *and sister* ***Sonam*** *and my three beautiful nieces who has always cheered me up.*

A special thanks to ***Dr.Aseem Tikku sir*** *for being like a god father who had always encouraged me,had given moral support and stood like a pillar through my ups and down.*

*I would also like to thank my seniors Dr.****Harmeet maam,Dr.Ayush sir and Dr.Deepak sir*** *who has been helping me even after they have finished their college.I would also like to thank my colleagues* ***Noor,Tanjula,Akansha,Deepa and Deepak*** *for their help and encouragement throughout my work sailing together in the same boat.*

*My special appreciation goes to my juniors****,Minerva,Swagat,Kamran,Bhanu,Senapati sir,Rahul Anand Jaya,Sweety,Aliya,Monika Shereen****,****Sabrajit*** *for their constant support and help in all my work and bringing the dissertation to completion.*

My special thanks is also to ***Dr.Shiva kr.Rai ,Mrs Kavitra Rai, Dr.Parajeeta di, Dr.Krishna da,Dr.Jimila Shenga ,Dr.Sandeep Pradhan,Dr.Durga Rai Dr.Deki Phempu,Dr.Kunzang,Dr.Jyotsnhna*** *who had always encouraged me and had given moral support.*

Last but not the least I would like to extend my special thanks to my loving and caring husband ***Dr.Jigme Palzor Denzongpa*** *who have shared intellectual support, assistance, suggestions and recommendations that contributed to the making of this dissertation a success.*

I also acknowledge the assistance rendered by the paradental staff in the department- ***Mr Surender , Mr.Narendra and Ammaji.*** *Besides this, several people have helped me knowingly and unknowingly in the successful completion of this project.*

Finally, I would like to thank all other unnamed who helped me in various ways. I would like to thank each and everyone….

Dr. Rigzing O.Lepcha

S.NO	ABBREVIATIONS	FULL FORM
1.	S	Sellae Turcica Center of the contour of Sella Turica:
2	Na	Nasion: Most anterior point of the Nasofrontal suture in the midsagittal plane.
3..	Or.	Orbitale:Lowest most point on the inferior rim of the orbit.
8.	Po	Porion :Most superiorly positioned point of the external auditory meatus.
9.	Point A	Deepest point in the midsaggital plane between the Anterior Nasal Spine and Prosthion
10.	Point B	Deepest point in the midsaggital plane between Infradentale and Pogonion
11.	Pog(Pg)	Pogonion ,most point of the bony chin
12.	Gn	1. Gnathion Antero-inferior point of bon chin located by taking the midpoint between the anterior (Pogonion) and inferior (Menton) points of the bony chin.
13.	Me	Menton :Lowest Point on the bony chin
14.	Go	GonionA point on the curvature of the angle of the mandible located by bisecting the angle formed by lines tangent to the posterior ramus and the inferior border of the mandible.
15.	Sn	Subnasale The junction of nose to upper lip
16.	Ls	Labrale Superius:The point indicating the mucocutaneous border of the upper lip.The most

		anterior point of the upper lip.
17.	Ls	Labrale inferius:The point indicating the mucotaneous border of the lower lip
18	Stms	Stomium superius:The lower most point on the vermilion of the upper lip
19	Stms	1. Stomium Inferius:The uppermost point on the vermilion border of the lower lip.
20	G’	Soft Tissue Glabella:The most prominent point of the forehead on the midsagittal plane at the superior aspect of the eyebrows.
21	N’	Soft tissue Nasion:The outer point of intersection between the nasion horizontal line and the soft tissu
22	NT	Pronasale:The most prominent or anterior point of the nose(tip of the nose)
23	NB	Nasal Base:An imaginary point between the most lateral points of the external inferior attachment of the alae nasi to the face.
24	Cm	Columella: The anterior most point on the columella of the nose
25.	Pg’	Soft tissue pogonion: The outer point of intersection between the Pogonion horizontal line and the soft profile.
26	Gn’	Soft tissue Gnathion:A constructed midpoint between the a soft tissue pogonion and soft tissue Menton.
27.	Me’	Soft tissue menton:The outer point of intersection between the Menton vertical line and the soft tissue

28	U 1 -to NA (mm)	Linear distance in mm measured from facial surface of upper maxillary incisor to line drawn from Nasion to point A.
29	U 1-to NA(angular)	Angular measurement between the line drawn along long axis of the maxillary incisor and the line drawn from Nasion to Point A.
30	L1- to NB(mm)	Linear distance(in mm) measured from facial surface of mandibular incisor to line from Nasion to Point B.
31	L1- to NB (angular):	Angular measurement formed between the line drawn along long axis of the mandibular incisor and the line drawn from Nasion to Point B.
32	pre	Pre treatment measurement
33	post	Post treatment measurement
34	FTO	Facial Treatment Objectives

Introduction:- The prediction of treatment outcome is an important part of Orthodontic planning and its presentation to patient is an effective tool for motivating patients to undergo orthodontic treatment.

Aim and Objectives:- To check the reliability of prediction using Nemoceph software by comparing the changes in the soft tissue parameters between prediction tracing and post treatment tracing in subjects with Class II Div I malocclusion and Class I Bimaxillary dentoalveolar protrusion.

Material and methods. Pre and post treatment lateral cephalogram of Angle's Class II Div 1 malocclusion(Group I,n=15) and Class 1 Bimaxillary dentoalveolar protrusion(Group II ,n=15) in the age range of 18-30 years were taken. The prediction was generated using FTO tool of Nemotech software, based on differences between the pre and post treatment values for postion and angulation of maxillary and mandibular incisor, as per Steiner's analysis. Selected soft tissue parameters were measured for prediction and post treatment tracing and adequate statistical comparisons were made .

Results:- Prediction tracing was relatively more accurate in vertical than horizontal direction. Most of the parameters that showed statistically significant prediction error had a mean difference < 2mm, that was within clinically acceptable limits

Conclusion:- The prediction tracing using Nemoceph software were fairly accurate. However prediction generated must be used with caution as lip tone, lip thickness, age, gender, complex morphology of the nasomaxillary complex etc might cause individual variations, resulting in prediction errror.

Keywords :- Prediction, Nemoceph, Orthodontics, post treatment, Reliabilty.

Introduction

Social and psychological concerns, improved function, appearance, and self-esteem encourages a patient to pursue Orthodontic treatment, therefore it is of great importance that the patient should understand the treatment outcome before giving their consent for treatment. The prediction of treatment outcome is an important part of Orthodontic planning and its presentation to patient is an important process of patient' informed consent.

Conventionally the extent of the hard tissue changes were predicted using Tweed Head Plate correction or Steiner stick analysis[1], however soft tissue alteration could not be predicted by this.Visual treartment objective had been proposed by Ricketts[2] and Holdway[3] but changes were visualized as cephalogram tracing only. Arnett discussed about dental VTO where extent of dental movements were predicted. These techniques did not allow us to predict or demonstrate altered soft tissue profile to the patient.

Computer technology has helped us in the world we live in. Manual cephalometric analysis has been replaced by computerized cephalometric softwares like Quick Ceph, Dolphin, Nemoceph etc.Cephalometric softwares decreased time required for various cephalometric analysis.On location of landmarks and completing the tracing using cephalometric software tools, different cephalometric analysis are just a click away. Besides this ,cephalometric software also provides the ability to easily and accurately perform the treatment simulations .These programs concentrate not only on teeth and the occlusion, but also on the soft tissue profile.

The morphing tool of cephalometric software produces corrected soft tissue profile from hard tissue movements and when superimposed on facial photographs it can be a excellent motivational tool for the patients.This revolutionized the mode of

presentation of post treatment facial appearance to the patient before the actual procedure was performed.There are differences between osseous changes and soft tissue translations after completion of orthodontic treatment due to variability in the thickness of the lip,and complex muscular attachment in nasolabial region.Also variability is seen in how soft tissue drape follows after skeletal movement of underlying hard tissue in subject undergoing orthognathic surgery. Prediction of upper and lower lip posed greatest difficulty during manual prediction for jaw surgeries. Many studies[4, 5,6]which demonstrate ratios of incisor retraction to lip retraction between pre and post treatment tracings found it to be ranging from 1:2.2 to 1:3 for maxillary arch and 1:1.2 for mandible.Considering variability in soft tissue changes after treatment due to variations in soft tissue thickness the soft tissue changes predicted before beginning of treatment need to be assessed for accuracy and reliability.

Many of the previous studies[6-10] evaluated accuracy and reliability of morphing softwares in cases who had undergone orthognathic surgery but not many studies have evaluated the accuracy of prediction of soft tissue changes after orthodontic treatment.Prediction tracing has been an integral part of orthognathic surgery which is done at two steps,one before starting the treatment and is used for overall treatment planning and illustrates both orthodontic and surgical skeletal changes.Next is surgical prediction tracing ,done immediately before surgery to plan specific surgical measurements. Prediction tracing also helped in determining the need of any adjunctive procedures like genioplasty, to know the sequence of surgery and orthodontic treatment .For prediction in orthosurgical cases cut and paste profile tracing of patient photographs were used initially or steps given by Epker Fish[11], Arnett[12] etc were followed for predicting the amount of skeletal and dental charges

using cephalometric tracing. With advent of computers, line drawings for soft tissue profile based on hard tissue changes were generated on computers and nowadays morphing tool of different software allows clear visualization of the post treatment soft tissue profile of patient as photographs are superimposed on morphed cephalometric tracing.

The result of various studies[8,13,14,15] done to evaluate accuracy of cephalometric software for prediction of skeletal changes after orthognathic surgery to those achieved actually were relatively accurate with small degree of error and could be used for patient education and communication. Another study compared accuracy of five different cephalogram software programs for accuracy of predicted skeletal changes in ortho surgical cases and found Dentofacial Planner better than other programs when actual and morphed images were rated by panel of Orthodontist, Oral Surgeon and Laymen.[15] . The accuracy of prediction tracing in all these studies had been evaluated by generating prediction based on difference in skeletal changes between pre and post treatment tracing.This generated prediction tracing was compared to actual post treatment tracing for assessment of treatment outcome on soft tissue profile. This removed the error because of treatment mechanics and other biological factors and helped in checking the reliability of computerized software only.

The study[16] done to find accuracy of prediction by Steiner stick analysis made comparison between predicted values of Steiner Stick Analysis to those with actual treatment achieved concluded that the changes were overestimated and did not find it to be accurate to base orthodontic treatment decision on this. The extent of changes predicted by morphing tool of cephalometric software and those actually achieved after fixed orthodontic treatment have not been studied extensively in literature.Few

studies demonstrate accuracy of morphing results for functional appliance simulation[17] or fixed orthodontic treatment[18] generated prediction in similar way as done for orthosurgical cases. The morphing results of functional appliance simulation were done based on difference between pre and post treatment after Functional Appliance for various hard tissue parameter to actual treatment outcome and it was found in this study significant difference were seen for vertical position of soft tissue parameters using the commercial assisted cephalometric predictions programs Quick Ceph System[17]

Another study[18] was conducted following a similar method where dental changes ie difference in linear and angular measurements of maxillary and mandibular incisors between pre and post treatment were used for generating prediction tracing. The accuracy of Dolphin Cephalometric Software was evaluated by comparing prediction tracing to post treatment tracing and found that prediction tracing was more accurate in vertical direction than horizontal direction and most accurate for soft tissue Point A and least accurate for soft tissue pogonion

None of the studies have compared predicted changes to post treatment cephalometric outcome in subjects undergoing fixed orthodontic treatment using Nemoceph Cephalometric software. Hence it was decided to evaluate the same in present study using, a similar method as used for previous studies for checking accuracy of prediction for orthosurgical cases undergoing orthodontic treatment alone. In orthodontic practice since Class II Div 1 malocclusion and Class I Bimaxillary patient are two most commonly observed malocclusion hence it was decided to include the subjects with these two malocclusion in the present study . Also extraction is required in such cases hence presentation of expected post treatment profile in these patient will help in convincing them for extraction. Considering this it was decided to check the

reliability of prediction done using Nemoceph software by comparing the changes in the soft tissue parameters between prediction tracing and post treatment cephalometric tracing in subjects with Class II Div I malocclusion and Class I Bimaxillary dentoalveolar protrusion in the present study.

Aim & Objectives

Aim

To check the reliability of prediction done using Nemoceph software by comparing the changes in the soft tissue parameters between prediction tracing and post treatment cephalometric tracing in subjects with Class II Div I malocclusion and Class I Bimaxillary dentoalveolar protrusion.

Objectives

1To generate prediction tracing after morphing of pretreatment tracing ,based on actual changes observed in maxillary and mandibular incisor position between pre and post cephalometric tracing in subjects with Angle's Class II div 1 malocclusion and Angle's Class I Bimaxillary dentoalveolar protrusion.

2. To evaluate and compare the changes in soft tissue parameters between prediction tracingand actual post treatment cephalometric tracing in subjects with Angle's Class II Div 1 malocclusion.

3.To evaluate and compare the changes in soft tissue parameters between prediction tracingand actual post treatment cephalometric tracing in subjects with Angle's Class I Bimaxillary dentoalveolar protrusion.

Review of Literature

1. **Kowalski CJ,Walker GF(1972)**[19]For diagnosis and treatment planning insical angles have been used as a guideline in the treatment of malocclusion.These angles plays very important role in number of cephalometric analysis and is considered important values to determine the variations from norms thereby indicating the severity of the problem.For treatment these measure relates to denture to the skeletal pattern and hence indicate the possibilities and limitation of appliance therapy. did a study to test whether the norms suggested by Steiner are 'normal',sexual dimorphism and dependence to age and found out that normality is a multivariate phenomenon and proper combination of measurement and study reflected more accurately to Steiner's "acceptable compromises"than by Steiner's "ideal"values for measurement.
2. **Angelle PJ (1973)**[20]compared soft-tissue profiles of Orthodontically treated children to untreated smile contest winners having excellent occlusions and esthetically pleasing faces. He reported significant sexual differences in the response of the soft-tissue profile due to orthodontic treatment. He found a marked tendency for the upper lip to be retruded in the treated children. The amount of retrusion was limited in boys but more significant in girls. The upper lip was found to become thicker during orthodontic treatment, which was not observed in the untreated group. A significant retrusion of the lower lip during treatment was found in girls, whereas in treated boys the lower lip continued to become more protrusive
3. **Nigel W, Harradine T,Birnie DJ (1985)**[21] reviewed various method of predicting the orthognathic results based on manual, numerical and computerized method..Orthognathic planning and prediction earlier involved either sectioning lateral photographs or alteration of tracings of lateral skull radiographs, or a

combination of both these methods .The disadvantage of use of sectioned photographs is that differential movement of tissues within each .was not possible ,the free hand tracings was another method reviewed with its cons of being time consuming and was difficult to collect the data of soft tissue changes and it required artistic skill and summarised the advantages of computer prediction being no expertise required,swift and effecient way of predicting also soft tissue changes associated with each operation is always at the clinician's disposal. With these disadvantages that the equipment required is expensive and software are required.

4. **Talass M, Talass L, Baker R (1987)[22]** primarily designed a project to improve clinician's ability to predict the soft tissue profile changes caused by retraction of maxillary incisors in growing and in adult class II, division I white female patients. The cephalometric records of 133 (80 treated and 53 untreated) subjects was analysed. The three clinically significant soft-tissue changes that occurred in response to orthodontic treatment were retraction of upper lip, the increase in the lower lip length and the increase in the nasolabial angle. The changes in lower lip in response to orthodontic tooth movement was more predictable than those of the upper lip.
5. **Finnoy JP, Wisth PJ, Boe OE (1987)[23]** evaluated the soft tissue response to four premolar extraction and non-extraction treatment in patients with Angle Class II, division 1 malocclusions. Both the groups included thirty patients. It was observed that during treatment the lower lip and chin area was protruded in the non-extraction group. In both groups the depth of the nose increased, and so did the thickness of the basal part of the upper lip. The soft tissue profile excluding the nose straightened out, whereas the profile convexity increased when the nose

was included. The nasolabial angle increased in both groups. There was also retrusion of the lips when related to the E-line as a result of the continuous growth of the nose. A post-treatment comparison revealed a very similar morphology in the two group

6. **Donatsky O,Hillerup,Bjern-Jergensen J,Jacobson P.U.(1992)[24]** did a study to investigate whether computerized cephalometric could be used to evaluate postoperative results in computerized predictions and they found no significant difference between any predicted and postoperative maxillary and mandibular position indicating that preoperative planning including cephalometric evalution,surgical simulation and prediction applied to model surgery and orthognathic surgery ensures acceptably predictable,postoperative results.
7. **Konstiantos KA, O'Reilly MT, Close DMJ (1994)[25]** conducted a study on 21 patient who had undergone Lefort 1 surgery to investigate the validity of the predicted soft tissue changes produced with the use the DentoFacial Planner and they found out that there was difference in the soft tissue changes between the prediction and actual treatment after the lefort 1 surgery with the largest difference in the area of labrale inferior both vertically and horizontal direction,further pronasale and subnasale were significant different statisticallyboth in vertical and horizontal planes.concluding that dentoFacial Planner needs to have good refined estimates of the intercepts in the regression equations associated with with these landmarks**.**
8. **Eales EA, Jones ML, Newton C, Sugar AW (1995)[26]** studied the accuracy of prediction of soft tissue changes produced by a computer software package (COG 3.4) in a 14 females and 11 males with a mean age at surgery of 22.6 years treated by the Le Fort I osteotomy and they found out that many of the points

processed by computer on the facial contour viewed from side were efficiently well predicted. In addition, the chin and profile changes resulting from mandibular auto-rotation also were fairly well predicted..Although, in a number of cases prediction was less compatible and this was exceptionally true in the region of the nose and lips. In such occasion , initial size, thickness and the existing patterning of the soft tissues appeared to be important factors**.**

9. **Aharon PA, Eisig S, Cisneros GJ (1997)**[7] compared two software Dentofacial planner and Quick Ceph Image software and found these programs worked well for simulation of single and double jaw surgery. However horizontal position of upper lip varied in quick Ceph software and position of lower lip varied in dentofacial planner between predicted and final outcome.
10. **Mike P, Upton P, Lionel Sadowsky,Sarver DM and Heaven TJ (1997)**[14] evaluated the accuracy of the soft tissue profile predictions by Quick Ceph Image in combined maxillary and mandibular orthognathic surgery and found that amount and direction of the soft tissue differed and most statistically significant difference between the Quick Ceph Image predicted profile tracings and post treatment radiographic profile tracings in the horizontal and vertical landmark associated to with the lower lip.Quick Ceph Image predicted the position of the lower lip more inferiorly shorter and more protrusive than the lip on the posttreatment radiographic tracing.
11. **Schultes G, Gaggl A, Karcher H (1998)**[8] measured an accuracy of cephalometric and vedio imagining program Dentofacial Planner Plus in orthognathic surgical planning and found out that in correction of mandibular dysgnathia by mandibular advancement significant changes were observed in the

lower face which can be predicted in the vertical and the horizontal plane with only small degree of error and overall predictability of more than 80% was stated.

12. **Kazandjian S, SameshimaGT Champlin T, Sinclair PM (1999)[13]** compared the accuracy of Quick Ceph Image and Portrait Planner video imaging program for predicting the soft tissue outcomes of mandibular setback surgery for patient and they found out that both program showed similar cephalometric and vedio imaging prediction.however visual treatment objective was found to be more accurate in horizontal plane approximately 30% of cases showed error greater than 2.0mm whereas in vertical plane,error was greater (50%)but proved to be accurate enough to be used in patient education and communication.
13. **Chunmaneechote P, Friede H (1999)[27]** conducted a stduy which they divided it into two parts.In the first part they derived the ratio between the soft tissue to the hard tissue changes after mandibular set back surgery to investigate the changes in the thickness of the lip and chin after surgery and tho test whether these ratio changes could be used for predictions in changes after surgery in the second part they compared the the predicted outcome using the customised ratios from the first part of the study with the actual posttreatment outcome profiles and they found out that the accuracy was low but accepatble precision which could be improved if larger sample size is taken.
14. **Loh S, Heng JK, Ward-Booth P, Winchester L, McDonald F. (2001)[6]** did accuracy and reliability of prediction using Quick ceph image prediction in adult patient treated with orthognathic surgery and they found that the predicted values for changes in ANB angle showed stastiscally significantly.
15. **Kusnoto J, Kusnoto H (2001)[28]** did a study to on 40 Indonesian adult patient who had bimaxillary dental protrusion. and had undergone Orthodontic treatment

with the extraction of four premolars to correlate the changes of anterior tooth position with changes in the upper and lower lip positions. They traced the Pretreatment and posttreatment cephalograms of these patients which included 6 males and 34 females superimposed, and measured and they found significant positive correlation was between changes of the maxillary and mandibular incisors with the changes in both the upper lip and the lower lip positions. They also was found that for every millimeter of mandibular incisor retraction, 0.4 mm of upper lip retraction and 0.6 mm of lower lip retraction were produced. Concluding that, for the Indonesian sample, a strong correlation exists between mandibular anterior tooth retraction and the position of both lips**.**

16. **Cousley RRJ ,Grant E (2004)[29]** did a retrospective study study to assess the accuracy of preoperative OPAL orthognathic predictions in 25 patient who had undergone orthodontic and mandicular advancement and found out that preoperative predictions accuracy was accurate in LAFH%,SNA,ANB,OJ AND OB but found wide variations between the actual and predicted changes for MxP/MnP,LPFH,Wits, and U1/MxP and L1/MnP value was very inaccurate.The prediction of preoperarative underestimated the amount of surgically induced backward rotation of mandible leading to systematic error in prediction in skeletal vertical changes.
17. **Smith JD, Thomas PM and Proffit WR (2004)[15]** investigated the differences in the ability of five program - Dentofacial Planner Plus, Dolphin Imaging, Orthoplan, Quick Ceph Image, and Vistadent..Actual treatment outcome was compared to default images obtained after morphing based on the results of the skeletal and dental changes between pretreatment and surgical tracing .Also actual treatment outcome was compared to retouched images which include

retracing of default images by built in image enhancement and soft tissue manipulation tool of these cephalometric software.Images were presented to the group of panel (Orthodontist,Oral surgeon and Layperson) for rating in the scale of 1-6.It was found that for Default had least score for comparison of default and actual images.Also same results were for comparison of retouched and actual image followed by Dolphin image and Quick Ceph and higher score were seen in Dentofacial Planner Plus and Orthoplan.Retracing of images improved scores to 1,2 with greater difference for Default Images and Quick Ceph than Dentofacial Planner Plus or other program.

18. **Koh CH, Chew MT(2004)[10]** evaluated the accuracy of soft tissue profile predictions in Chinese skeletal Class III patient treated with Bimaxillary surgery. They simulated hard tissue movements on the presurgical cephalogram until good superimposition of the hard tissues was achieved with posttreatment cephalograms. The software tended to underestimate the vertical position of both the upper and lower lip and overestimated the horizontal position of the lower lip.
19. **Gossett CB, Presto B, Dunford R, Lampasso J (2005)[30]** did a retrospective study on 31 patients to evaluate the use of conventional visualized treatment objectives(VTOs) and the prediction value of Dolphin computer assisted (VTOs').They had made custom cephalometric analysis to measure angular and linear measurements with images digitized.They used paired student t test which showed seven out of sixteen measurement were statistically significant difference between predicted and actual values for conventional visualized treatment which overrated facial angle,SNB,U1,to Na in degrees and millimeters and N perpendicular to pog and underated the angle of convexity and ANB angle ,similary nine measurement were statistically significant for Dolphin visualized

treatment objective concluding that dolphin visualized treatment objectives is approximate to conventional VTO and signifies that both could be used to determine post procedure with precise accuracy.

20. **Power G, Breckon J,Sherriff M, McDonald F (2005)[31]**.did a study to assess the precision of Dolphin Imaging with manual tracing on a same radiographs and how accurate is the software in predicting the postoperative skeletal and dental relationships in a variety of orthognathic cases.eight measurement were used from the Eastman Analysis SNA,SNB,ANB,SNMx,MxMd,UIMx,LIMd,LAFH% and found out the traditional manual tracing was more reliable when measuring SNA,SNB,SNMx,and MxMd,whilist Dolphin digital is more reliable than traditional manual tracing when measuring measurement ANB,UIMx and LIM.The value for LAFH% were approximately equal but there was systematic error in its software's calculation which was larger than manual tracing and hence the difference was clinically significant.
21. **Ramosa AL, Sakimab MT, Pintob AS,Jay Bowmanc SJ (2005)[32]** conducted a study on 16 class II div 1 patient to evaluate the changes in the soft tissue changes after the extraction of maxillary first premolars and subsequent anterior tooth retraction. Evaluations of the Pre and post treatment lateral head cephalograms were done using superimpositions on Bjork type 0.5 3 1.5 mm tantalum implants in the maxilla. Implants were placed bilaterally below the anterior nasal spine and below the zygomatic processes in the maxilla. Then they divided the patient sample two groups based on the lip seal , group I patients, those who did exhibit lip seal at rest in the pretreatment cephalogram and group II patients, those who did not exhibit lip seal at rest in the pretreatment cephalogram. They found out that Upper incisor retraction followed by a similar ratio of upper lip retraction in

both the lip seal and nonsealed groups (1:0.75 and 1:0.70 mean ratios, respectively). However, those without lip seal did demonstrate more retraction at stomion (USt). The final upper lip position (Ls) was reasonably correlated with retraction of the cervical maxillary incisor point (cU1) with determination coeffificients of 63.6% in the lip sealed and 68.5% in the lip incompetent groups. Although labial and nasolabial angles tended to open after incisor retraction, there was little predictability for this response.

22. **Abdullah et al (2006)[17]** examined the accuracy and precision of the Steiner prediction cephalometric analysis they found that the predicted values for changes in ANB angle, the distance of upper incisor U1 to NA as well as the distance Pg to NB were significantly overestimated when compared with the actual outcome, while the change in the distance of lower incisor L1 to NB was underestimated.

23. **Kolokitha OE,Chatzistavrou E (2007)[5]** conducted a study on eighteen patients who had undergone mandibular setback surgery to determine the validity of a manual cephalometric method in predicting the soft tissue profiles of patients and did a comparision of prediction of post operative soft tissue profile changes between manually cephalometric prediction and computerized cephalometric prediction method and found out that the manual method results in more convex soft tissue profiles the upper lip was found in a more prominent position, upper lip thickness was increased and, the mandible and lower lip were found in a less posterior position than that of the actual profiles and when compared with computerized cephalometic analysis the manual prediction method showed upper lip thickness and more anterior position of upper lip also increase in lower facial height..

24. **Pektas et al (2007)[9]** evaluated the accuracy of a computer-assisted imaging system in predicting the soft tissue response following orthognathic surgery. They found out that in the sagittal plane, the tip of nose was the most accurate site and the largest difference was shown in the upper lip. The lower lip was noted to be the least accurate and the subnasale the most accurate region in the vertical plane. Predictions were found to be more accurate for the sagittal plane when compared with those for the vertical plane.

25. **Kaipatur NR,, Carlos Flores Mir (2009)[33]** did a review to systematically evaluate the accuracy of computer prediction programs available for soft tissue changes obtained after orthognathic surgical procedures.In there studies they found out that seven studies showed accrate prediction outcomes when compared with final outcome both in horizontal and vertical directions.Few landmarks showed difference larger than 2mm for pogonion vertically, lower lip 2.2 and 2,9 vertically ,3.8 for stomion inferior horizontally.stated reason for the discrepancy are difference in lip tonicity ,length,posture and mass.

26. **Filho OM,Ernica NM,Quieroz TP,Marcondes A,Garcia IR (2010)[34]** did a comparative study taking ten patient in their study to subjectively compare the soft tissue images of preoperativ ,real predictive of two software Dentofacial Planner Plus and Dolphin Images and postoperative images were compared to predict orthognathic surgery outcome.For analysizing the profile they had taken tip of the nose,nasolabial angle upper lip lower lip menton, and base of the mandible and complete profile. The images was evaluated by the orthodontist, maxillofacial surgeon and general dentist.One patient was taken as the control and that patient image was repeated and compared and they found out that differences between the two program was found ,favouring DFP for the

nasolabial angle, upper and lower lips, and a favouring DI for the tip of the nose ,chin and base of the mandible and the total profile showed no statistical difference between the software.

27. **Carla Maria Melleiro Gimenez (2010)**[35] conducted a study on 25 long face patient in whom bimaxillary surgical procedure was done to comapre the predictibility done with manual and Dentofacial Planner Plus(DFPlus) and Dolphin Image Software with the actual post treatment outcome and they found out that there was no statistically difference from the post treatment outcome in those done with manual method,further DFPlus and Dolphin software observed a similar cephalometric values and came to the conclusion that prediction based on manual and computerized proved to be satisfactory and similar but manual method was more reliable.
28. **Leonardi R, Annunziata A, Licciardello V, Barbato E (2010)**[36] conducted a study to quantify following the extraction of four premolars in patients with bimaxillary protrusion who had nearly completed their active growth the amount of perioral tissue changes . They conducted a review of literature search was to identify clinical trials that estimate cephalometric perioral soft tissue changes in patients affected by biprotrusion and treated with extractions. The research concluded that the upper and lower lips retracted and the nasolabial angle increased following premolar extraction. Upper lip retraction ranged from 2 mm to 3.2 mm, lower lip retraction ranged from 2 mm to 4.5 mm with an increase in the nasolabial angle and also the lip procumbency improved following the extraction of four premolars and this improvement was predictable. However, soft tissue changes involved was few entities and do not dramatically modify the

profile. A ‘‘dished in’’ profile is not to be expected. Individual variation in response is large.

29. **Khamba B, Ullah R (2014)**[37]conducted a study on 10 patient who has undergone maxillary advancement to assess the accuracy and the reliability of the three dimensional method of analysis.They compared the predicted 3D soft tissue images with soft tissue firstly converting the CBCT into surface data prior to analysis which is then joined to form ‘polygonal surface mesh or triangular surface mesh .For evaluation the accuracy of 3D surgical prediction the segmented soft and hard tissue was saved in STL(Standard Tesselation Language)format.the pre and the postoperative hard tissue STL files were imported and aligned on the base of the skull.These two images were merged and exported as a single STL files providing a template to guide the actual hard tissue movements generated soft tissue prediction.Analysis was based on surface mesh and landmarks and they found out that method which used specific anatomically regions were more clinically acceptable than the full face as there is reduction of bias in accuracy by reducing the im pact of error that will be off center towards smaller values.

30. **Verma S, Sharma VP, Tandon P, Singh GP (2014)**[38] conducted a study to analyze and compare the soft tissue changes in Class I malocclusion borderline cases treated with extraction or non extraction. The pretreatment and post treatment cephalograms of 100 female patients, (50 patients were treated with premolar extraction and 50 were treated without premolar extraction) were taken. After a thorough soft tissue cephalometric analysis they concluded that extraction treatment of Class I borderline malocclusions led to significant soft tissue changes in relation to the upper and lower lip position and thickness as well as

the nasiolabial angle, whereas the nonextraction treatment resulted in significant upper lip retraction and lower lip protraction.

31. **Zeynep A, Akcan C, Hakan EL,Ciger S (2014)**[17]did a study to compare the accuracy of the treatment simulation in 26 patient with skeletal Class II Div 1with functional appliances with digitized lateral cephalograms and they found that vertical measurement Upper lip, soft tissue A point, soft tissue pogonion, and soft tissue B point measurements showed statistically significant difference between actual and treatment simulation in the vertical plane but no significant difference were they found that the predicted values for changes in ANB angle, found for anteroposterior landmarks.
32. **Sanofer A (2015)**[39]conducted a study on 20 patients (8 males and 12 females) to evaluate soft tissue, skeletal and dental changes following fixed mechanotherapy in bimaxillary protrusion cases treated with all four first premolars extractions. They found statistically significant changes in upper lip and nasolabial angle. Nasolabial angle is decreased by 7mm.E plane to lower lip decreased by 3mm and E plane to upper lip showed not much changes.
33. **Preethitha S (2015)**[40] did a retrospective study to estimate the changes in the lip with the retraction of anterior teeth in Orthodontically treated patients. Lateral cephalogram consisting pre and post treatment of 41 patients who underwent correction of class I or class II division I malocclusion was acquired and traced manually and analyzed cephalometrically. She found a positive correlation between the retractions of the upper lip following the upper teeth retraction is seen in an average of 0.51 cases. Negative correlation i.e. increase in the lip thickness with the retraction of upper anterior teeth is seen in an average of 0.29

cases and no changes are seen after the anterior teeth retraction in average of 0.19 cases.

34. **Lira AL, Moura WL, Artese F,Bittencourt MA,Nojima LI (2016)[41]** conducted a retrospective case series study to study the accuracy of the digital predictions and actual outcome with Dolphin program software on 80 Caucasian patient with class II malocclusion treated with orthodontic and surgical procedure diving them into two Groups based on the surgery as mandibular advancement (group 1)and maxillary impaction (group 2).The pretreatment and post treatment radiographs was digitized.Prediction tracing was done for both the groups with XY coordinated system constructed corresponding to FHP and Nasion Perpendicular.They found out that at pretreatment Go-Gn,Sn-Mp,Yaxis length and Y axis measurement was significanly greater in group with maxillary impaction surgery also the post treatment outcomes in both the groups was larger than the predicted values but no significant difference was found in soft tissue measurements concluding that surgery was more extensive than planned.

35. **Villaseñor JP (2016)[42]** explained bi-dimensional cephalometric prediction in orthognathic surgery by way of accessible software based on mean values and techniques and stated that with advent of technology role of surgical techniques and planning method has evolved and computer based surgical simulation has the abilities to replace completely the reference standard both in surgical prediction as well as in plaster models surgery,and also added that it is impossible to make three dimensional prediction with specific software a standardized.

36. **Umale VV, Singh K, Azam A, Bhardwaj M, Kulshrestha R (2017)[43]** conducted a study to evaluate sexual dimorphism in nasal proportions of 120 adult patients (60 males and 60 females) with Class I and Class II skeletal

malocclusions. They found sexual dimorphism in various nasal parameters and a significant amount of difference was found in the nasal proportions of Class I and Class II (male and female) participants**.**

37. **Mattos C (2017)[44]** investigated a study in a young adolescent individuals for evaluating cephalometric changes in tooth and profile positionwho had Class I biprotrusion and had undergone orthodontic treatment with extractions of four first premolars. 20 patients with Class I biprotrusion malocclusion lateral cephalometric radiographs consisting of pre and post treatment were used to assess nasolabial angle, distance from lips to E line, distance from lips, incisors, tip of the nose and soft tissue pogonion to S line. All measurements showed significant changes after treatment ($p<0.05$), except the distance from lips and soft tissue pogonion to S line. There was a positive correlation between the retraction of incisors and the change of upper and lower lips ($p<0.001$). The profile retrusion occurred more due to nose growth than to lips retraction. The response from soft tissues to incisors retraction showed a great range.
38. **Jongphairotkhosit J, Suntornlohanakul S, Youravong N (2018)[45]** did a study in Thai female who had class II division 1 and assessed the relationship of lip changes in antero-posterior direction and incisor retraction . They had taken 100 pairs of pre and post treatment lateral cephalograms. All these patient were treated orthodontically with four premolar extraction and edgewise technique. Sixteen linear and eight angular measurements were made and evaluated for dental and lip changes. They observed a significant correlation between lip changes and incisor retraction. Ratios of upper and lower incisors at tip point to upper and lower lips retraction were 1:0.46 and 1:1, respectively. The coefficient

of determination for predicting upper and lower lips was 0.29 and 0.48 showing low to moderate predictability for lip changes.

39. **Zhang Xu,Mei Li,Xinyu Yan,Wei Jieya,Li Hanshi, Li Yu et al (2019)[18]** did a study to evaluate the accuracy of the Dolphin VTO prediction in soft tissue changes after orthodontic treatment by comparing the changes between predicted and actual values.They did a retrospective study.They took the parameters from Holdaway analysis.The actual changes in of the maxillary and mandibular incisor before and after treatment including the horizontal and vertical displacement and angulation changes were calculated and subsequently input into the Dolphin treatment simulation software module to generate a VTO predicted treatment outcome and the found difference between the predicted and actual values of soft tissue changes.the prediction of the landmarks in the lip are was turning to be overestimated horizontally and underestimated horizontally and overestimated vertically.the most accurate prediction was found to be in the soft tissue region A, and the most inaccurate prediction to be in the area near the chin region.

40. **Arumugam E, Duraisamy S, Ravi K, Krishnaraj R (2019)[46]** did a study to find the relationship between the changes in soft tissue profile in 30 south Iindian female patients who had undergone Orthodontic treatment involving extraction of first premolars in south Indian and the amount of incisor retraction. Pre and post treatment lateral cephalograms of these subject were assessed and evaluated. They observed that a significant positive correlation occured between changes in upper and lower lips and the amount of incisor retraction . The ratio of maxillary incisor retraction and upper lip retraction ratio was 3:1 and for mandibular incisor retraction and amount of lower lip retraction was 1.5:1. A significant increase in upper and lower lip thickness and length was observed with incisor retraction.

Material & Method

This study was conducted in the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das college of Dental sciences, Lucknow with an aim to check the reliability of prediction done using Nemoceph software by comparing the changes in the soft tissue parameters between prediction tracing and post treatment cephalometric tracing in subjects with Class II Div I malocclusion and Class I Bimaxillary dentoalveolar protrusion in the present study. The sample for this study comprised of two groups ,Group I included 15 subjects with Angle's Class II Div 1 malocclusion and Group II included 15 subjects with Class 1 Bimaxillary dentoalveolar protrusion in the age range of 18-30 years.Pre-treatment and Post-treatment lateral cephalogram were taken from the records of the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das college of Dental sciences, Lucknow.

CRITERIA FOR SAMPLE SELECTION:

Samples were selected on the basis of following inclusion and exclusion criteria.

Inclusion criteria

1. Adult patients with age range of 18-30 years to ensure complete growth of soft tissues.

2. Subjects with Class II Div 1 malocclusion or Class I Bimaxillary dentoalveolar protrusion as per case record file and who had undergone fixed orthodontic treatment after extraction of all permanent 1st premolars.

Exclusion criteria

1.History of trauma in maxillofacial region.

2.Patients with congenital defect in craniofacial region or syndromes or any facial asymmetry.

3.Patients having history of previous orthodontic treatment or orthognathic surgery.

4.Patients with abnormal morphology or size of nose, lip and chin region.

ETHICAL COMMITTEE APPROVAL

Prior to study, approval was taken from the Ethical Committee Babu Banarasi Das College of Dental Sciences, Babu Banarasi Das University, Lucknow, U.P., India. Informed consent was also taken from all the subjects as per the format.

ARMAMENTARIUM FOR THE STUDY:

To conduct the present study armamentarium used are listed below:

A. Material used for obtaining lateral cephalogram:

i. **Cephalostat machine**: Planmeca proline XC cephalostat (Finland) machine were used to take digital lateral cephalograms of selected subjects. The exposure was set at 68KV, 5mA and exposure time of 23 second and receptor was placed at a distance of 60 inches.Fig 1

ii. **Soft copy of lateral cephalograms**: Soft copy of Pre and Post treatment lateral were taken from the record files also post treatment lateral cephalogram were taken for ongoing subjects who have completed their treatment.Fig 2.

iii. **Nemoceph software**: Nemoceph software (Dental studio version 6.0) was used to trace and analyze the lateral cephalogram.

METHODOLOGY:

A)Methods of taking radiographs:

Planmeca proline XC was used to take the digital lateral cephalogram of selected subjects. The lateral cephalograms were taken in natural head position with lips relaxed and teeth in centric occlusion (Figure-1). Natural head position is a standardized and reproducible orientation of head. The ear posts were used for correct alignment of the patients head for undistorted symmetrical image of the patient. Relaxed lip was achieved by giving direct instructions to the patient. The receptor-source distance was fixed at 60 inch. The exposure values were set at 68kV, 5mA at 23 second exposure time (fig 1) .

Fig 1:Position of patient for taking lateral cephalogram.

B) Transfer of soft copies of lateral cephalogram

The soft copies of all the lateral cephalograms were transferred from planmeca software to CD Rom then from CD-Rom to laptop with Nemoceph software program (Dental studio-NX, version 6.0).(fig 2)

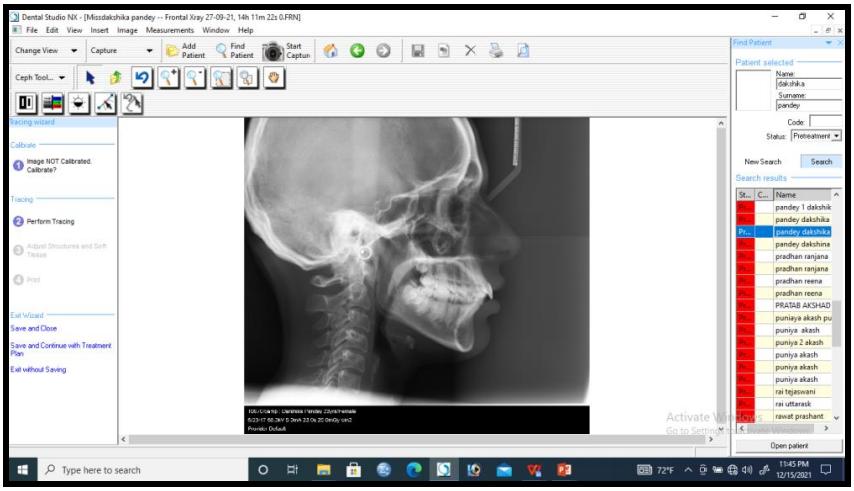


Fig 2: Lateral cephalogram transferred to Nemoceph software

C) Calibration of images:

The images were calibrated by identifying two crosshairs 10 mm apart on lateral cephalogram using calibration tool of the software, both for pre and post treatment lateral cephalogram .

D) Identification of landmarks:

The image enhancement feature of the software (basic an advanced cephalometric tools), like brightness, contrast adjustment and magnification were used to identify

individual cephalometric landmarks as precisely as possible. The landmarks were marked with the help of mouse/cursor.

Following landmarks were used in the study(fig 3)

Hard tissue landmarks: **(Figure- 3)**

1. Sella (S): Center of the contour of Sella Turica[jacobson].
2. Nasion (N): Most anterior point of the Nasofrontal suture in the midsagittal plane.
3. Orbitale (Or): Lowest most point on the inferior rim of the orbit.
4. Porion (Po): Most superiorly positioned point of the external auditory meatus.
5. Point A: Deepest point in the midsaggital plane between the Anterior Nasal Spine and Prosthion.
6. Point B: Deepest point in the midsaggital plane between Infradentale and Pogonion.
7. Pog(Pg): Most anterior point of the bony chin.
8. Gnathion(Gn): Anero-inferior point of bon chin located by taking the midpoint between the anterior (Pogonion) and inferior (Menton) points of the bony chin.
9. Menton (Me): Lowest point on the bony chin.
10. Gonion (Go): A point on the curvature of the angle of the mandible located by bisecting the angle formed by lines tangent to the posterior ramus and the inferior border of the mandible.

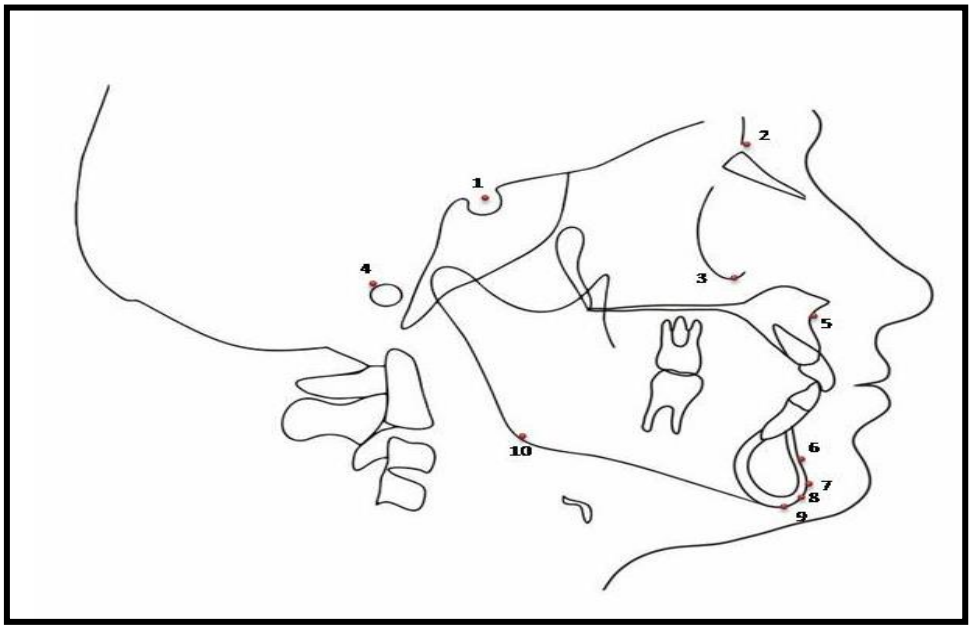


Figure 3:- Hard tissue cephalometric landmarks use in this study: 1-sella (S), 2-nasion (N), 3-orbitale (Or), 4-porion(Po), 5-point A, 6-point B, 7-Pogonion(Pg), 8-Gnathion(Gn), 9-Menton(Me), 10-Gonion(Go).

Soft tissue landmarks: **(Figure- 4)**

1. Subnasale (Sn):The junction of nose to upper lip.
2. Labrale superius (Ls): The point indicating the mucocutaneous border of the upper lip.The most anterior point of the upper lip.
3. Labrale inferius (Li): The point indicating the mucotaneous border of the lower lip .
4. Stomion superius (Stms): The lower most point on the vermilion of the upper lip.

5. Stomion inferius (Stmi): The uppermost point on the vermilion border of the lower lip.
6. Soft tissue Glabella (G'): The most prominent point of the forehead on the midsagittal plane at the superior aspect of the eyebrows.
7. Soft tissue Nasion (N'): The outer point of intersection between the nasion horizontal line and the soft tissue.
8. Pronasale (NT): The most prominent or anterior point of the nose(tip of the nose)
9. Nasal base(NB):An imaginary point between the most lateral points of the external inferior attachment of the alae nasi to the face.
10. Columella point (Cm): The anterior most point on the columella of the nose.
11. Soft-tissue pogonion (Pg'): The outer point of intersection between the Pogonion horizontal line and the soft profile.
12. Soft tissue Gnathion (Gn'): A constructed midpoint between the a soft tissue pogonion and soft tissue Menton.
13. Soft tissue Menton (Me'): The outer point of intersection between the Menton vertical line and the soft tissue.

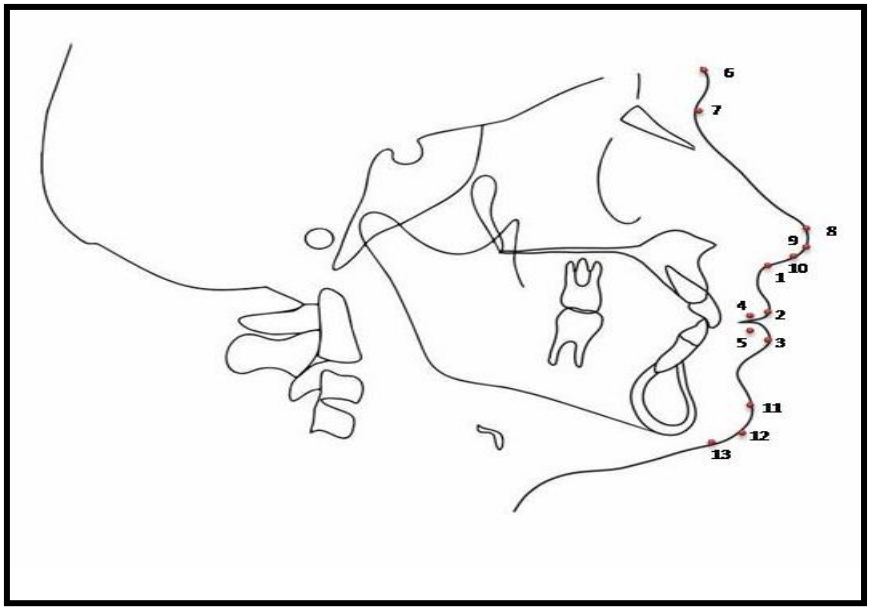


Figure 4:- Soft tissue cephalometric landmarks used in this study: 1-Subnasale (Sn), 2-Labralesuperioris(Li), 3-Labrale inferioris (Ls), 4- Stomion inferioris (Stmi), 5-Stomion superioris (Stms), 6-Glabella (G'), 7-Soft tissue nasion (N'), 8- Pronasale (NT), 9- Nasal base (NB), 10-Columella (C), 11-Soft tissue Pogonion(Pg'), 12-soft tissue Gnathion(Gn'), 13-Soft tissue menton(Me').

Once all the landmarks were marked, these landmarks were again adjusted and corrected for completing the tracing on Nemotech Software.)

E.Parameters used in the study for prediction:

Following Hard tissue parameters from Steiner analysis were measured on pre and post treatment cephalometric tracing and difference between them was used for generating prediction on pretreatment tracing:(fig.5)

Hard tissue parameters used for prediction on pretreatment tracing:(fig.5)

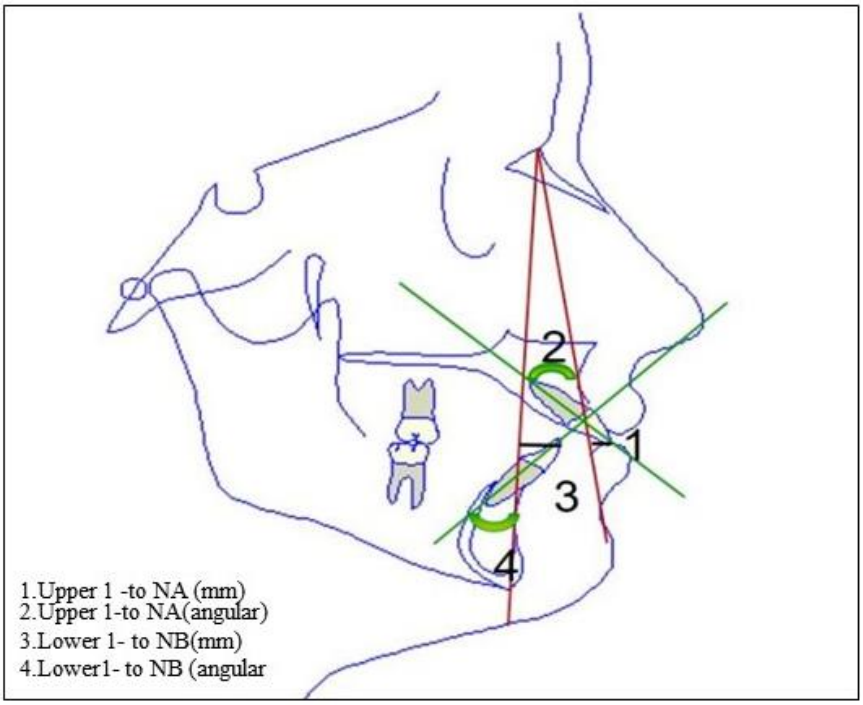


Fig. 5 Parameters used in the study.

1. Upper 1 -to NA (mm)Linear distance in mm measured from facial surface of upper maxillary incisor to line drawn from Nasion to point A.

2. Upper 1-to NA(angular):Angular measurement between the line drawn along long axis of the maxillary incisor and the line drawn from Nasion to Point A.

3. Lower 1- to NB(mm):Linear distance(in mm) measured from facial surface of mandibular incisor to line from Nasion to Point B.

4. Lower 1- to NB (angular): Angular measurement formed between the line drawn along long axis of the mandibular incisor and the line drawn from Nasion to Point B.

F)Method of doing Prediction.

1 Difference was calculated between pre and post treatment measurement for the selected parameters of Steiner's analysis ie position and angulations of Maxillary and Mandibular incisors(fig 6,fig7

Position of Maxillary incisor	Difference between U1-NA(Pre) and U1-NA (post) in mm
Angulation of Maxillary incisor	Difference between U1-NA(Pre) and U1 -NA (post) in degree
Position of Mandibular incisor	Difference between L1-NB (Pre) and L1-NB(post) in mm
Angulation of Mandibular incisor	Difference between L1-NB (Pre) and L1-NB(post) in degree

Table 1:Values of pre and post treatment measurement for the selected parameters of Steiner's analysis

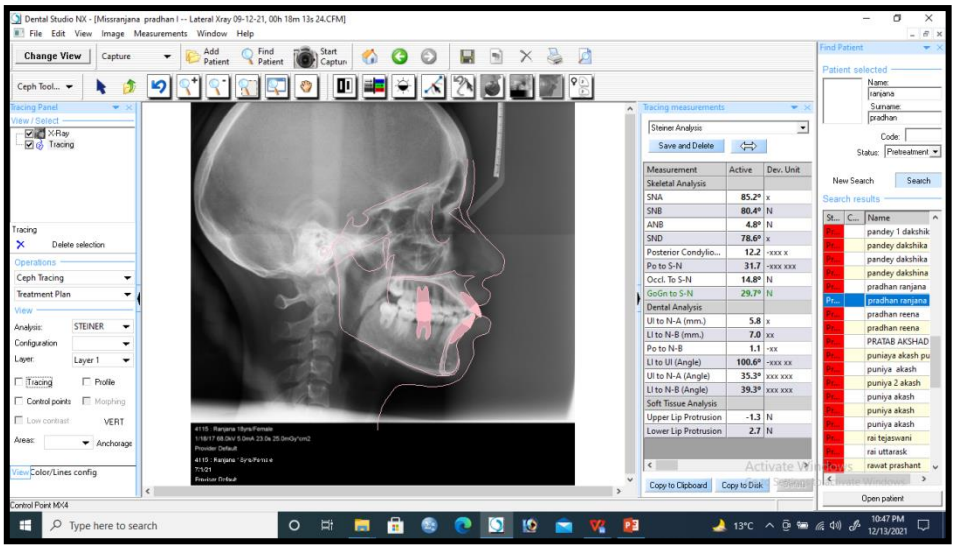


Fig.6.Pretreament tracing with Steiner's Analysis

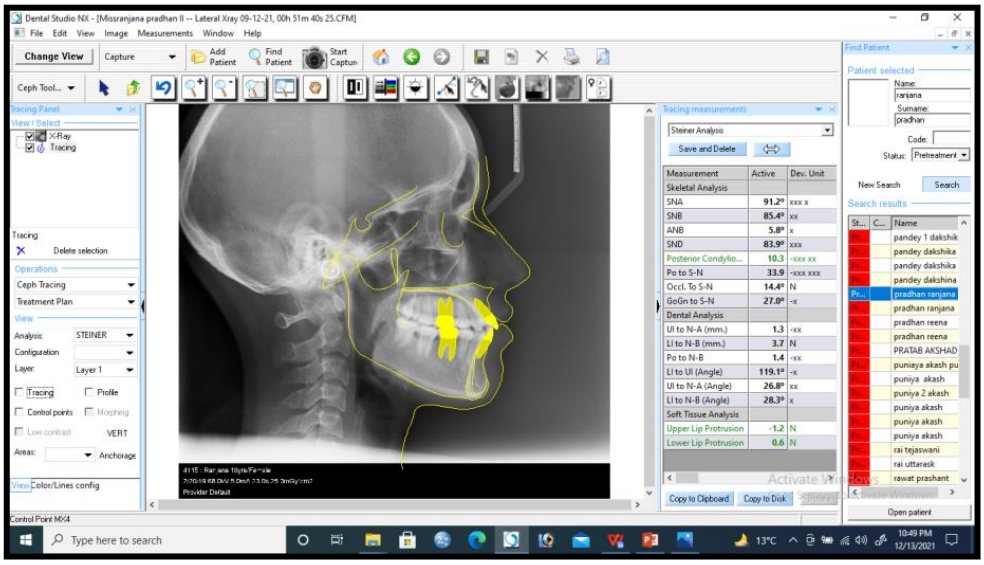


Fig.7 Post treatment tracing with Steiner's Analysis

2. Based on these difference between the pre and post treatment values for postion and angulation of maxillary and mandibular incisor,prediction was generated on pretreatment tracing using the following steps on Nemotech software.

Tracing ⟶ New treatment plan ⟶ New tracing ⟶ New FTO **(Facial Treatment Objective)** tracing(fig 8)

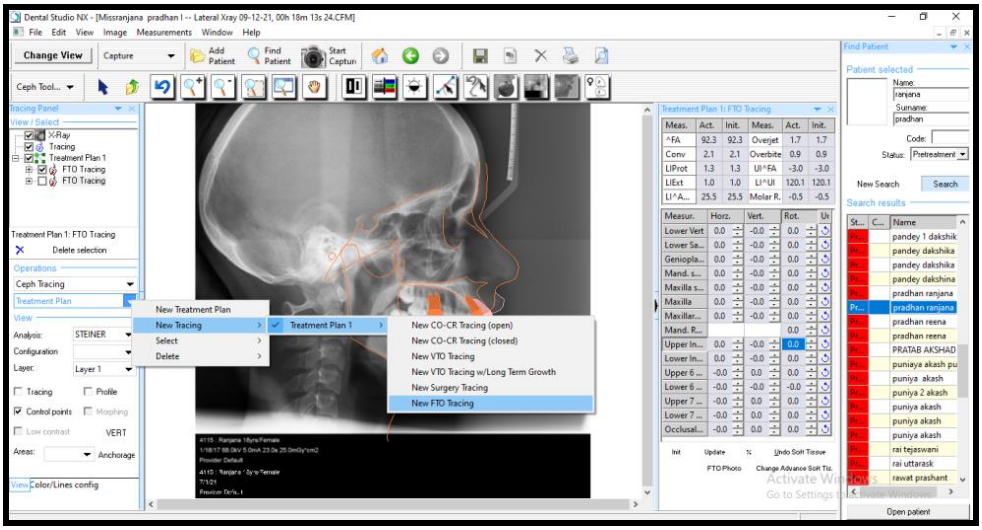


Fig.8 The process as to get the prediction values in the pretreatment.

3. On selection of FTO tracing,((**Facial Treatment Objective)** chart opened in the software where values for horizontal and vertical and rotatation correction could be put for generation of prediction.For maxillary,incisor in horizontal column,the difference in amount of retraction between pre and post was put whereas difference in angulation between pre and post was put in column 'rotatation'.Vertical measurement were not considered.Same method was followed for mandibular incisor. The movement of hard of hard and soft tissue was visible on generated prediction,and measurement of prediction tracing for various cephalometric analysis was obtained on checking the box.(fig 9)

FTO tracing ⟶ tracing measurements.

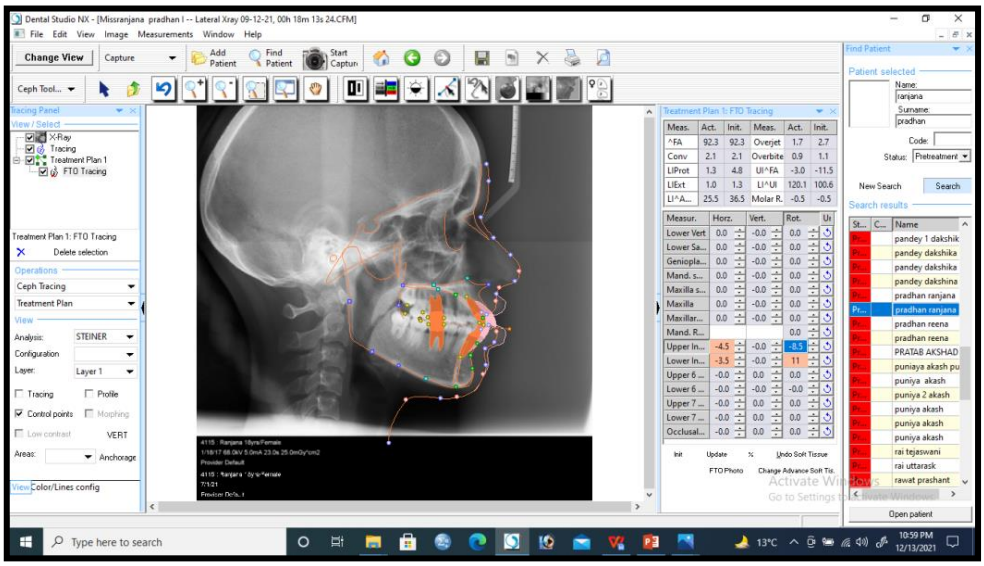


Fig :9 Tracing measurement of Prediction Tracing on Nemoceph Software.

From tracing measurement various soft tissue parameters of prediction tracing were obtained.

4. The method of generating prediction is explained on one of the cases representative of the samples selected for the study.

i) Pre treatment and post treatment tracing was done for a case with bimaxillary dentoalveolar malocclusion (fig 10 a,fig 10b)

ii)Values for generating prediction were obtained as difference in values of position and angulation of maxillary and mandibular incisors using Steiner's Analysis.(table 2)

Parameters	Pretreatment	Post treatment	Difference
Position of Maxillary Incisor	5.7	.5	5.2
Angulation of Maxillary Incisor	37.5	18.6	18.9
Position of Mandibular Incisor	4.2	3	1.2
Angulation of Mandibular Incisor	31.5	29.2	1.3

Table 2: Values used for generating prediction for one subject

iii) The values obtained as difference between pre and post treatment tracing were subsequently entered in the FTO(Facial Treatment Objectives) tracing as" horizontal " and "rotational" correction of Maxillary and Mandibular Incisors(fig 10 c)

iv) Prediction tracing was generated (fig10 d) and tracing measurement of various soft tissue parameters were noted(fig 10 e)

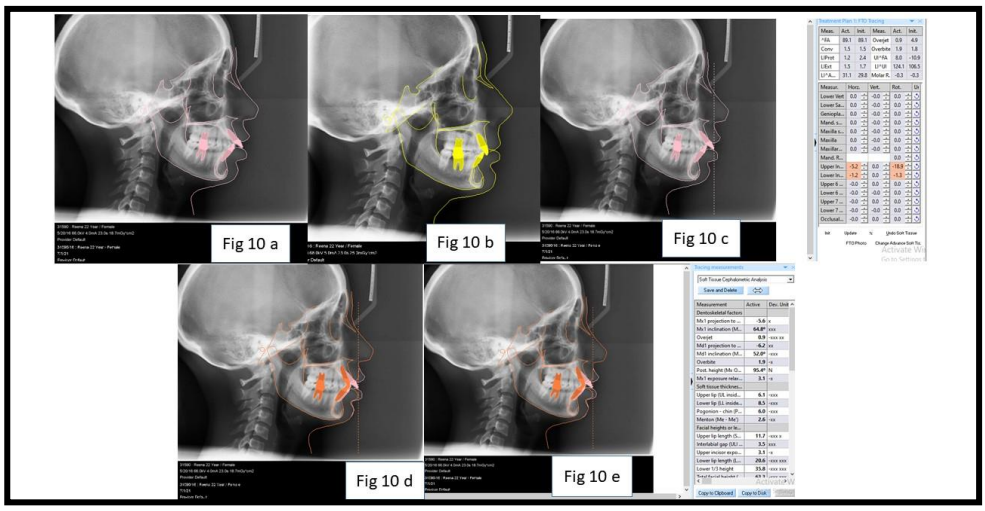


Fig 10:Steps to be followed for generating prediction tracing

a:Pretreatment tracing on Nemoceph Software

b:Post treatment tracing on Nemoceph Software

c: "Horizontal" and "Rotational" correction of maxillary and mandibular incisors on FTO tracing

d: Generation of prediction tracing

e:Tracings measurement of various soft tissue parameters..

5.Similar landmarks were identified on post treatment lateral cephalogram ,tracing was completed and measurement for various cephalometric analysis were obtained.

G **Comparision of various soft tissue parameters between prediction tracing with post treatment tracing**.

Following soft tissue parameters were used to assess profile,nose ,lips and chin in the study-

Soft tissue Profile

1. Facial convexity angle(G'-Sn'-Pg')[cogs] this angle is formed by the line from soft tissue Glabella to soft tissue subnasale (Sn')and the line Sn' to soft tissue pogonion (Pg') and depicts soft tissue profile of patient.(fig 10)

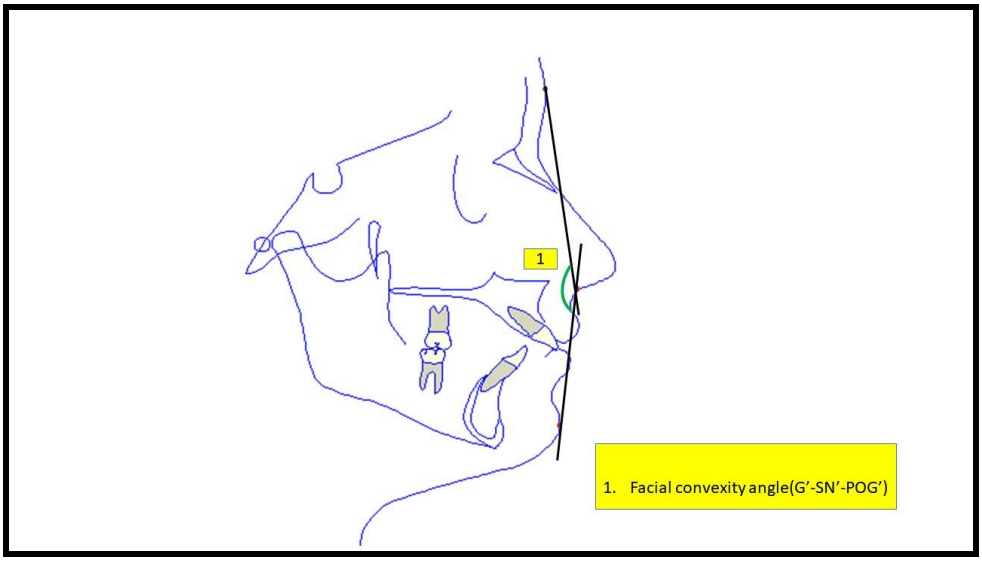


Fig:11 Parameter to show the soft tissue profile taken the study.

Nose

1. Nasal base length (NB-TVL):the distance between NB and TVL(fig:11)

2. Nasal projection (NT_TVL):the distance between NT and TVL.(fig 11)

3. Nasolabial angle (Cm-Sn-Ls): The angle formed by the intersection of the Cm tangent and the upper lip (Ls).(fig 11).

4. Nasomental angle(NM):the angle lies between the the line drawn along the dorsum to the nasion and the line drawn from nasal tip to pogonion(fig 12)

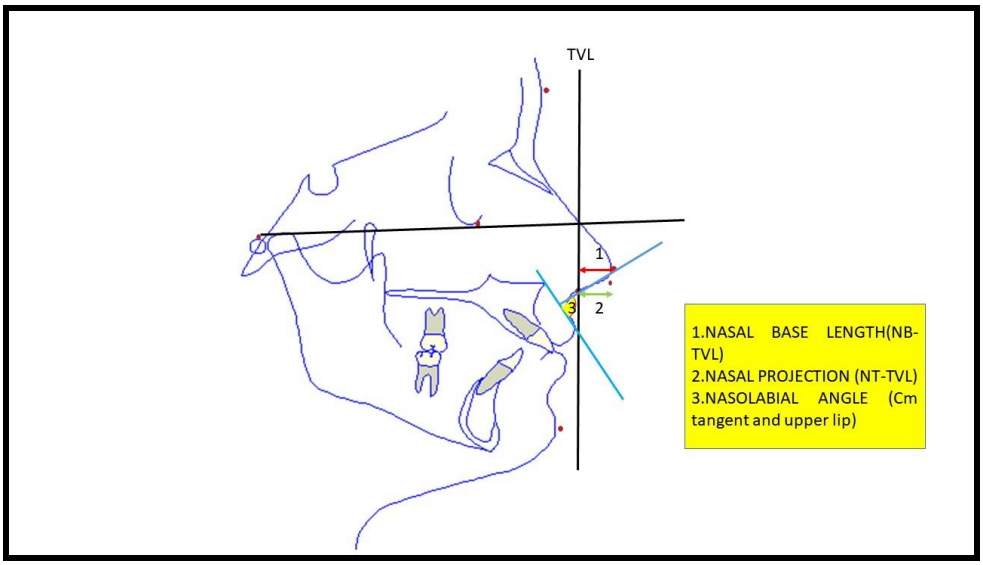


Fig:12 Parameters for assessment of nose

Fig :13 Parameter for assessment of nose.

Lips

1. Interlabial gap (Stmi-Stms): the distance between Stomion superius(Stmi) and Stomion inferius(Stms).(fig 13)
2. Upper lip length (Sn-Ls): the distance between Subnasale(Sn)-Labrale superius(Ls).(fig 13)
3. Lower lip length (Li-Me'): the distance between Labrale inferius(Li)-Soft tissue menton(Me').(fig 13)
4. Upper lip thickness (Ls): the distance from upper lip inside to upper lip anterior.(fig 13)
5. Lower lip thickness (Li): the distance from lower lip inside to lower lip anterior.(fig 13)
6. Upper lip protrusion (Sn-Pog') : the linear distance from the most prominent part of upper lip to the line joining Sn to Pog'(fig 13)
7. Lower lip protrusion: the linear distance from the most prominent part of lower lip to the line joining Sn to Pog'.(fig 13)
8. Upper lip protrusion (Ls to E-Line):Rickett's Esthetic E line is drawn from Soft tissue pogonion and nose tip.Linear distance from upper lip to E line is measured.(fig 14)
9. Lower Lip protrusion (Li to E line):Linear distance is measured from lower lip to E Line is measured(fig 14).
10. Upper lip protrusion (UL to TVL):Linear distance from most prominent upper lip to TVL is measured.(fig 15)
11. Lower Lip protrusion (LL to TVl):Linear distance from most prominent lower lip to TVL is measured(fig 15)

12. Merrifield Z Angle.Angle formed by the intersection of Frankfort Horizontal and a line connecting the soft tissue chin and the most protrusive lip point(maybe upper or lower lip) (fig 16)

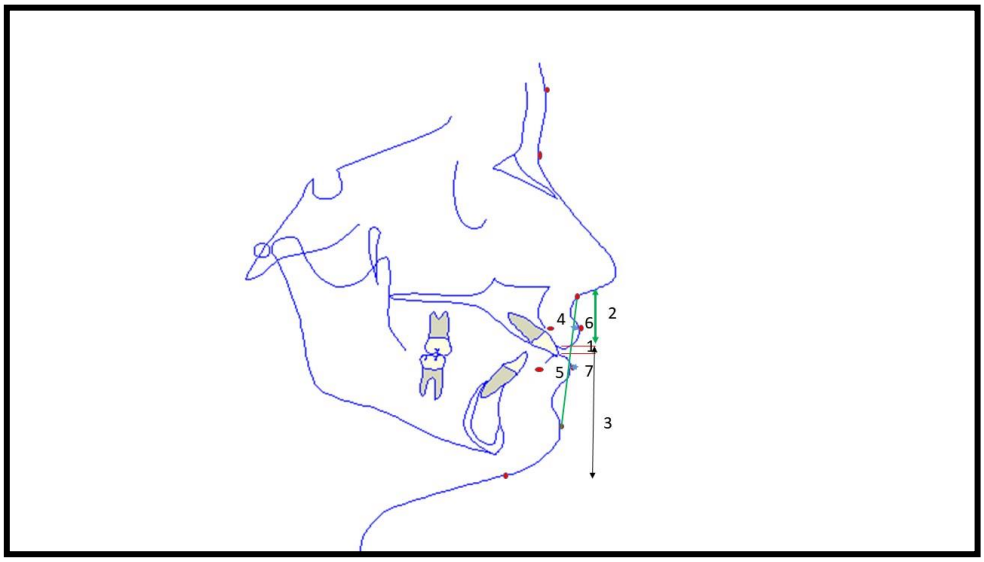


Fig 14:Parameters taken for assessment of lips in the study:1. Interlabial gap (Stmi-Stms), 2- Upper lip length (Sn-Ls), 3- Lower lip length (Li-Me'), 4-Upper lip thickness (Ls), 5- Lower lip thickness (Li), 6- Upper lip protrusion, 7- Lower lip protrusion.

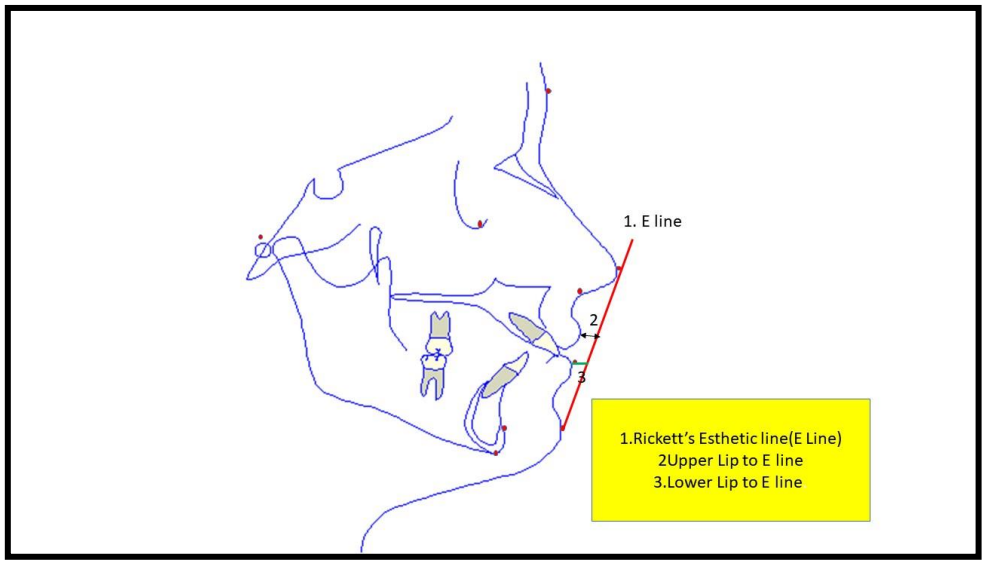


Fig:15: Upper Lip and lower lip protrusion to Rickett's E line

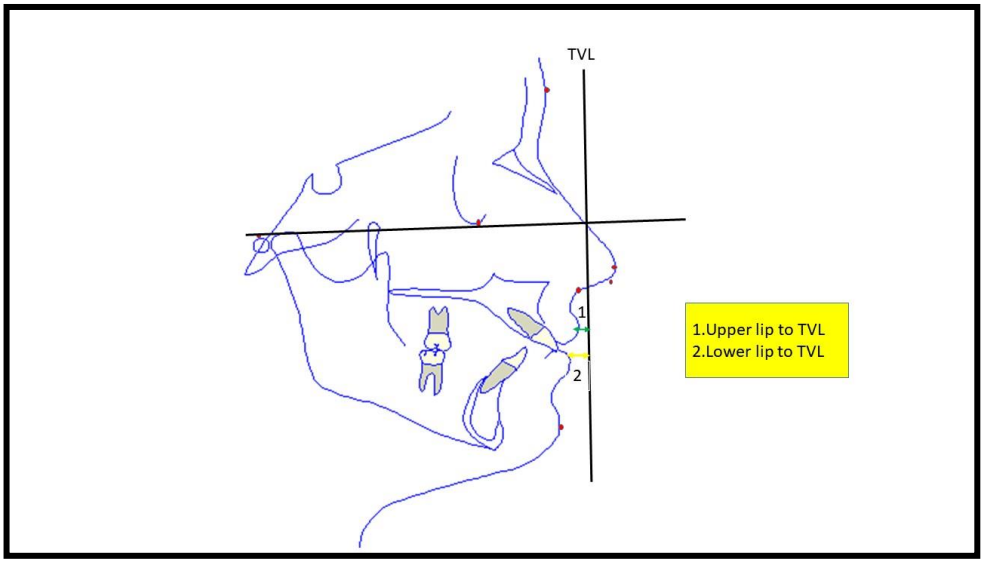


Fig:16 Upper Lip and Lower protrusion to TVL

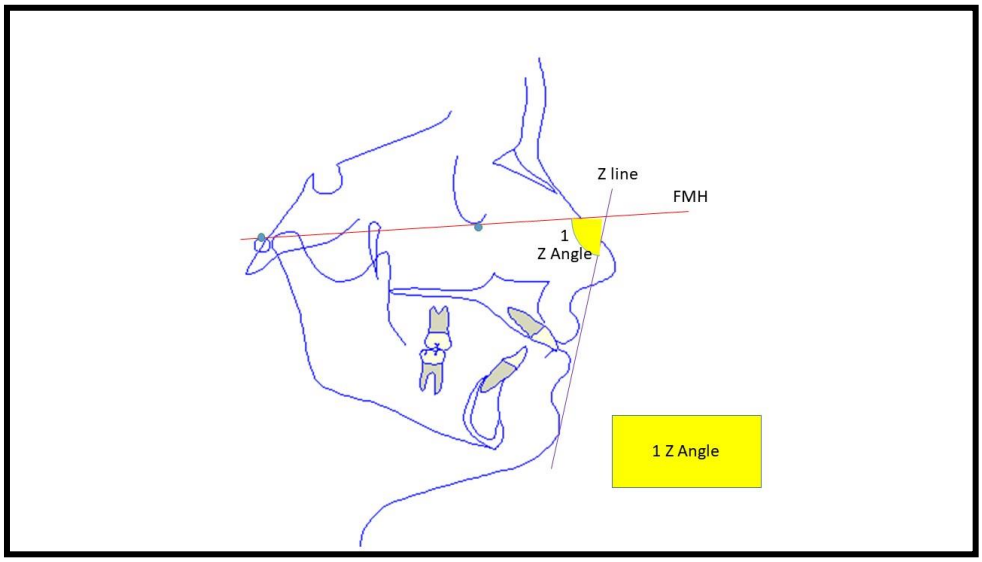


Fig 17: Merrifield's Z Angle

Chin:

1. Soft tissue thickness at menton (Me-Me'): the linear distance between hard tissue menton (Me) to soft tissue menton (Me').(fig17)
2. Soft tissue thickness at pogonion (Pg-Pg'): the linear distance between hard tissue pogonion (Pg) to soft tissue pogonion (Pg').(fig 17)
3. Inferior labial sulcus: the perpendicular distance from deepest concavity of chin, to line drawn from soft tissue pogonion(Pg') to the most anterior point of the lower lip (Li).(fig17)
4. Soft Tissue Pogonion to TVl:Linear distance is measured from soft tissue pogonion to TVL(fig 18)

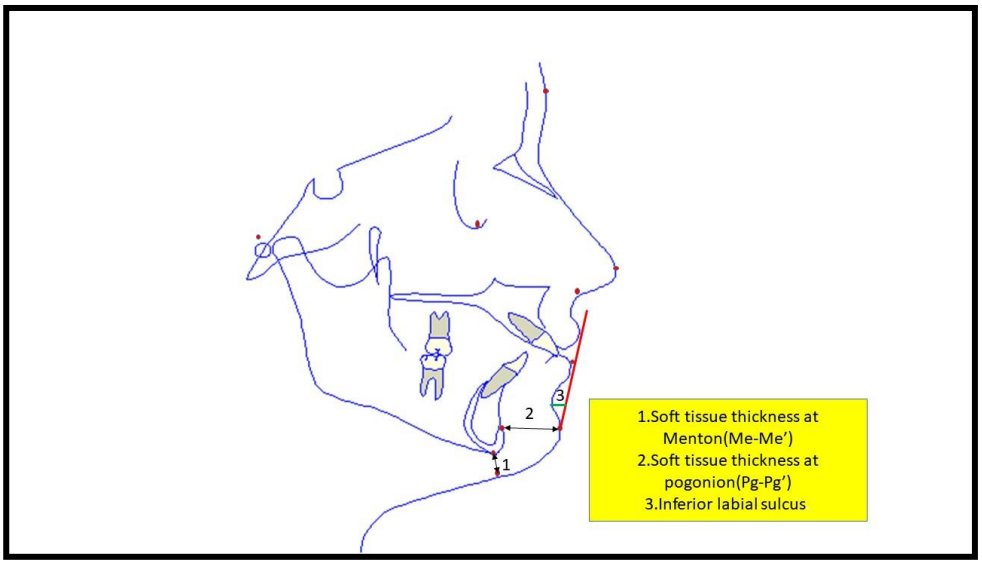


Fig:18 Parameters for assessment of chin taken in the study

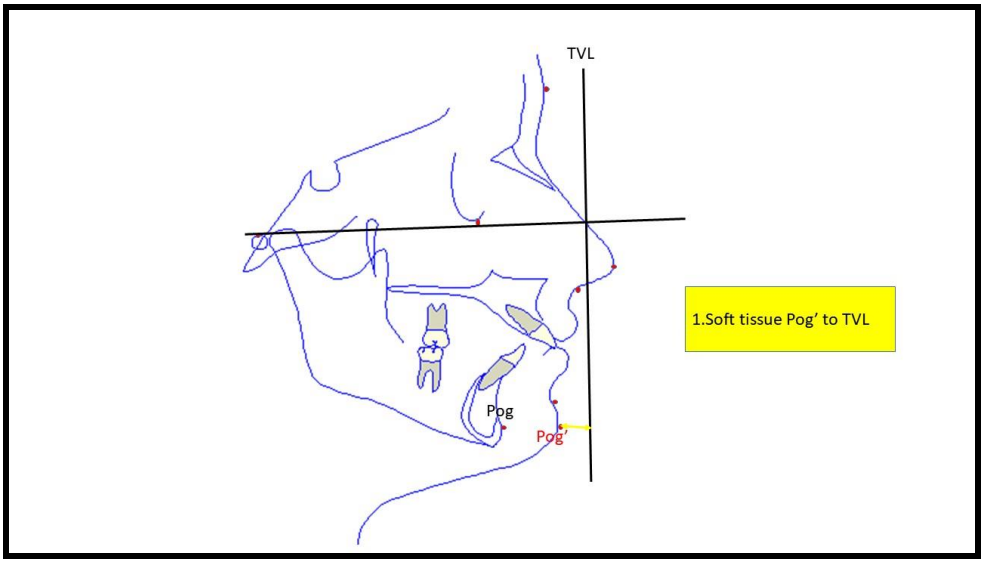


Fig 19: Soft Tissue Pogonion to TVL

Jaw Bases:

1. Soft Tissue Point A' to TVL:Linear distance is measured from soft tissue point A' to TVl(fig 19)

2. Soft Tissue Point B' to TVL :Linear distance is measured from soft tissue Point B' to TVL(fig 19)

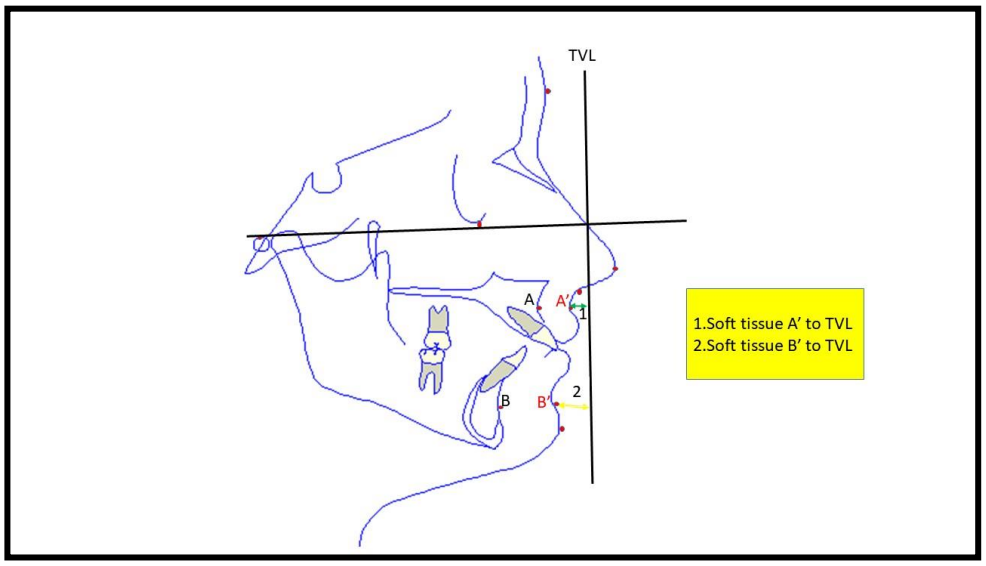


Fig 20: Parameters taken for assessment of Jaw Bases taken in the study.

Statistical Analysis Tool

Data was entered into Microsoft Excel spreadsheet and was checked for any discrepancies. Summarized data was presented using Tables and Graphs. The data was analysed by SPSS (21.0 version). Shapiro Wilk test was used to check which all variables were following normal distribution. Data were not normally distributed (p-value was more than 0.05). Therefore, bivariate analyses were performed using the parametric tests i.e Independent t test (for comparing two groups) and Paired t test for intragroup comparison. Level of statistical significance was set at p-value less than 0.05

In this study Parametric tests were used

a) **The data was normally distributed**
b) **The data was obtained from the sample which is randomly selected**
c) **The data was quantitative data**

I. T TEST.

T tests are based on the t distribution which is a symmetrical, bell-shaped curve like the normal distribution, but having different area and probability properties.

T distribution is a family of curves which are differentiated by their degrees of freedom.

With increasing sample sizes, the t distribution assumes the shape of the normal distribution. 2 A sample size of 100 is often chosen as the cut-off point for deciding when to apply For t or z.

TYPES OF T TESTS INDICATIONS.

a) Paired T Test

The paired t test is used to decide whether the differences between variables measured on the same or similarly matched individual are on average zero. As the data are matched there must be an equal number of observations in each sample.

Assumption. The paired t-test assumes that the differences in scores between pairs are approximately normally distributed, although the two sets of data under scrutiny do not need to be normally distributed.

b) Unpaired or two-sample t test (equal variance assumed)

The unpaired t test is used for comparing two independent groups of observations when no suitable pairing of the observations is possible.The samples do not need to be of equal sizes.

Assumptions. The test requires the populations to be normally distributed with equal variance, though the test is relatively robust to deviations from these assumptions. Unpaired t test or two-sample t test (unequal variance)

When the variances of the two groups differ and transformation does not produce equal variance, the calculation of the t test becomes more complex. Instead of using the pooled variance, estimates of the individual population variances are used

Formula:

$$t = \frac{M_x - M_y}{\sqrt{\frac{S_x^2}{n_x} + \frac{S_y^2}{n_y}}}$$

M =mean

n = number of scores per group

$$S^2 = \frac{\sum (x - M)^2}{n - 1}$$

x = individual scores

M = mean

n= number of scores in group

- Define the problem
- State null hypthesis(H_0) & alternate hypothesis(H_1)
- Find t value, Find (X_1 - X_2)
- Calculate SE of difference between two means

SE = $\sigma\sqrt{1/n_1+1/n_2}$ or

t = (X_1 - X_2) / SE

- Calculate degree of freedom = n_1 + n_2 - 2
- Fix the level of significance (0.05)
- Compare calculated value with table value at corresponding degrees of freedom and significance level
- If observed t value is greater than theoritical t value, t is significant, reject null hypothesis and accept alternate hypothesis

Level of significance "p" is level of significance signifies as below:

p > 0.05 Not significant (ns)

p <0.05 Significant (*)

Measurement reliabilty

To check reliability of various measurements, predictions tracing was generated for five subjects using the same method. The readings of various soft tissue parameters were obtained and tabulated as second reading whereas reading obtained originally were taken as first reading.Student t test was used to obtain statistical significance between first and second reading of each parameter.

s.no	Parameters	1st Reading	2nd readings	P value
1.	NBTVL	5.5mm	5.6	P >0.05
		-3.4mm	-3.4	
		-2mm	-2.1	
		-3.3mm	-3.4	
		-2.6mm	-2.6	
	Mean value	-1.160000± 3.766	-1.18± 3.83	
2.	Nasomental	127.8^0	127.5	P >0.05
		123^0	122.3	
		119.9^0	120	
		131.5^0	131.1	
		124.5^0	124.8	
		125.34± 4.26	125.140± 4.35	
3.	Upper lip protrusion	5.3mm	5.1	P >0.05
		1.7mm	1.7	
		-1.4mm	-1.3	
		-1.9mm	-2.0	
		0.6mm	0.6	
	Mean value	.860± 2.88	.820± 2.81	
4.	Lower lip protrusion	-3.1mm	-3.0	P >0.05
		-0.3mm	-0.3	
		-3.4mm	-3.3	
		-1.5mm	-1,4	

		-0.2mm	-0.2	
	Mean value	1.70±1.50	1.64± 1.46	
5.	Soft tissue pognonion to TVL	-7.9mm	-7.8	P >0.05
		-4.6mm	-4.6	
		-6.8mm	-6.7	
		-2.9mm	-2.8	
		-7mm	-6.9	
	Mean value	5.84±2.04	-5.76±2.02	
6.	Chin thickness	9.7mm	9.8	P >0.05
		7.1mm	7.0	
		4.8mm	4.8	
		6mm	6.1	
		6.8mm	6.9	
	Mean value	6.88±1.81	6.92±1.834	
7.	Soft tissue point A to TVL	.9mm	0.8	P >0.05
		1mm	1.0	
		-0.9mm	-0.8	
		0.4mm	0.4	
		-1.5mm	-1.4	
	Mean value	-.0200±1.12	0.000+1.048	
8.	Soft tissue point B to TVL	-8.5mm	-8.7 mm	P >0.05
		-7.9mm	-7.8	
		-5.6mm	-5.5	
		-4.5mm	-4.5	
		-7.9mm	-7.8	
	Mean value	-6.88+ 1.73	-6.4±3.205	

It was seen that mean difference between first and second reading of all eight parameters of five subjects was statistically non significant, suggestive of reliability of measurements taken in the present study.

Observations And Results

The present study was conducted in the Department of Orthodontics & Dentofacial Orthopedics, Babu Banarasi das College of Dental Sciences, Lucknow with an aim to check the reliability of prediction done using Nemoceph software by comparing the changes in the soft tissue parameters between prediction tracing and post treatment cephalometric tracing in subjects with Class II Div I malocclusion and Class I Bimaxillary dentoalveolar protrusion

The sample for this study comprised of two groups ,Group I included 15 subjects with Angle's Class II Div 1 malocclusion and Group II included 15 subjects with Class 1 Bimaxillary dentoalveolar protrusion in the age range of 18-30 years.

A total of 22 parameters were measured for soft tissue analysis, out of which 18 were linear and 4 were angular.

The data was entered into the Microsoft Excel spreadsheet and was checked for any discrepancies. Shapiro Wilk test showed that all variables were following normal distribution.

Means, standard deviations, standard error for various soft tissue parameters of prediction and post treatment tracing of Group I were tabulated in Table 3 and comparision was done between prediction and post treatment tracing using ANOVA (Table 4).

Similary, means, standard deviation, standard error for various soft tissue parameters of prediction and post treatment tracing of Group II were tabulated in Table 5 and comparision was done between prediction and post treatment tracing using ANOVA (Table 6).

Table 3: Mean Standard Deviation and Standard Error for soft tissue parameters of Prediction and Post treatment tracing of Group I

	Parameter	Prediction tracing measurement Mean±Std deviation	Prediction tracing measurement Std Error	Post treatment tracing measurement Mean±Std deviation	Post treatment measurement Std error
Profile	Facial convexity angle	163.08±6.4^o	1.671	165.28±6.6^o	1.724
NOSE	NBTVL	-3.16±1.6mm	.4242	-2.60±1.7mm	.4631
	NTTVL	7.61±.96mm	.2480	8.54±1.9mm	.4298
	Nasolabial angle	117±4.8^o	1.258	119.4±3.7^o	.9617
	Nasomental angle	124.2±3.5^o	.9258	125.1±4.3^o	1.1278
LIPS	Interlabial gap	2.94±1.8mm	.4860	1.7±1.17mm	.3045
	Upper lip length	13.1±2.0mm	.5193	13±2.2mm	.5742
	Lower lip length	26.5±3.0mm	.7949	29.4±3.0mm	.7913
	Upper lip thickness	6.9±1.1mm	.3009	8.7±2.0mm	.5166
	Lower lip thickness	8.52±1.4mm	.3793	8±1.9mm	.4990
	Upper lip protrusion	.973±1.7mm	.4535	2.1±1.9mm	.5066
	Lower lip protrusion	-0.57±2.0mm	.5379	-1.56±1.8mm	.4798
	Lip protrusion to Ricketts E line	-1.9±2.1mm	.5454	-1.7±1.4mm	.3829
	Upper lip protrusion to TVL	-1.0±3.2mm	.8284	1.3±1.9mm	.4950
	Lower lip protrusion to TVL	-2.0± 1.9mm	.4917	-1.0±3.1mm	.8226
	Merrifield Z	73.60±10.8^o	2.796	72.35±7.7^o	1.992

	angle				
CHIN	Chin thickness at menton	4.44±1.2mm	.3264	4.59±1.0mm	.2789
	Chin thickness at pogonion	6.5±1.7mm	.4403	7.09±1.9mm	.4970
	Inferior labial sulcus	-3.7±1.3mm	.3614	-4.2±2.2mm	.5792
	Soft tissue pogonion to TVL	-3.0±4.4mm	1.149	-2.7.6±4.8mm	1.247
JAW BASES	Soft tissue Point A to TVL	-0.98±2.1mm	.5470	-0.97± 2.0mm	.5296
	Soft tissue Point B to TVL	6.57±1.9mm	.5161	-5.64± 3.0mm	.7842

Table 4: Comparision between soft tissue parameters of prediction and post treatment tracing of Group I

		Paired Differences				t	df	Sig. (2-tailed)
		Mean difference between prediction and post treatment measurement	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Profile	Facial convexity angle	-0.72±3.06°	0.79	-2.42	0.98	-0.91	14.00	0.38
NOSE	NBTVL	-0.23±1.23mm	0.32	-0.91	0.45	-0.74	14.00	0.48
	NTTVL	0.09±2.02mm	0.52	-1.03	1.21	0.17	14.00	0.87
	Nasiolabial angle	-2.43±8.83°	2.28	-7.32	2.46	-1.07	14.00	0.30
	Nasomental angle	-8.95±27.37°	7.07	-24.11	6.21	-1.27	14.00	0.23
LIPS	Interlabial gap	1.97±2.59mm	0.67	0.54	3.41	2.95	14.00	<0.05
	Upper lip length	-0.69±1.65mm	0.43	-1.61	0.22	-1.62	14.00	0.13
	Lower lip length	-1.89±4.34mm	1.12	-4.29	0.51	-1.69	14.00	0.11
	Upper lip thickness	-1.13±1.38mm	0.36	-1.89	-0.36	-3.16	14.00	<0.01
	Lower lip	0.54±2.07mm	0.54	-0.61	1.69	1.01	14.00	0.33

	thickness							
	Upper lip protrusion	-1.65±1.51mm	0.39	-2.49	-0.81	-4.23	14.00	<.001
	Lower lip protrusion	0.99±1.47mm	0.38	0.17	1.80	2.59	14.00	<.05
	Lip protrusion to Ricketts E line	-0.79±1.31mm	0.34	-1.52	-0.07	-2.34	14.00	<0.05
	Upper lip protrusion to TVL	-2.79±2.81mm	0.72	-4.34	-1.23	-3.85	14.00	<.01
	Lower lip protrusion to TVL	-0.91±3.14mm	0.81	-2.65	0.83	-1.13	14.00	0.28
	Merrifield angle	1.39±4.34^{o}	1.12	-1.02	3.79	1.24	14.00	0.24
CHIN	Chin thickness at menton	0.03±0.83mm	0.22	-0.43	0.49	0.16	14.00	0.88
	Chin thickness at pogonion	-0.58±1.72mm	0.44	-1.53	0.37	-1.31	14.00	0.21
	Inferior labial sulcus	0.33±1.23mm	0.32	-0.35	1.01	1.03	14.00	0.32
	Soft tissue	-1.45±1.63mm	0.42	-2.35	-0.54	-3.43	14.00	<.001

	pogonion to TVL							
JAW BASES	Soft tissue point A to TVL	0.30±0.95mm	0.24	-0.22	0.82	1.23	14.00	0.24
	Soft tissue point B to TVL	-1.23±1.65mm	0.43	-2.14	-0.31	-2.87	14.00	<0.05

For Group I subjects, mean difference for measurement of various soft tissue parameters between the prediction and post treatment tracing showed that the parameters Interlabial gap, Upper lip thickness ,upper and lower lip protrusion to SnPg',lower lip protrusion to E line, upper lip protrusion to TVL and soft tissue B'to TVL,soft tissue Pog' to TVL showed statistically significant difference whereas other parameters did not show significant difference between pediction and post treatment tracing.Each parameters will be discussed as follows.

Soft tissue Profile:

Facial convexity angle (Gn'Sn'Pg')

Mean value for the facial convexity angle in prediction tracing (163.6±6.47^{o}) was less than the measurement as obtained for post treatment tracing(165.2.± 6.6^{o}) and mean difference of **facial convexity angle** (0.72±3.06^{o}) between the two tracings was statistically non significant (p value 0.38)

Nose:

For the parameter ,**Nasal Base length to TVL** measurement was overestimated in prediction tracing (3.16±1.6mm)than post treatment tracing(-2.6±1.7mm)and mean difference (0.23±1.23mm) between the two tracing was statistically non significant.(p = 0.48)

No statistically significant difference was seen between prediction tracing(7.6±.96mm)and post treatment tracing (8.5±1.6mm)for the parameter Nasal projection(**NT-TVL)** (p=0.87)

Prediction measurement for parameter **Nasolabial angle** (117±4.8 ^{o})was less than the measurement as obtained for post treatment tracing(119.3± 3.7^{o})and mean difference (2.43±8.83^{o})between the two tracings was statistically non significant (p value=0.30)

Mean difference of (8.95±27.3^{o}) **Nasomental angle** did not show statistically difference between between prediction tracing(124.2± 3.5 ^{o})and post treatment tracing (125.1± 4.3 ^{o})

Lips:

For the parameter ,I**nterlabial gap** measurement was overestimated in prediction tracing (2.9±1.8mm) than post treatment tracing(1.7±1.1mm) and the mean difference (0.197±2.59mm) between the two tracing was statistically significant($p<0.05$)

Similary prediction measurement for parameter **Upper lip length** (13±2.0mm)was less than the measurement as obtained for post treatment tracing(13± 2.2mm) ,however mean difference (0.69±1.65) between the two tracings was statistically non significant.(p = 0.13)

Similarly prediction measurement for parameter **lower lip length** (26.5±2.3mm) was less than the measurement for post treatment tracing (29.61+ 3.0mm),however mean difference (1.89±4.34mm)was statistically non significant (p=0.11)

Prediction measurement for parameters **upper lip thickness** (6.9+1.1mm)was less than the measurement as obtained for post treatment tracing(8.76+ 2.0mm)and mean difference (1.13±1.38mm)between the two tracings was statistically significant.($p<0.01$)

For the parameter,**lower lip thickness** measurement was overestimated in prediction tracing (8.7.±1.4mm) than post treatment tracing(8±1.9mm) and mean difference (0.54±2.0mm) between the two tracings was statistically non significant (p=.33)

Prediction measurement for parameters **upper lip protrusion** (.97±1.7mm)was less than the measurement as obtained for post treatment tracing(2.1+ 1.9mm) and mean difference (1.65±1.5mm) between the two tracings was statistically significant. ($p<0.05$)

Similary prediction measurement for parameter **lower lip protrusion** (-.573±2.0mm) was less than the measurement for post treatment tracing (1.56± 1.8mm)and the mean difference (.99±1,47mm) between the two tracings was statistically significant ($p<0.05$)

Statistically significant difference for the parameter **lip protrusion to E line** was seen between prediction tracing(1.9±.2.1mm)and post treatment tracing (1.7±1.4mm) ($p<0.05$)

Prediction measurement for parameters **upper lip protrusion to TVL** (0.1.0±3.2mm)was less than the measurement as obtained for post treatment tracing(1.3± 1.9mm) and mean difference between(2.79±2,28mm) the two tracings was statistically significant.($p<.01$)

For the parameter,**lower lip protrusion to TVL** measurement was overestimated in prediction tracing (2.0.±1.9mm) than post treatment tracing(-1.0±3.1mm)and the mean difference (0.92±3.14mm)was statistically non significant ($p=.28$)

For the parameter,M**errifield Z angle** measurement was overestimated in prediction tracing (73.6±10.3^{o}) than post treatment tracing(72.3±7.7 ^{o}) and the mean difference (1.39±4.34^{o}) between the two tracings was statistically non significant ($p=0.24$)

Chin:

Though prediction measurement for parameter **chin thickness at menton** (4.4±1.2mm)was less than the measurement as obtained for post treatment tracing(4.5± 1.0mm),however the mean difference (0.03+0.83mm)between the two tracings was statistically non significant.($p = 0.88$)

Though prediction measurement for parameter **chin thickness at pogonion** (6.5±1.7mm)was less than the measurement as obtained for post treatment tracing(7.09± 1.9mm,however mean difference (0.58± 1.72mm) between the two tracings was statistically non significant.($p = 0.21$)

Prediction measurement for parameters **Inferior labial sulcus** (-3.7±1.3mm)was less than the measurement as obtained for post treatment tracing(4.2± 2.2mm) and the

mean difference (2.79±2.28mm) between the two tracings was statistically non significant.(p=0.32)

For the parameter,**soft tissue pogonion to TVL** measurement was overestimated in prediction tracing (-3.0.± 4.4mm) than post treatment tracing(-2.7± 4.8mm) and the mean difference(1.45±1.63mm) between the two tracings was statistically significant (p<0.05).

Jaw Observation:

For the parameter **soft tissue point A to TVL** measurement was less in prediction tracing

(-.98.± 2.1mm) than post treatment tracing(-.97± 2.05mm) and the mean difference (0.30±0.95mm) between the two tracings was statistically non significant (p=.24)

For the parameter,**soft tissue point B to TVL** measurement was overestimated in prediction tracing (-6.5± 1.99mm) than post treatment tracing(-5.64±3.03mm) and the mean difference (1.23± 1.65mm) between the two tracings was statistically significant (p<.05)

Table 5: Mean, Standard Deviation and Standard Error for soft tissue parameters of Prediction and Post treatment tracing of Group II

	Parameter	Prediction tracing measurement Mean±Std deviation	Prediction tracing measurement Std Error	Post treatment measurement Mean±Std deviation	Post treatment measurement Std error mean
Profile	Facial convexity angle	162.3±2.7°	.7144	163.0±3.3°	.8685
NOSE	NBTVL	-3.66±1.6mm	.4286	-3.4±1.1mm	.3062
	NTTVL	8.0±1.1mm	. 2918	7.9±1.8mm	.4802
	Nasolabial angle	117.4±8.1°	2.109	119.8±10.7°	2.774
	Nasomental angle	118.1±25.7°	6.63	127.1±5.1°	1.335
LIPS	Interlabial gap	3.46±2.4mm	.6396	1.49±.90mm	.2331
	Upper lip length	12.6±1.6mm	.4255	13.3±1.4mm	.3774
	Lower lip lenght	27.95±4.71mm	1.218	29.84±4.48mm	1.1585
	Upper lip thickness	7.2±1.14mm	.2968	8.3±1.5mm	.4051
	Lower lip thickness	8.4±1.5mm	.3930	7.8±1.1mm	.3017
	Upper lip protrusion	1.12±1.9mm	.4939	2.7±1.2mm	.3146
	Lower lip protrusion	-1.6±1.7mm	.4587	-2.6±1.8mm	.4652
	Lip protrusion to Ricketts's E line	-1.30±1.8mm	.4838	-0.51± 1.9mm	.5091
	Upper lip protrusion to TVL	-1.1±2.8mm	.7360	1.60±1.23mm	.3177
	Lower lip protrusion to TVL	-1.87±1.6mm	.4356	-0.96±3.2mm	.8275
	Merrifield 's Z line	71.1±8.4°	2.17	69.7±7.5°	1.958
	Chin thickness at menton	4.3±1.6mm	.4157	4.2±1.5mm	.3898
	Chin thickness	6.83±2.0mm	.5382	7.4±2.3mm	

CHIN	at pogonion				.5988
	Inferior labial sulcus	-3.5±1.2mm	.3202	-3.8±1.5mm	.3931
	Soft tissue pogonion to TVL	-5.8±1.4mm	.3756	-4.4±1.7mm	.4417
JAW BASES	Soft tissue Point A to TVL	-0.58±.93mm	2402	-0.88±.84mm	.2171
	Soft tissue Point B to TVL	-6.68±2.3mm	.6162	-5.4±2.2mm	.5692

Table 6: Comparision between soft tissue parameters of prediction to post treatment measurement tracing of Group II

		Paired Differences				t	df	Sig. (2-tailed)
		Mean difference between prediction and post treatment tracing measurements	Std. Error Mean	95% Confidence Interval of the Difference				
				Lower	Upper			
Profile	Facial convexity angle	-2.20+1.69	0.44	-3.14	-1.26	-5.05	14.00	<0.001
NOSE	NB-TVL	-0.55±0.70	0.18	-0.94	-0.16	-3.04	14.00	.<0.01
	NT-TVL	-0.93±1.83	0.47	-1.95	0.08	-1.97	14.00	0.07
	Nasiolabial angle	-1.57±4.93	1.27	-4.31	1.16	-1.24	14.00	0.24
LIPS	Nasomental angle	-0.89±3.30	0.85	-2.72	0.93	-1.05	14.00	0.31
	Interlabial gap	1.21±2.19	0.56	0.00	2.42	2.14	14.00	0.05
	Upper lip length	-0.36+1.34	0.35	-1.10	0.38	-1.04	14.00	0.32
	Lower lip length	-2.81±2.57	0.66	-4.23	-1.39	-4.25	14.00	.001
	Upper lip	-1.80±2.00	0.52	-2.91	-0.69	-3.48	14.00	<0.01

	thickness							
	Lower lip thickness	0.52±1.60	0.41	-0.37	1.41	1.26	14.00	0.23
	Upper lip protrusion	-1.22±2.21	0.57	-2.45	0.01	-2.13	14.00	<0.05
	Lower lip protrusion	0.99±1.12	0.29	0.37	1.61	3.41	14.00	<0.01
	Lip protrusion to Ricketts E line	-0.23±1.61	0.41	-1.12	0.66	-0.55	14.00	0.59
	Upper lip protrusion to TVL	-2.41±3.40	0.88	-4.29	-0.52	-2.74	14.00	<0.05
	Lower lip protrusion to TVL	-1.00±3.05	0.79	-2.69	0.69	-1.27	14.00	0.22
	Merrifield Z angle	1.25±5.10	1.32	-1.57	4.08	0.95	14.00	0.36
CHIN	Chin thickness at menton	-0.15±0.64	0.16	-0.50	0.21	-0.89	14.00	0.39
	Chin thickness at pogonion	-0.53±0.96	0.25	-1.06	0.00	-2.13	14.00	0.05
	Inferior labial sulcus	0.51±1.51	0.39	-0.33	1.34	1.30	14.00	0.22
	Soft tissue pogonion to TVL	-0.24±2.42	0.63	-1.58	1.10	-0.38	14.00	0.71
JAW BASES	Soft tissue point A to TVL	-0.01±1.29	0.33	-0.73	0.70	-0.04	14.00	0.97
	Soft tissue point B to TVL	-0.93±2.72	0.70	-2.43	0.58	-1.32	14.00	0.21

For Group II subjects ,mean difference for measurement of various soft tissue parameters between the prediction and post treatment tracing showed that the parameters **Facial Convexity Angle , NB-TVL,NT-TVL,Lower lip length,upper lip thickness,upper lip protrusion,lower lip protrusion and upper lip protrusion to TVL showed** showed statistically significant difference whereas the other parameters did not show significant difference between pediction and post treatment tracing.Each parameters will be discussed as follows

Soft tissue Profile:

Facial convexity angle (Gn'Sn'Pg')

Mean value for the facial convexity angle in prediction tracing (162.3±2.7^{o}) was less than the measurement as obtained for post treatment tracing(163.02.± 3.3^{o})and mean difference (-2.20±1.69^{o}) between the two tracings was statistically significant .($p < 0.001$)

Nose:

For the parameter, **Nasal Base length to TVL** measurement was estimated in prediction tracing (-3.66±1.6mm) and post treatment tracing(-3.42±1.8mm),and the mean difference (-0.55±0.70mm)was statistically significant.($p < 0.05$)

For the parameter **Nasal projection(NT-TVL)**measurement was overestimated in prediction tracing(8.0±1.1mm)than post treatment tracing (7.99±1.8mm)and mean difference (-0.93±1.83mm)between the two tracings was statistically non significant ($p = 0.07$)

Prediction measurement for parameter **Nasolabial angle** (117±8.1 ^{o})was less than the measurement as obtained for post treatment tracing(119.8± 10.7^{o})and mean

difference (-1.57±4.93^{o}) between the two tracings was statistically non significant (p value=0.24)

Nasomental angle did not show statistically difference between between prediction tracing(118± 25.7 ^{o})and post treatment tracing (127.1± 5.1 ^{o}) and mean difference (-.89±3.30^{o})between the two tracings was statistically non significant (p=0.31)

Lips:

For the parameter ,**Interlabial gap** measurement was overestimated in prediction tracing (3.4±2.4mm) than post treatment tracing(1.4±0.9mm)and mean difference (1.21±2.19mm)between the two tracings was statistically significant($p<0.05$)

Though prediction measurement for parameter **Upper lip length** (12.6±1.6mm)was less than the measurement as obtained for post treatment tracing(13± 1.4mm) and mean difference between the two tracings(-0.36±1.34mm) was statistically non significant.(p =0 .32)

Similarly prediction measurement for parameter **lower lip length** (27.9±4.7mm) was less than the measurement for post treatment tracing (29.84+ 4.4)and the mean differernce (-2.81±2.57mm)between the two tracings was statistically significant ($p<0.01$)

Prediction measurement for parameters **upper lip thickness** (7.2+1.1mm)was less than the measurement as obtained for post treatment tracing(8.3+ 1.5mm) and mean difference(-1.80±2.00mm)between the two tracings was statistically significant.($p<0.01$)

For the parameter,**lower lip thickness** measurement was overestimated in prediction tracing (8.4.±1.5mm) than post treatment tracing(7.8±1.1mm) and the mean

difference was (-0.52±1.6mm) between the two tracings was statistically non significant (p=0.23)

Prediction measurement for parameters **upper lip protrusion** (1.1±1.9mm)was less than the measurement as obtained for post treatment tracing(2.7+ 1.2mm) and mean difference (-1.22±2.2mm)between the two tracings was statistically significant.($p<0.05$)

Similarly prediction measurement for parameter **lower lip protrusion (-1.6±1.7**) was less than the measurement for post treatment tracing (-2.6± 1.8mm) and mean difference (.99±1.12mm) between the two tracings was statistically significant ($p<0.05$)

Statistically non significant difference for the parameter **lip protrusion to E line** was seen between prediction tracing(-1.6±1.7mm)and post treatment tracing (-2.6±1.8mm) ($p = 0.59$)

Prediction measurement for parameters **upper lip protrusion to TVL** (-1.1± 2.8mm)was less than the measurement as obtained for post treatment tracing(1.6± 1.2mm) and the mean difference(-2.41±3.40mm) between the two tracings was statistically significant.($p<0.05$)

For the parameter,**lower lip protrusion to TVL** measurement was overestimated in prediction tracing (-1.8.±1.6mm) than post treatment tracing(-.960±3.2mm) and the mean difference (-1.00±3.05mm) between the two tracings was statistically non significant (p=.22)

For the parameter,M**errifield Z angle** measurement was overestimated in prediction tracing (71.16±8.4 ^{o}) than post treatment tracing(69.7.3±7.5 ^{o})and the mean difference (1.25±5.10^{o}) between the two tracings was statistically non significant (p=0.36)

Chin:

Prediction measurement for parameter **chin thickness at menton** (4.3±1.6mm)and measurement as obtained for post treatment tracing(4.2± 1.5mm)and mean difference (-0.15±0.96mm) between the two tracings was statistically non significant.(p = 0.39)

Though prediction measurement for parameter **chin thickness at pogonion** (6.8±2.0mm)was less than the measurement as obtained for post treatment tracing(7.4± 2.3mm) and mean difference (-0.53±0.96mm) between the two tracings was statistically non significant.(p = 0.21)

Prediction measurement for parameters **Inferior labial sulcus** (-3.5.±1.2mm)was less than the measurement as obtained for post treatment tracing(-3.8± 1.5mm) and mean difference (0.51±1.51mm) bewteen the two tracingswas statistically non significant.(p=0.22)

For the parameter,**soft tissue pogonion to TVL** measurement was overestimated in prediction tracing(-5.867.± 1.4mm) than post treatment tracing(-.4.4± 1.75mm)and the mean difference (-0.24±2.42) between the two tracings was statistically non significant (p=0.71).

Jaw Observation:

For the parameter **soft tissue point A to TVL** measurement was overestimated in prediction tracing (-.587 ± .9303mm) than post treatment tracing(-.887.4± .84mm)

and mean difference (-0.01±1.29mm) between the two tracings was statistically non significant (p=0.97)

For the parameter,**soft tissue point B to TVL** measurement was overestimated in prediction tracing (-6.6± 2.3mm) than post treatment tracing(-5.45±2.2mm) and mean difference (-0.93±2.72mm) between the two tracings was statistically non significant (p=0.21)

Discussion

The prediction of treatment outcome is an important part of Orthodontic planning and its presentation to patient is an important process of patient' informed consent.The attempt to predict treatment changes dates back to prediction using Tweed and Steiner's Stick Analysis[1].

Computer technology has helped us in the world we live in. Manual cephalometric analysis has been replaced by computerized cephalometric softwares.Now different cephalometric analysis are just a click away. Besides this ,cephalometric software also provides the ability to easily and accurately perform the treatment simulations and altered soft tissue profile of the patient could be obtained.The morphing tool of cephalometric software produces corrected soft tissue profile from hard tissue movements and when superimposed on facial photographs it can be a excellent motivational tool for the patients.

There is considerable variability in soft tissue changes after treatment due to variations in soft tissue thickness hence soft tissue translation to underlying hard tissue changes is variable .Considering this the soft tissue changes predicted before beginning of treatment need to be assessed for accuracy and reliability.

Many of the previous studies[6-9] evaluated accuracy and reliability of morphing softwares in cases that had undergone orthognathic surgery but not many studies have evaluated the accuracy of prediction of soft tissue changes after orthodontic treatment alone.The result of various studies[1,2,3,4] done to evaluate accuracy of cephalometric software for prediction of skeletal changes after orthognathic surgery to those achieved actually were relatively accurate with small degree of error and could be used for patient education and communication.The result of few studies done to evaluate the

accuracy of the prediction in subjects who had undergone fixed orthodontic treatment were not conclusive.

None of the studies have compared predicted changes to post treatment cephalometric outcome in subjects undergoing fixed orthodontic treatment using Nemoceph Cephalometric software.Most of the previous studies evaluated accuracy of prediction generated by calculating difference between prediction and post treatment tracing for selected parameters and using the same for generating prediction from pretreament tracing. This removes error arising because of mechanics,operator or individual patient response. Hence it was decided to evaluate the accuracy of Nemoceph software same in present study using, a similar method as used in previous studies. In Orthodontic practice, Class II Div 1 malocclusion and Class I Bimaxillary Dentoalveolar protrusion are two most commonly observed malocclusion hence it was decided to include the subjects with these two malocclusion in the present study . Considering this it was decided to conduct this study with an aim to check the reliability of prediction done using Nemoceph software by comparing the changes in the soft tissue parameters between prediction tracing and post treatment cephalometric tracing in subjects with Class II Div I malocclusion and Class I Bimaxillary dentoalveolar protrusion

The sample for this study comprised of two groups ,Group I included 15 subjects (mean age 23$\pm$2.7 years) with Angle's Class II Div 1 malocclusion and Group II included 15 subjects mean age 22$\pm$3.7years) with Class 1 Bimaxillary dentoalveolar protrusion .Pre-treatment and Post-treatment lateral cephalogram were taken of all the

subject from the records of the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das college of Dental sciences, Lucknow.

To generate prediction tracings, linear and angular hard tissue parameters related to maxillary and mandibular incisors from Steiner's analysis were measured on pre and post treatment cephalometric tracing and difference in their values were subsequently entered in the" FTO (Facial Tratment Objective)tracing box" of pretreatment tracing.The change in linear measurement during retraction was added in "Horizontal"box and changes in angulation during retraction correction was added in "Rotational" box of the FTO tracing.The movement of hard and soft tissue was visible on generated prediction and measurement of soft tissue parameters for various cephalometric analysis was obtained.

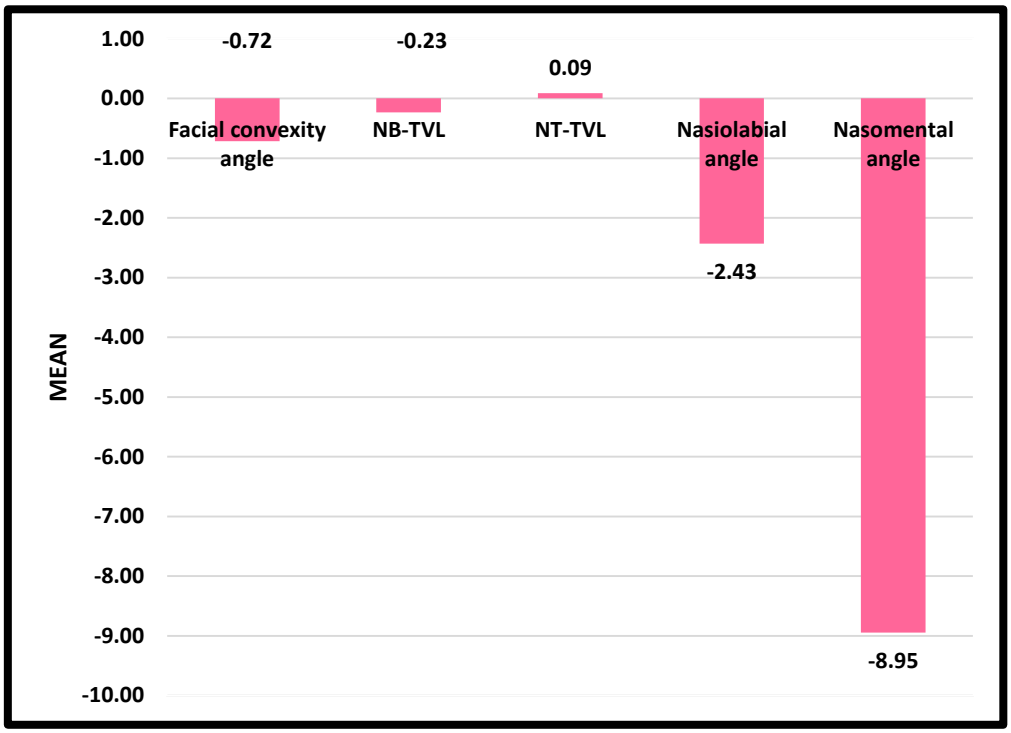
A total of 22 soft tissue parameters were measured on generated prediction tracing and post treatment tracing, out of which 18 were linear and 4 were angular.

The data was entered into the Microsoft Excel spreadsheet and was checked for any discrepancies. Shapiro Wilk test showed that all variables were following normal distribution.Appropriate statistical analysis was applied for comparision between the measurements of generated prediction tracing and post treatment tracing.

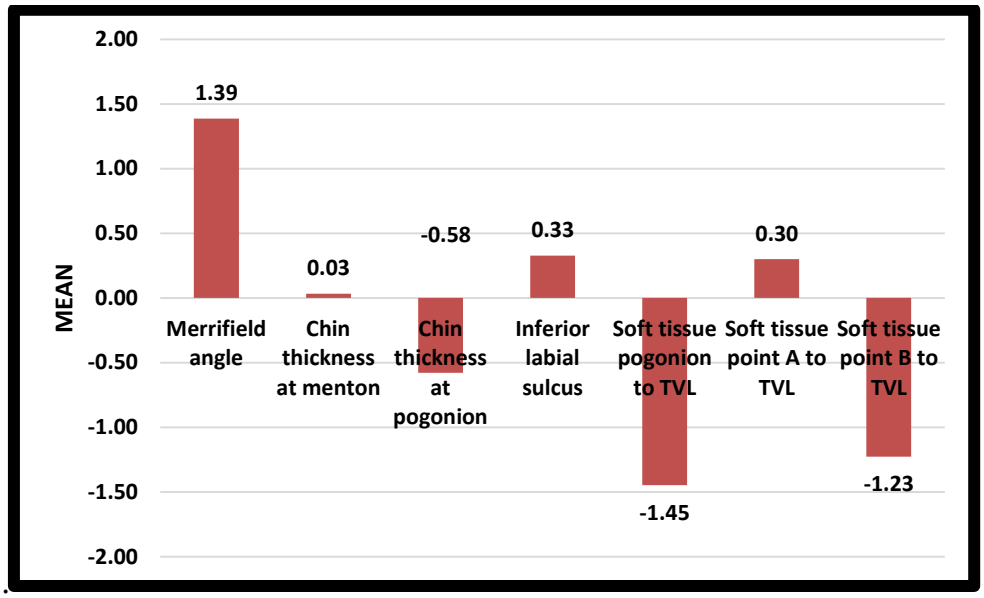
The parameters analyzed were grouped and discussed as changes seen in position of **Profile** (Gn'Sn'Pg'), **Nose(** NBTVL, NTTVL Nasolabial angle, Nasomental angle),**Lips** (interlabial gap, upper lip length, lower lip length, upper lip thickness, lower lip thickness, upper lip protrusion, lower lip protrusion,lip to Rickets E line,Upper lip protrusion to TVL,Lower lip protrusion toTVL ,Merrifield Z

angle),**Chin**(Chin thickness at menton,chin thickness at pogonion,inferior labial sulcus,soft tissue pogonion to TVL),**Jaw bases**(soft tissue point A to TVL.soft tissue point B to TVL).

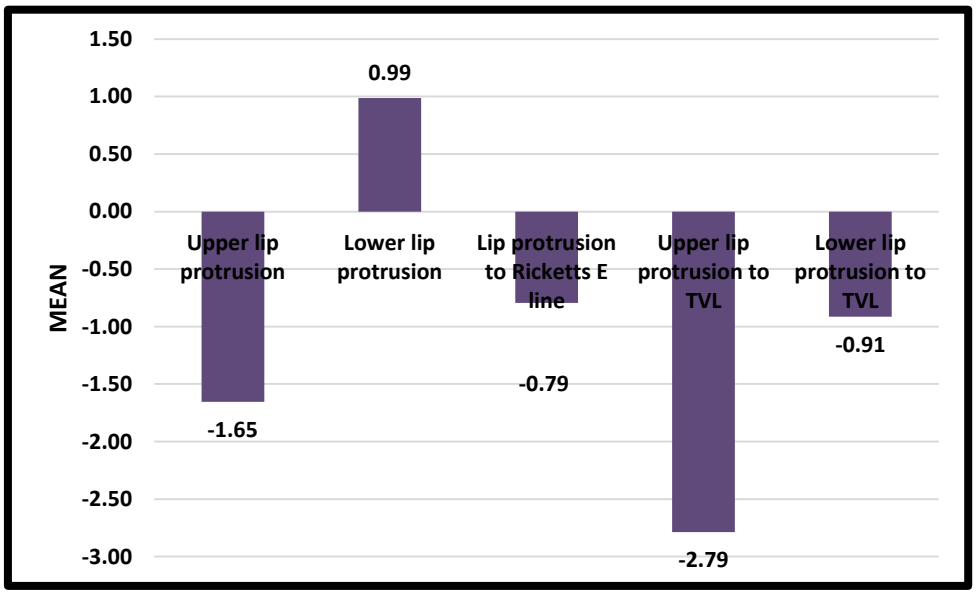
The results of the present study for Group I subject showed that mean difference for measurement of various soft tissue parameters between the prediction and post treatment tracing for the parameters Interlabial gap,Upper lip thickness ,upper and lower lip protrusion to SnPg',lower lip protrusion to E line,upper lip protrusion to TVL and soft tissue B'to TVL,soft tissue Pog' to TVL between the prediction and post treatment tracing showed statistically significant difference whereas other parameters did not show significant difference between prediction and post treatment tracing.(Bar Diagram 1-4)



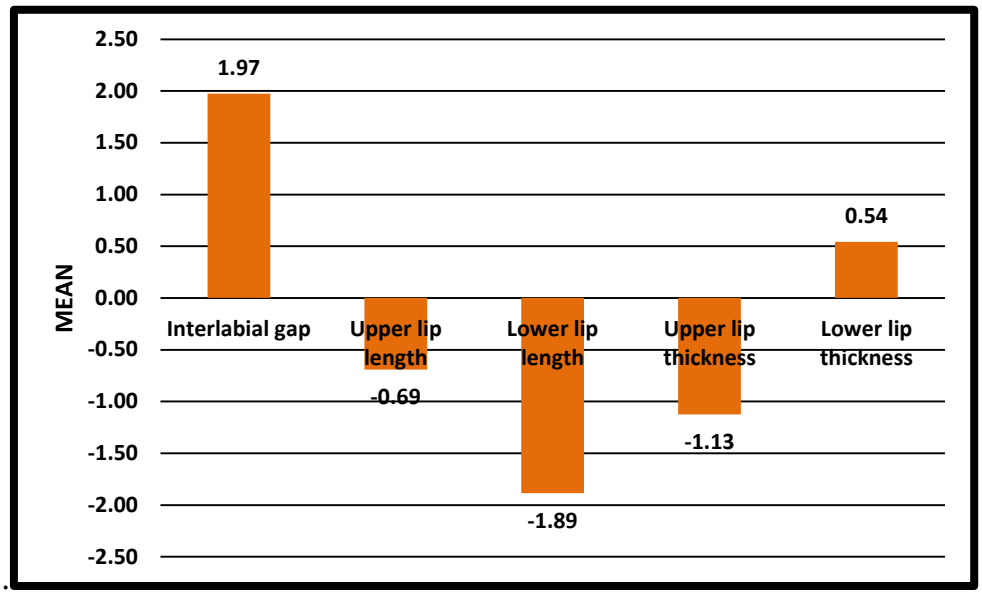
Bar diagram 1: Mean difference of various soft tissue parameters(Profile,Nose) of Group I between prediction and post treatment tracing



Bar diagram 2:Mean difference of various soft tissue parameters(Chin,Jaw Bases) of Group I between prediction and post treatment tracing

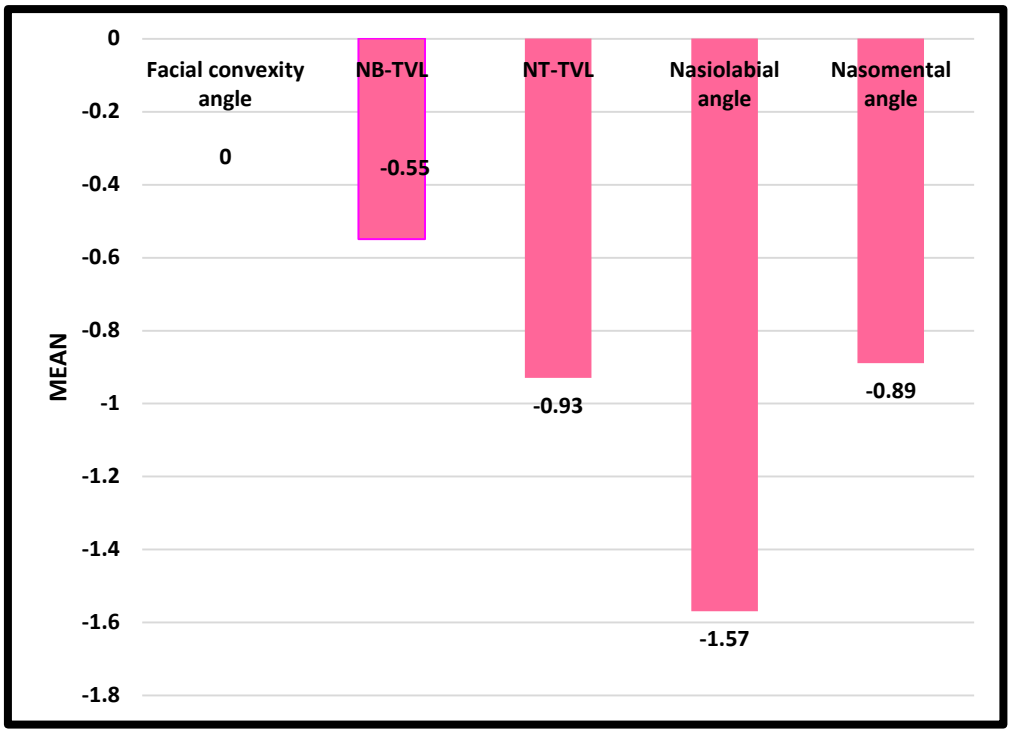


Bar diagram 3:Mean difference of various soft tissue parameters(Lips) of Group I between prediction and post treatment tracing

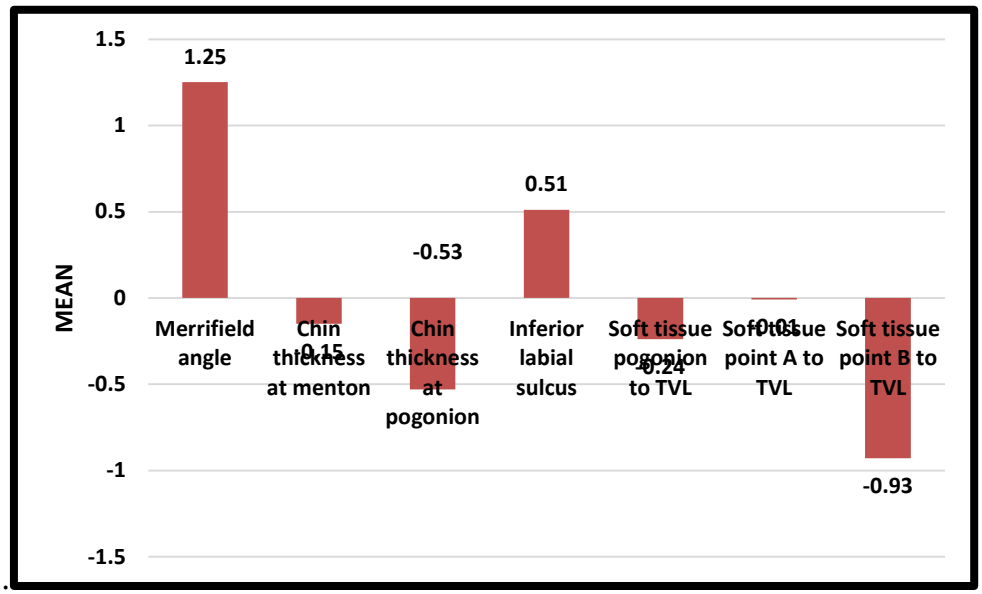


Bar diagram 4:Mean difference of various soft tissue parameters(Lips) of Group I between prediction and post treatment tracing

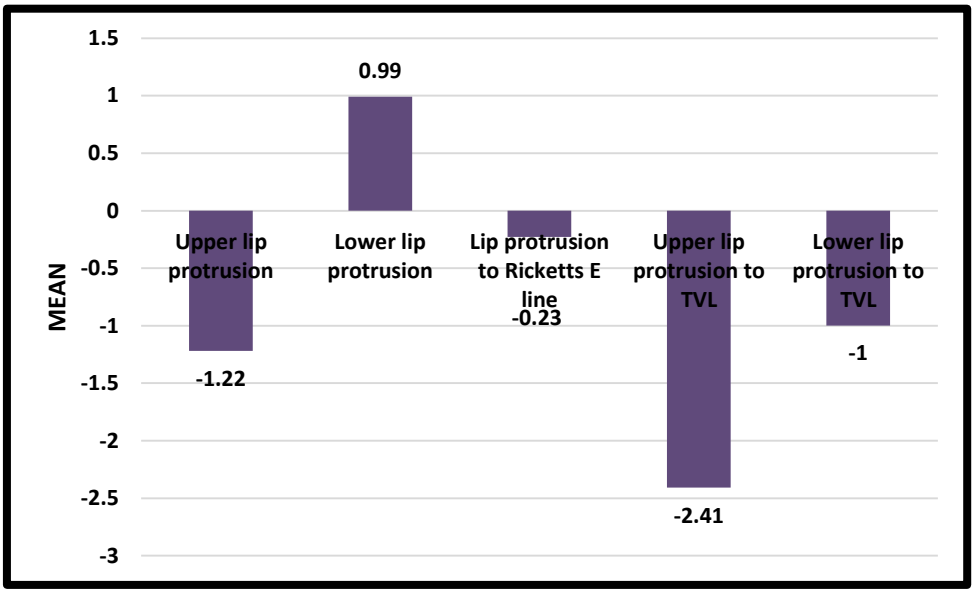
For Group II subjects ,mean difference for measurement of various soft tissue parameters between the prediction and post treatment tracing showed that the parameters Facial Convexity Angle , NB-TVL,NT-TVL,Lower lip length,upper lip thickness,upper lip protrusion,lower lip protrusion and upper lip protrusion to TVL showed showed statistically significant difference whereas the other parameters did not show significant difference between pediction and post treatment tracing.The results suggested that the prediction tracing was relatively more accurate in vertical than horizontal direction.(Bar diagram 5-8).



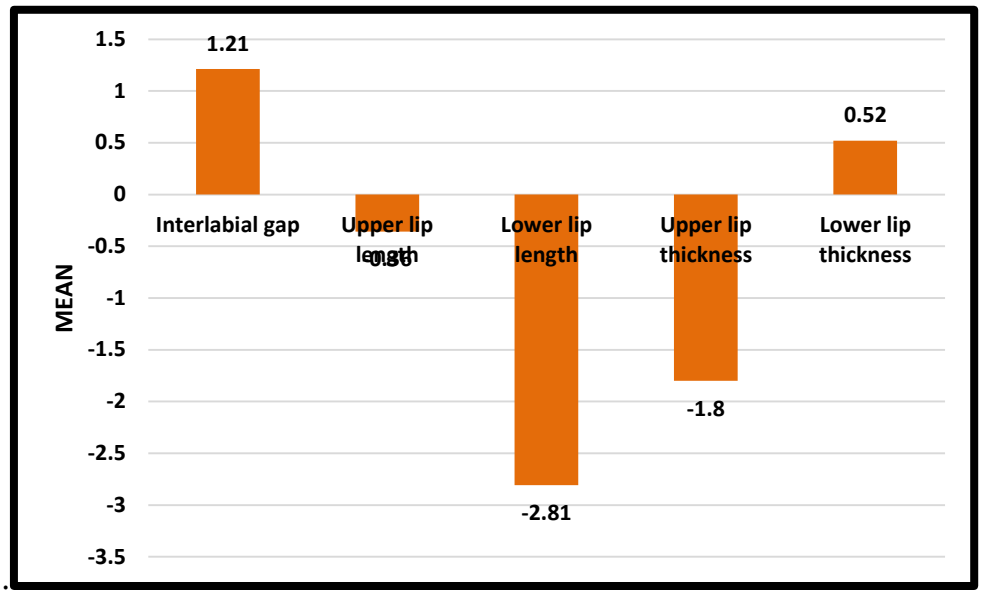
Bar diagram 5:Mean difference of various soft tissue parameters(Profile ,Nose) of Group II between prediction and post treatment tracing



Bar diagram 6:Mean difference of various soft tissue parameters(Chin,Jaw bases) of Group II between prediction and post treatment tracing.



Bar diagram 7:Mean difference of various soft tissue parameters(Lips) of Group II between prediction and post treatment tracing



Bar diagram8: Mean difference of various soft tissue parameters(Lips) of Group II between prediction and post treatment tracing.

As not many studies have been conducted to check the accuracy of cephalometric software for prediction of soft tissue changes after orthodontic treatment alone ,hence direct comparision was not possible .The study by **Zhang et al**[18] evaluated accuracy of Dolphin imaging system was seen for 34 subjects with Class I Bimaxillary Dentoalveolar protrusion who had undergone fixed Orthodontic treatment .They found that there was statistically significant difference in the Lower lip to H line,between prediction and actual post treatment outcome with mean difference (1.69±0.30mm), and the predicted value (2.27± 30mm) were overestimated than the actual post treatment value (0.57±2.4mm). In the present study Lower lip protrusion was measured with respect to E line,B line and TVL,however lower lip protrusion to B line only showed statistically significant difference (.99± 1.12mm)and prediction measurement (1.6±1.7mm) was less than post treatment measurement (2.67±1.04mm).Also for upper lip thickness in their study[19] the predicted value

(14.41±0.46mm)was estimated more than post treatment value(13.72±0.36mm) and mean difference of (0.69±0.37mm)was statistically significant($p<0.05$) .In the present study mean difference(1.80±2.0mm)for Upper lip thickness was statistically significant between prediction measurement (7.2±1.1mm) and the measurement in the post treatment tracing(8.3±1.5mm)however prediction measurement was less than post treatment value in the present study contrary to study by **Zhang et al[18].**

For soft tissue chin thickness in both the studies the predicted value was underestimated than the post treatment value and difference was statistically non significant .The predicted value was 11.75±0.47mm and post treatment value was 12.00±0.39mm in the study of **Zhang et al[18]** whereas in the present study the predicted value was 6.8±2.0mm and post treatment values was 7.4±2.3mm.Most of the landmarks in vertical plane showed non significant difference in both the study suggestive of relatively more accuracy of prediction in vertical plane in both the studies.

Cangialosi et al [4]evaluated reliability of Quick ceph software generated prediction in 30 patients who were treated on a non extraction basis with fixed orthodontic treatment .Growth forecast was generated according to the length of active treatment. And the software had "special radial method"to calculate growth.To check the soft tissue changes during treatment Holdaway ratio or Ricketts ratio was used.with the tracing produced from the growth forecast as the base ,treatment simulation application was then used to create the VTO by moving the teeth into the corrected positions.They found out that software program overestimated growth at points A and B,the prediction for ANB was fairly close to actual posttreatment value.The

prediction for lower incisor appeared to be inaccurate.this could be due to difficulty in placement of the tooth while using the treatment simulation application or failures of the clinician to attain the desired VTO. They found out that most reliable predictions were those involving angular measurement while least reliable had to do with anteroposterior or the angular measurements of incisor.They did not evaluate any soft tissue parameters.

Abdullah et al[16] evaluated accuracy of prediction by Steiner Stick Analysis and found that predicted values of ANB ,Upper Maxillary incisor to NA were overestimated whereas values of Pog -NB was underestimated and difference was statistically significant with actual post treatment value.As they did not evaluate any soft tissue parameters,hence direct comparison was not possible. However the result of this study can be interpreted as lack of prediction by Steiner Stick Analysis.Also the authors suggested that its not reliable to base orthodontic decisions base orthodontic decision on Steiner Stick Analysis alone.

Zeynep et.al[17] evaluated the soft tissue parameters of treatment simulation to that of actual treatment outcome in patients with Class II Div 1 malocclusion treated with functional appliance.They found that the upper lip protrusion with respect to Na perpendicular was overestimated in the prediction tracing (13.90 $\pm$ 4.01mm) than actual treatment value (13.90$\pm$4.1mm) and mean difference between the two (-0.83$\pm$2.1mm) was statistically significant($p<0.05$).Similar to this study ,Group I of our study that include subject with Class II Div 1 malocclusion showed that measurement of upper lip protrusion to TVL was overestimated in prediction values(1.0$\pm$3.2mm) than post treatment tracing(1.3$\pm$1.9mm)and mean difference of (-

2.79±2.81) was statistically significant.The parameters showing Lower Lip Protrusion,soft tissue chin, soft tissue point A and point B to Nasion Perperpendicular in study by **Zeynep et al** and to TVL in present study did not show statistically significant difference between prediction and post treatment tracing. Overall conclusion drawn from above mentioned studies is that prediction is more accurate in vertical plane.

Most of the parameters showed mean difference of less than 2mm except **Nasolabial angle**(2.43±8.83$^{o)}$,**Nasomental angle**(8.95±27.73^{o}) and **Upper lip protrusion to TVL**(2.79 ±2.81mm)for Group I and **Facial convexity angle (**2.20±1.69^{0}), **Lower lip length(**2.81±2.57mm) and **Upper lip protrusion to TVL(** 2.41 ± 3.40mm)for Group II for most of the parameters hence difference between prediction and post treatment tracing was within acceptable limits.The variation in parameters related to upper lip ,lower lip in final treatment outcome in comparision to prediction tracing could be due complex muscular attachment of upper lip to nose, variation in tonicity of lips variation in thickness of lips as thinner lips tend to follow underlying hard tissue translations more closely than thicker lips,upper lip translation is guided by lower lip translation ,varaition in lip strain etc.

Most of the previous studies that compared soft tissue tissue changes between pre and post treatment found ration of movement between upper lip and maxillary incisor ranging from 1:1(Holdaway),2:3 by Ricketts,1:3.8 in upper lip by Waldman[47] and 1.75:1 for lower lip ,Mandibular incisor .This suggest that there is variation in soft tissue change in response to incisor retraction in different studies.

Overall conclusion from above mentioned studies suggested that prediction was more accurate in vertical than in horizontal direction for the cases treated with orthodontic treatment alone.

Other studies by **Upton et al[14],Gossett et al[30], Eales et al[26].Serge et al[13],Cangialosi et al[4],Neelembar et al[33].** evaluated accuracy of the prediction in cases who had undergone orthognathic suregry.**Petkas et al[9]** compared computer generated prediction using dolphin software to actual post treatment outcome and found Tip of the nose was the most accurate site ,whereas the largest difference was shown in the upper lip in the sagittal plane.The only mean difference < 1mm was reported at subnasale in the vertical plane.The lower lip was noted to be the least accurate region in the vertical plane.They found prediction error <2mm was 91% in horizontal plane whereas 68% of prediction error was <2mm in vertical plane.

Lourdes et al[41] compared actual surgical outcome to prediction tracing measurement and found out that Facial Convexity angle ,upper and lower lip protrusion to Na perpendicular did not show statistically significant difference between the two tracing for both the groups(group I had mandibular advancement alone and Group II had both Mandibular advancement and Lefort I deimpaction)Also in their study[3] the Nasolabial angle in both the groups in post treatment tracing outcome(group 1: 101.6$\pm$8.27 and group 2 : 103.69$\pm$5.58) was less than predicted values group 1 : 102.4$\pm$7.98) and group 2: 104.72$\pm$5.13) and difference was statistically significant on contrary in the present study prediction measurement for parameter Nasolabial angle (117$\pm$4.8 ^{o}) was less than the measurement as obtained for post treatment tracing(119.3$\pm$ 3.7^{o}) and

mean difference (2.43 ± 8.83^{o}) between the two tracings was statistically non significant (p value=0.30).

Upton et al[14] evaluated accuracy of the soft tissue profile using Quick ceph images in 40 patient who had undergone Lefort I osteotomy and mandibular advancement through BSSO with or without genioplasty and they found out that the error between prediction tracing and post treatment tracing in horizontal plane was less than in vertical landmark positions.

Konstantina et al[25] conducted a study on 21 patients who had undergone surgical procedure of Lefort I using the DentoFacial Planner(DPF) software and they found lower lip protrusion was underestimated in the prediction tracing than post treatment with difference of 1.57 that was statistically significant.

Koh CH, Chew MT[10] evaluated the accuracy of soft tissue profile predictions in 35 Chinese skeletal Class III patient treated with Bimaxillary surgery using computer assisted simulation system for orthognathic surgery (CASSOS) They simulated hard tissue movements on the presurgical cephalogram until good superimposition of the hard tissues was achieved on presurgical and posttreatment cephalograms.This represented the actual amount of anteroposterior and vertical surgical changes that had occured during surgery.A computerized superimposed cephalometric line drawing of the hard and soft tissue was then generated which was used to compare and analyze the accuracy of the cephalometric soft tissue outlines.They had taken 32 linear measurement out of which 16 soft tissue landmarks were measured in both the horizontal and vertical reference lines in both predicted and actual post treatment

profiles. The software tended to underestimate the vertical position of both the upper and lower lip and overestimated the horizontal position of the lower lip.

Loh S, Heng JK, Ward Booth P, Winchester L, McDonald F[6]. did accuracy and reliability of prediction using Quick ceph image prediction in 28 adult patient treated with orthognathic surgery which included either down fracture ,or set back or BSSO and they found that the predicted values for changes in ANB angle showed statistically significantly difference prediction and actual treatment outcome.

Aharon PA, Eisig S, Cisneros GJ[7] compared two software Dentofacial planner and Quick Ceph Image software and found these programs worked well for simulation of single and double jaw surgery. However horizontal position of upper lip varied in quick Ceph software and position of lower lip varied in dentofacial planner between predicted and final outcome.

Eales et al[26] conducted a study to compare the accuracy of predicted soft tissue changes using computer software package (COG 3.4) in 25 subject who had undergone Lefort I.They had used the incisor and molar points changes (horizontal and vertical).The immediate pre surgical and post surgical lateral cephalogram was digitised using DFP before prediction could be generated in COG 3.4 software.Once the immediate pre surgical plot has been transferred into the COG 3.4 software, prediction plot was generated by entering the incisor tip and molar tip movements calculated as occuring between the immediate pre surgical and the immediate post surgical plot. They found out that statistically significant difference was found in horizontal plane in stomion inferius ,horizontal mid fold ,thickness upper lip and in vertical plane only stomion superius was found to be statistically significant.Among

the software ,they found DFP generated prediction by default whereas COG software used dental movement achieved.They found COG 3.4 software was better prediction that DFP software.

Schultes et al[8] conducted a study to examine the accuracy of computer generated prediction of soft tissue changes using DentoFacial Planner in 25 patients with skeletal mandibular retrognathia.They concluded that mandibular advancement in correction of mandibular dysnathia resulted in significant changes in lower face ,which can be predicted in the vertical and horizontal plane with only a small degree of error.They noted lesser error in lower lip area than chin.The highest degree of error was determined to occur in the submental area, and the error grows as the extent of mandibular advancement increases.They stated that advanced algorithm of DFP software enabled predictability of more than 80%.

Overall conclusion of these studies suggested that prediction was fairly accurate and prediction error were within clinically accepted limits for cases treated by orthognathic surgery.The prediction errors for orthosurgical cases were noted in vertical plane as well as in horizontal plane. This could be due to the fact that vertical skeletal changes occur during orthognathic surgery along with sagittal correction, hence soft tissue stretch was variable post surgically. For orthodontic cases prediction errors were more accurate in vertical plane than horizontal directions.

The variability in soft tissue translation in response to underlying hard tissues is responsible for the prediction error, whether done for subjects undergoing orthodontic treatment alone or in combination with jaw surgeries. Cephalometric software uses

fixed ratio in their software to generate prediction of soft tissue. By providing amount of linear and angular correction of maxillary and mandibular incisors to generate predictions, bias due to mechanics, operator and patient response could be eliminated but fixed ratio of upper lip translation in response to tooth movement as per software, decides the profile of the patient. The same fixed ratio is used for all subjects whereas there is variation in the ratio for different subjects depending on various factors like lip tonicity, muscle mass of lips, lip strain etc.

Within the limitations of this study, it can be suggested that Nemoceph Software can be used to generate effective prediction for patient motivation before undertaking orthodontic treatment. However, software should be used with caution to avoid unrealistic expectations. The patients must be communicated in clear language that treatment outcome in terms of facial esthetics will be closely related to what is seen in prediction but may not be exactly same, this will help in eliminating patient's dissatisfaction later on.

It must be emphasized that lip tone, thickness, age, gender, complex morphology of the nasomaxillary complex and other soft tissue characteristics guide the soft tissue translations are not the same in each individual, hence results will not be exactly same as prediction generated before starting treatment.

Few studies had evaluated realistic expectations of prediction from patient's point of view.**Kiyak et al**[48] found out that less than 45% of subject who did not see morphed images were satisfied with their aesthetic results. Similarly, **Sarver et al**[49] showed that 89% of the patients believed that the image predictions were realistic and the

desired result were achieved. Also 83% of the patient believed that the imaging process helped them to decide whether to have surgery or not.

To conclude, it can be stated that prediction using Nemoceph software can be used with caution to demonstrate need of extractions and corresponding change in their facial esthetics for subjects with Class I Bimaxillary dentoalveolar protrusion and Class II Div 1 malocclussion.

Further studies must be conducted on larger sample size. Also accuracy of Nemoceph software should be assessed for cases undergoing orthognathic surgery. As two dimensional prediction has their own limitations three dimensional prediction methods must be evaluated in future.

Conclusion

The present study was conducted in the department of Orthodontics and Dentofacial Orthopeadics,Babu Banarasi Das college of Dental sciences, Lucknow with an aim to check the reliability of prediction done using Nemoceph software by comparing the changes in the soft tissue parameters between prediction tracing and post treatment cephalometric tracing in 15 subjects each of Class II Div I malocclusion and Class I Bimaxillary dentoalveolar protrusio in the age range of 18-30. .

Following conclusion can be drawn from the present study:

1)Prediction tracing was relatively more accurate in vertical than horizontal direction.

2)For subjects with Class II div 1 malocclusion, prediction error was noted for parameters-Interlabial gap, Upper lip thickness ,upper and lower lip protrusion to SnPg',lower lip protrusion to E line,upper lip protrusion to TVL and soft tissue B'to TVL,soft tissue Pog' to TVL, as these parameters showed statistically significant difference between prediction tracing and post treatment tracing .

3)For subjects with Class I Bimaxillary Dentoalveolar protrusion, prediction error was seen for Facial Convexity Angle , NB-TVL,NT-TVL,Lower lip length,upper lip thickness,upper lip protrusion,lower lip protrusion and upper lip protrusion to TVL as these parameters showed statistically significant difference between prediction tracing and post treatment tracing.

4) Most of the parameters that showed statistically significant difference between prediction and post tracing had a mean difference less than 2mm that was within clinically acceptable limits except for **Nasolabial angle** ($2.43\pm8.83^{o)}$,**Nasomental angle** (8.95 ± 27.73^{o}) and **Upper lip protrusion to TVL** (2.79 ± 2.81mm) for Group I and **Facial convexity angle (**2.20 ± 1.69^{0}), **Lower lip length (**2.81 ± 2.57mm) and

Upper lip protrusion to TVL (2.41 ± 3.40mm) for Group II that had prediction error > 2mm.

The prediction generated using Nemotech software can be used with caution to demonstrate need of extractions and corresponding changes in the facial esthetics for patients with Class I Bimaxillary dentoalveolar protrusion and Class II Div 1 malocclussion. The lip tone, lip thickness, age, gender, complex morphology of the nasomaxillary complex and other soft tissue characteristics guide the soft tissue translations and are not the same in each individual,,hence results will not be exactly same as prediction generated before starting treatment.

Further studies must be conducted on larger sample size .The software could be upgraded where separate fixed ratio between lip to tooth movement can be used for subjects with thick or thin lips for generating effective prediction and its accuracy can be evaluated.As two dimensional prediction has their own limitation three dimensional prediction methods must be evaluated in future.Also accuracy of Nemoceph software should be assessed for cases undergoing orthognathic surgery.As two dimensional prediction has their own limitations three dimensional prediction methods must be evaluated in future.

Summary

The prediction of treatment outcome is an important part of Orthodontic planning and its presentation to patient is an effective tool for motivating patients to undergo orthodontic treatment. The attempt to predict treatment changes dates back to prediction using Tweed and Steiner's Stick Analysis.

Manual cephalometric analysis has been replaced by computerized cephalometric softwares. Now different cephalometric analysis are just a click away. Besides this ,cephalometric software also provides the ability to easily and accurately perform the treatment simulations and altered soft tissue profile of the patient can be obtained.The morphing tool of cephalometric software produces corrected soft tissue profile from hard tissue movements and when superimposed on facial photographs it can be a excellent motivational tool for the patients.

There is considerable variability in soft tissue changes after treatment due to variations in soft tissue thickness hence soft tissue translation to underlying hard tissue changes is variable .Considering this the soft tissue changes predicted before beginning of treatment need to be assessed for accuracy and reliability.

Many of the previous studies evaluated accuracy and reliability of morphing softwares in cases that had undergone orthognathic surgery and found it to be relatively accurate with small degree of error and could be used for patient education and communication. However, not many studies have evaluated the accuracy of prediction of soft tissue changes after orthodontic treatment alone and results were non conclusive.

None of the studies have compared predicted changes to post treatment cephalometric outcome in subjects undergoing fixed orthodontic treatment using Nemoceph Cephalometric software.Most of the previous studies evaluated accuracy of prediction generated by calculating difference between prediction and post treatment tracing for selected parameters and using the same for generating prediction from pretreament tracing. This removes error arising because of mechanics,operator or individual patient response. Hence it was decided to evaluate the accuracy of Nemoceph software in present study using, a similar method as used in previous studies. In Orthodontic practice, Class II Div 1 malocclusion and Class I Bimaxillary Dentoalveolar protrusion are two most commonly observed malocclusion hence it was decided to include the subjects with these two malocclusion in the present study . Considering this it was decided to conduct this study with an aim to check the reliability of prediction done using Nemoceph software by comparing the changes in the soft tissue parameters between prediction tracing and post treatment cephalometric tracing in subjects with Class II Div I malocclusion and Class I Bimaxillary dentoalveolar protrusion

The sample for this study comprised of two groups ,Group I included 15 subjects (mean age 23$\pm$2.7 years) with Angle's Class II Div 1 malocclusion and Group II included 15 subjects mean age 22$\pm$3.7years) with Class 1 Bimaxillary dentoalveolar protrusion .Pre-treatment and Post-treatment lateral cephalogram were taken of all the subject from the records of the Department of Orthodontics and Dentofacial Orthopaedics, Babu Banarasi Das college of Dental sciences, Lucknow.

To generate prediction tracings, linear and angular hard tissue parameters related to maxillary and mandibular incisors from Steiner's analysis were measured on pre and

post treatment cephalometric tracing and difference in their values were subsequently entered in the" FTO (Facial Treatment Objective) tracing box" of pretreatment tracing.The change in linear measurement during retraction was added in "Horizontal"box and changes in angulation during retraction correction was added in "Rotational" box of the FTO (Facial Treatment Objective) tracing.The movement of hard and soft tissue was visible on the generated prediction and measurement of soft tissue parameters for various cephalometric analysis was obtained from it. Similarly values of different soft tissue parameters were obtained from the post treatment tracing.

A total of 22 soft tissue parameters were measured on generated prediction tracing and post treatment tracing, out of which 18 were linear and 4 were angular.

The following conclusions can be drawn from the study:

1) Prediction tracing was relatively more accurate in vertical than horizontal direction

2) For subjects with Class II div 1 malocclusion, prediction error was noted for parameters-Interlabial gap, Upper lip thickness ,upper and lower lip protrusion to SnPg',lower lip protrusion to E line,upper lip protrusion to TVL and soft tissue B'to TVL,soft tissue Pog' to TVL, as these parameters showed statistically significant difference between prediction tracing and post treatment tracing .

3)For subjects with Class I Bimaxillary Dentoalveolar protrusion, prediction error was seen for Facial Convexity Angle, NB-TVL,NT-TVL,Lower lip length,upper lip thickness,upper lip protrusion,lower lip protrusion and upper lip protrusion to TVL as

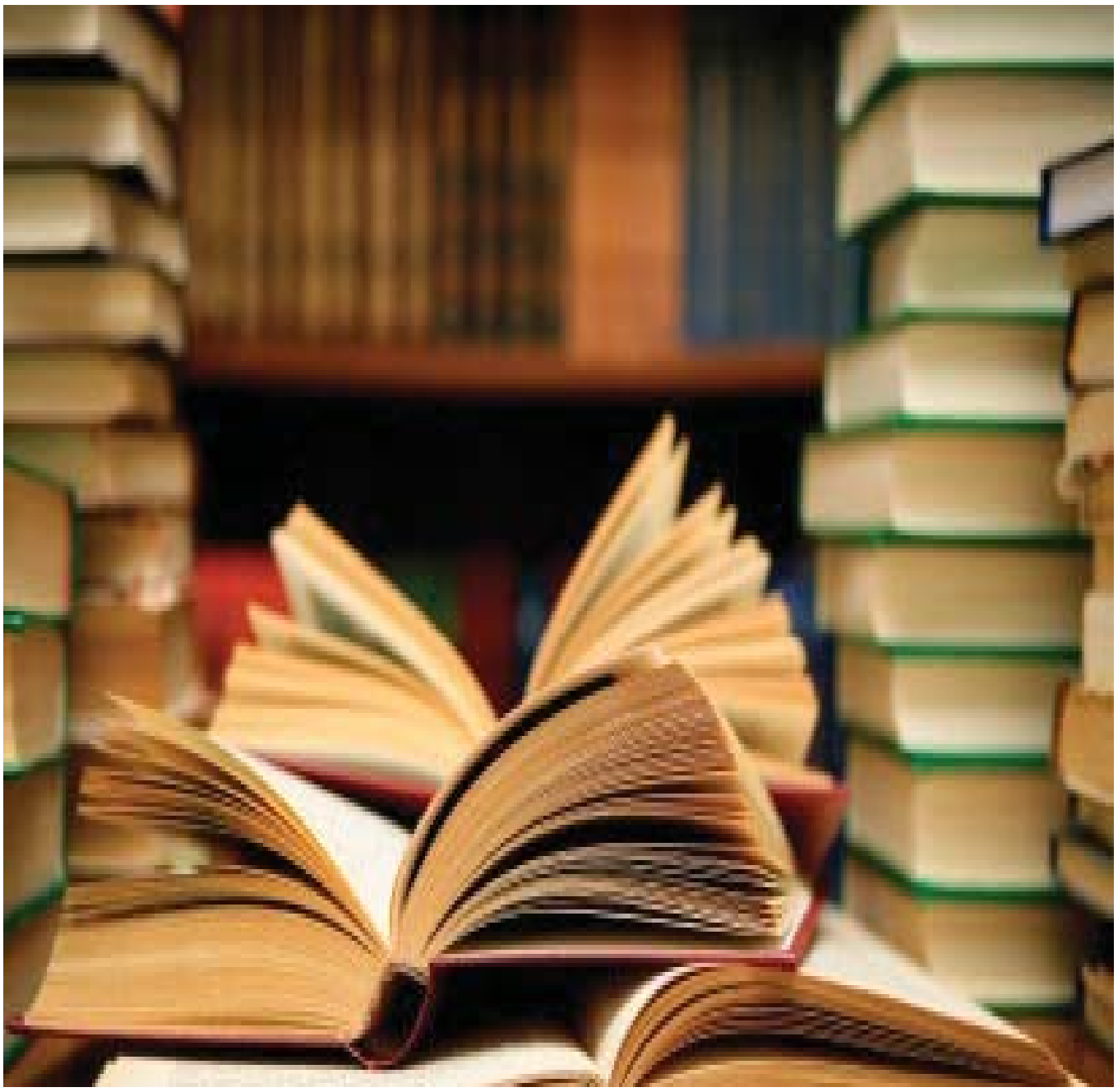
these parameters showed statistically significant difference between prediction tracing and post treatment tracing.

4) Most of the parameters that showed statistically significant difference between prediction and post tracing had a mean difference of less than 2mm that was within clinically acceptable limits except for **Nasolabial angle** ($2.43 \pm 8.83^{o)}$,**Nasomental angle** (8.95 ± 27.73^{o}) and **Upper lip protrusion to TVL** (2.79 ±2.81mm) for Group I and **Facial convexity angle (**2.20 ± 1.69^{0}), **Lower lip length (**2.81 ± 2.57mm) and **Upper lip protrusion to TVL (** 2.41 ± 3.40mm) for Group II that had prediction error > 2mm.

Within the limitations of this study ,it can be suggested that Nemoceph Software can be used to generate effective prediction in subjects with Class I Bimaxillary dentoalveolar protrusion and Class II Div 1 malocclussion and can be used for patient motivation and treatment planning before undertaking orthodontic treatment.However software should be used with caution to avoid unrealistic expectations.The patients must be communicated that facial esthetics will be closely related to what is seen in prediction but may not not be exactly same, this will help in eliminating patient's dissatisfaction later on.

Further studies must be conducted on larger sample size .Also accuracy of Nemoceph software should be assessed for cases underlying orthognathic surgery. The software could be upgraded where separate fixed ratio between lip to tooth movement can be used for subjects with thick or thin lips for generating effective prediction and its accuracy can be evaluated.As two dimensional prediction has their own limitation three dimensional prediction methods must be evaluated in future.

Bibliography



1. Steiner CC. The use of cephalometric as and aid to planning an assessing orthodontic treatment.*Am J Orthod 1960;46:721-35*.
2. Toepel-Sievers C, Fischer-Brandies H. Validity of the computer-assisted cephalometric growth prognosis VTO (visual treatment objective) according to Ricketts. *J Orofac Orthop. 1999;60(3):185-94.*
3. Holdaway RA. A soft-tissue cephalometric analysis and its use in orthodontic treatment planning. Part I. *Am J Orthod. 1983 Jul;84(1):1-28.*
4. Cangialosi TJ, Chung JM, Elliott DF, Meistrell ME Jr. Reliability of computer-generated prediction tracing. Angle Orthod 1995;65:277-84.
5. Kolokitha OE, Chatzistavrou E. Factors influencing the accuracyof cephalometric prediction of soft tissue profifile changes following orthognathic surgery. J Maxillofac Oral Surg 2012; 11:82-90
6. Loh S, Heng JK, Ward-Booth P, Winchester L, McDonald F. A radiographic analysis of computer prediction in conjunction with orthognathic surgery. *Int. J. Oral Maxillofac. Surg. 2001 Aug 1;30(4):259-63.*
7. Aharon PA, Eisig S, Cisneros GJ. Surgical prediction reliability: a comparison of two computer software systems. *Int J Adult Orthodon Orthognath Surg. 1997;12(1):65-78.*
8. Schultes G, Gaggl A, Kärcher H. Accuracy of cephalometric and video imaging program Dentofacial Planner Plus® in orthognathic surgical planning. *Comput Aided Surg. 1998;3(3):108-14*.
9. Pektas ZO, Kircelli BH, Cilasun U, et al: The accuracy of computer-assisted surgical planning in soft tissue prediction following orthognathic surgery. *Int J Med Robot. 2007;3:64-71*.

10. Koh CH, Chew MT. Predictability of soft tissue profile changes following bimaxillary surgery in skeletal class III Chinese patients. *J Oral Maxillofac Surg. 2004;62:1505-9.*
11. .Epker B,N,Fish L.C.Dentofacial Deformities Integrated Orthodontics and Surgical Correction. 2 nd edition Vol II original ISBN 978-08016-7729- published by Elsevier ,Mosby,St.Louis ,Missouri 1980
12. G.william Arnett, Robert T. Bergman Facial keys to orthodontic planning. Part I diagnosis and treatment planning part I American Journal of ORTHODONTICS and DENTOFACIAL ORTHOPEDICS Founded in 1915 Volume 103 Number 4 April 1993
13. Serge Kazandjian, Glenn T. Sameshima ,Thad Champlin, Peter M. Sinclair Accuracy of video imaging for predicting the soft tissue profile after mandibular set-back surgery (Am J Orthod Dentofacial Orthop 1999;115:382-9)
14. Mike Upton,P. Lionel Sadowsky,David M.Sarver and Tim J.Heaven Evaluation of vedioimaging prediction in combined maxillary and mandibular orthognathic surgery. (Am J Orthod Dentofacial Orthop 1997 ;112:656-65)
15. J. Dempsey Smith, Paul M. Thomas, and William R. Proffit A comparison of current prediction imaging programs (Am J Orthod Dentofacial Orthop 2004;125:527-36)
16. Abdullah RT, Kuijpers MA, Bergé SJ, Katsaros C. Steiner cephalometric analysis: predicted and actual treatment outcome compared. *OrthodCraniofac Res. 2006;9:77-83.*

17. Zeynep A, Akcan C, Hakan El, Ciger S. Evaluation of the soft tissue treatment simulation module of a computerized cephalometric program. *Eur J Dent. 2014; 8: 229–233*.
18. Xu Zhang, Li Mei, Xinyu Yan, Jieya Wei, Yanxi Li, Hanshi Li,Zhengzheng Li, Wei Zheng, and Yu Li Accuracy of computer-aided prediction in soft tissue changes after orthodontic treatment (Am J Orthod Dentofacial Orthop 2019;156:823-31)
19. Geoffrey F. walker,Charles J.Kowalski. Use of Angular Measurements in Cephalometric Analyses J Dent Res July-August 1972 Vol 51 No. 4
20. Angelle PL. A cephalometric study of the soft tissue changes during and after orthodontic treatment. Trans Eur Orthod Soc. 1973:267-80. PMID: 4533637.
21. Nigel W.Harradine,David J.Birnie Computer Prediction of the Result of Orthognathic surgery,J.max.fac.Surg.13(1985).
22. Talass FM, Talass L, Baker RC. Soft tissue profile changes resulting from retraction of maxillary incisors. Am J Orthod 1987;91(5):385-394.
23. Finnoy JP. Changes in soft tissue profile during and after orthodontic treatment. Trans Eur Orthod 1987;68-7
24. Donatsky O,Hillerup,Bjern-Jergensen J,Jacobson P.U.Computerized Cephalometric orthognathic surgical simulation prediction evaluation of precision. J Oral Maxillofac Surg 1997 Oct;55(10):1071-9
25. Konstantina A. Konstiantos, Maria T. O'Reilly, DMD, John Close:the validity of the prediction of soft tissue profile changes after LeFort I osteotomy using the dentofacial planner (computer software) Am J Orthod dentofacial orthop 1994:105:241:-9)

26. E. A. Eales, M. L. Jones, C. Newton, A. W. Sugar A study of the accuracy of predicted soft tissue changes produced by a computer software package (COG 3.4) in a series of patients treated by the Le Fort I osteotomy British Journalof Oral and Maxiilofacial Surgery (1995) 33,362-369 .
27. Piyachit Chunmaneechote, Hans Friede Mandibular setback osteotomy: Facial soft tissue behavior and possibility to improve the accuracy of the soft tissue profile prediction with the use of a computerized cephalometric program: QuickCeph Image Pro: v. 2.5 1 *Clin. Orth.* Res. Z, 1999; 85-98 Kusnoto J,
28. Kusnoto H. The effect of anterior tooth retraction on lip position of orthodontically treated adult Indonesians. Am J Orthod 2001;120(3):304-06.
29. R.R.J.Cousley ,E Grant The accuracy of preoperative orthognathic predictions Br J Oral Maxillofac Surg 2004 Apr;42(2):96-104
30. Christel Buck Gossett, Brian Presto, Robert Dunford, Judith Lampasso Prediction Accuracy of Computer –Assisted Surgical visual treatment objective as compared with conventional visual treatment objectives. J Oral Maxillofac Surg 2005 May;63(5):609-17.
31. G. Power, J. Breckon, M. Sherriff, F. McDonald Dolphin Imaging Software: An analysis of the accuracy of cephalometric digitization and orthognathic prediction International Journal of Oral and Maxillofacial Surgery October 2005 34(6):619-26
32. Adilson Luiz Ramosa, Maurı´cio Tatsuei Sakimab, Ary dos Santos Pintob,S. Jay Bowman Upper Lip Changes Correlated to maxillary Incisor Retraction – A Metallic Implant Study. (Angle Orthod 2005;75:499-505)

33. Neelambar R. Kaipatur, Carlos Flores-Mir Accuracy of Computer Programs in Predicting Orthognathic Surgery Soft Tissue Response American Association of Oral and Maxillofacial Surgeons J Oral Maxillofac Surg 67:751-759, 2009
34. Osvaldo Magro-Filho, Natasha Magro-Ernica, Thallita Pereira Queiroz,c Alessandra Marcondes Aranega,and Idelmo Rangel Garcia J Comparative study of 2 software programs for predicting profile changes in Class III patients having double-jaw orthognathic surgery (Am J Orthod Dentofacial Orthop 2010;137:452.e1-452.e5)
35. Carla Maria Melleiro Gimenez Cephalometric evaluation of the predictability of bimaxillary surgical-orthodontic treatment outcomes in long face pattern patients: a retrospective study Dental Press J Orthod Sep-Oct 2013;18(5):53-8.
36. Leonardi R, Annunziata A, Licciardello V, Barbato E. Soft tissue changes following the extraction of premolars in non growing patients with bimaxillary protrusion. Angle Orthod 2010;80(1):211-16
37. B. Khambay, R. Ullah Current methods of assessing the accuracy of the three dimensional soft tissue facial predictions:technical and clinical considerations International associations of Oral and Maxillofacial Surgery (2014)
38. Verma S, Sharma V, Tandon P, Singh G. The impact of extraction vs non extraction treatment on soft tissue profile in borderline class I malocclusion: A cephalometric study. J Ind Orthod Soc 2014;48(1):47-53.
39. Sanofer A. Soft tissue profile changes following treatment with all four first premolars in bimaxillary protrusion cases. IOSR-JDMS 2015;14(10):70-72.
40. Preethita S. Lip changes following anterior teeth retraction in orthodontically treated patients. IJSR 2015;6(7):897-98.

41. Ana de Lourdes Sá de Lira , Walter Leal de Moura , Flávia Artese , Marcos Alan Vieira Bittencourt , Lincoln Issamu Nojima: Surgical prediction of skeletal and soft tissue changes in treatment of Class II Journal of Cranio-Maxillo-Facial Surgery 41 (2013) 198e203
42. Jorge Pérez Villaseñor **Bi-dimensional cephalometric prediction in orthognathic surgery** Revista Mexicana de OrtodonciaVol. 4, No. 3 July-September 2016
43. B.Khambay, R. Ullah: Current methods of assessing the accuracy of threedimensional soft tissue facial predictions: technical and clinical considerations. Int. J. Oral Maxillofac.Surg. 2015; 44: 132–138. # 2014
44. Mattos C. Assessment of facial profile changes in Class II subjects. Dental press J Orthod 2017;19(1):33-37.
45. Jongphairotkhosit J, Suntornlohanakul S, Youravong N. Prediction of lip changes after incisor retraction in class II division 1. IJEDS 2018:7(2):48-53.
46. Arumugam E, Duraisamy S, Ravi K, Krishnaraj R. Prediction of soft tissue profile changes following orthodontic retraction of incisors in south indian females. SRM University Journal of Dental sciences 2019;3(1):10-14
47. Waldman BH. Change in lip contour with maxillary incisor retraction. Angle Orthod 1982;52:129-34
48. Kiyak HA, Bell R, Proffit WR, White RP. Surgical-orthodontic treatment. St Louis: Mosby Year Book. 1991:71-95.
49. Sarver, David M., Mark W. Johnston, and Victor J. Matukas. "Video imaging for planning and counseling in orthognathic surgery." Journal of oral and maxillofacial surgery 46.11 (1988): 939- 945

Annexures

APPENDIX-I

BABU BANARASI DAS COLLEGE OF DENTAL SCIENCES
(FACULTY OF BBD UNIVERSITY), LUCKNOW

INSTITUTIONAL RESEARCH COMMITTEE APPROVAL

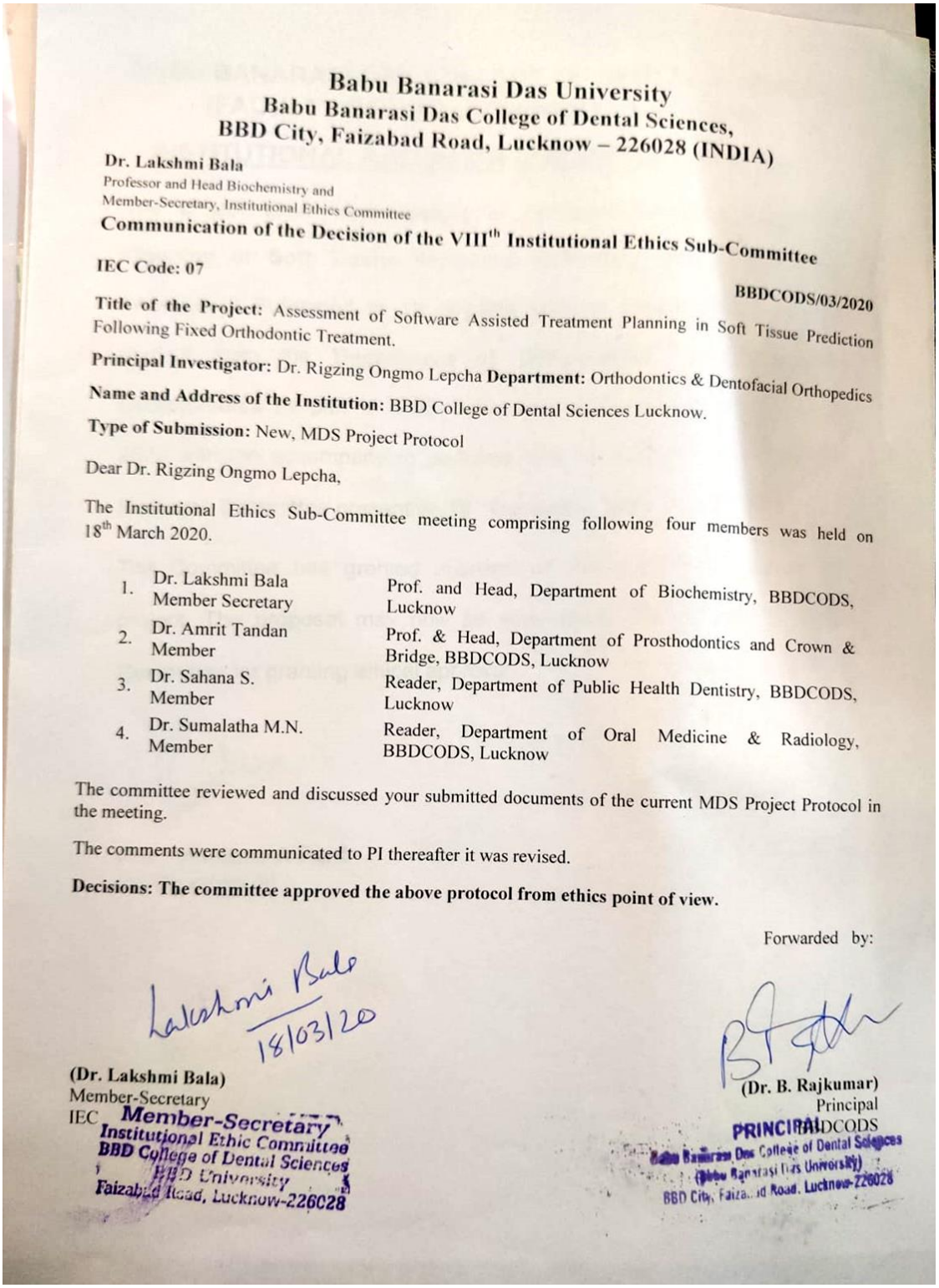
The project titled **"Assessment of Software Assisted Treatment Planning in Soft Tissue Prediction Following Fixed Orthodontic Treatment"** Submitted by **Dr Rigzing Ongmo Lepcha** Post graduate student from the **Department of Orthodontics and Dentofacial Orthopaedics** as part of MDS Curriculum for the academic year 2019-2022 with the accompanying proforma was reviewed by the Institutional Research Committee present on **19th December 2019** at BBDCODS.

The Committee has granted approval on the scientific content of the project. The proposal may now be reviewed by the Institutional Ethics Committee for granting ethical approval.

Prof. Vandana A Pant
Co-Chairperson

Prof. B. Rajkumar
Chairperson

APPENDIX-II



Babu Banarasi Das University
Babu Banarasi Das College of Dental Sciences,
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

Dr. Lakshmi Bala
Professor and Head Biochemistry and
Member-Secretary, Institutional Ethics Committee

Communication of the Decision of the VIII[th] Institutional Ethics Sub-Committee

IEC Code: 07 **BBDCODS/03/2020**

Title of the Project: Assessment of Software Assisted Treatment Planning in Soft Tissue Prediction Following Fixed Orthodontic Treatment.

Principal Investigator: Dr. Rigzing Ongmo Lepcha **Department:** Orthodontics & Dentofacial Orthopedics

Name and Address of the Institution: BBD College of Dental Sciences Lucknow.

Type of Submission: New, MDS Project Protocol

Dear Dr. Rigzing Ongmo Lepcha,

The Institutional Ethics Sub-Committee meeting comprising following four members was held on 18[th] March 2020.

1.	Dr. Lakshmi Bala Member Secretary	Prof. and Head, Department of Biochemistry, BBDCODS, Lucknow
2.	Dr. Amrit Tandan Member	Prof. & Head, Department of Prosthodontics and Crown & Bridge, BBDCODS, Lucknow
3.	Dr. Sahana S. Member	Reader, Department of Public Health Dentistry, BBDCODS, Lucknow
4.	Dr. Sumalatha M.N. Member	Reader, Department of Oral Medicine & Radiology, BBDCODS, Lucknow

The committee reviewed and discussed your submitted documents of the current MDS Project Protocol in the meeting.

The comments were communicated to PI thereafter it was revised.

Decisions: The committee approved the above protocol from ethics point of view.

Forwarded by:

Lakshmi Bala 18/03/20

(Dr. Lakshmi Bala)
Member-Secretary
IEC

Member-Secretary
Institutional Ethic Committee
BBD College of Dental Sciences
BBD University
Faizabad Road, Lucknow-226028

(Dr. B. Rajkumar)
Principal
BBDCODS

PRINCIPAL
Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow-226028

APPENDIX-III

APPENDIX-III

Babu Banarasi Das College of Dental Sciences

(BabuBanarasi Das University)
BBD City, Faizabad Road, Lucknow – 226028 (INDIA)

Consent Form (English)

Title of the Study - ASSESSMENT OF SOFTWARE ASSISTED TREATMENT PLANNING IN SOFT TISSUE PREDICTION FOLLOWING FIXED ORTHODONTIC TREATMENT.

Study Number……..

Subject's Full Name…….

Date of Birth/Age……..

Address of the subject ……

Phoneno.ande-mailaddress…….

Qualification

……

Occupation: Student / Self Employed / Service / Housewife/ Other (Please tick as appropriate)

Annual income of the Subject……

Name and of the nominees(s) and his relation to the subject…… (For the purpose of compensation in case of trial related death).

1. I confirm that I have read and understood the Participant Information Document dated…….for the above study and have had the opportunity to ask questions. **OR** I have been explained the nature of the study by the Investigator and had the opportunity to ask questions.
2. I understand that my participation in the study is voluntary and that I am free to withdraw at any time, without giving any reason and without my medical care or legal rights being affected.
3. I understand that the sponsor of the project, others working on the Sponsor's behalf, the Ethics Committee and the regulatory authorities will not need my permission to look at my health records both in respect of the current study and any further research that may be conducted in relation to it, even if I withdraw from the trial. However, I understand that my Identity will not be revealed in any information released to third parties or published.
4. I agree not to restrict the use of any data or results that arise from this study provided such a use is only for scientific purpose(s).
5. I permit the use of stored sample (tooth/tissue/blood) for future research.

Yes [ ] **No [ ]** **Not Applicable [ ]**

6. I agree to participate in the above study. I have been explained about the complications and side effects, if any, and have fully understood them. I have also read and understood the

participant/volunteer's Information document given to me.
Signature (or Thumb impression) of the Subject/Legally
Acceptable Representative:……...
Signatory's Name……. Date …….
Signature of the Investigator…… Date……..

Study Investigator's Name..... Date…….
Signature of the witness…….. Date……..
Name of the witness……

APPENDIX-IV

Babu Banarasi Das College of Dental Sciences
(Babu Banarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

सहमति पत्र

अध्ययन शीर्षक. सॉफ्ट टिशू प्रेडिक्शन में फिक्स्ड ऑर्थोडोंटिक ट्रीटमेंट के बाद सॉफ्टवेयर असिस्टेड ट्रीटमेंट प्लानिंग का आकलन।
अध्ययन संख्या.....
प्रतिभागी के पूर्ण नाम.....
जन्म तिथि / आयु.....
प्रतिभागी का पता .....
फोन नं. और ई-मेल पता .....
योग्यता .....
व्यवसाय: छात्र / स्व कार्यरत / सेवा / ग्रहिणी .....
अन्य (उचित रुप मे टिक करें) .....
प्रतिभागी की वार्षिक आय .....
प्रत्याशीयो के नाम और प्रतिभागी से संबंध...(परीक्षण से संबंधित मौत के मामले मे मुआवजे के प्रयोजन के लिए)

1. मेरी पुष्टि है कि मैने अध्ययन हेतु सुचना पत्र दिनांक ..... को पढ व समझ लिया तथा मुझे प्रश्न पुछने या मुझे अध्ययन अन्वेषक ने सभी तथ्यों को समझा दिया है तथा मुझे प्रश्न पुछने के समान अवसर प्रदान किए गये।

2. मैंने यहाँ समझ लिया कि अध्ययन में मेरी भागीदारी पूर्णत: स्वैच्छिक है और किसी भी दबाव के बिना स्वतंत्र इच्छा के साथ दिया है किसी भी समय किसी भी कारण के बिना , मेरे इलाज या कानूनी अधिकारो को प्रभावित किए बिना , अध्ययन में भाग न लेने के लिए स्वतंत्र हुँ ।

3. मैंने यह समझ लिया है कि अध्ययन के प्रायोजक , प्रायोजक की तरफ से काम करने वाले लोग, आचार समिति और नियामक अधिकारियों को मेरे स्वास्थ्य रिकार्ड को वर्तमान अध्ययन या आगे के अध्ययन के सन्दर्भ देखने के लिए मेरी अनुमति की जरूरत नही है, चाहे मैने इस अध्ययन से नाम वापस ले लिया है। हॉलाकि मै यह समझता हुँ कि मेरी पहचान को किसी भी तीसरे पक्ष या प्रकाशित माध्यम में नही दी जायेगी।

4. मै इससे सहमत हूँ कि कोई भी डेटा या परिणाम जो इस अध्ययन से प्राप्त होता है उसका वैज्ञानिक उददेश्य (ओं) के उपयोग के लिए मेरी तरफ से कोई प्रतिबंध नही है।
5. भविष्य के अनुसंधान के लिए भंडारित नमूना (ऊतक/रक्त) पर अध्ययन के लिए अपनी सहमति देता हुँ।

हाँ [ ] नही [ ] अनउपयुक्त [ ]

6. मै परीक्षण की अनुमति देता हुँ। मुझे इसके द्वारा यदि कोई परेशानी होती है, इसके बारे में जानकारी दे दी गई है। मैने रोगी जानकारी सूचना पत्र को पढ तथा समझ लिया है।

प्रतिभागी / कानूनी तौर पर स्वीकार्य प्रतिनिधि का हस्ताक्षर (या अंगूठे का निशान.....

हस्ताक्षरकर्ता का नाम..... दिनांक .....अन्वेषक के

हस्ताक्षर ..... दिनांक .....

अध्ययन अन्वेषक का नाम .....

गवाह के हस्ताक्षर ..... दिनांक .....गवाह के

नाम .....

मैनें पीआईडी और विधिवत भरे सहमति फार्म का एक हस्ताक्षर की नकल प्राप्त की.

प्रतिभागी कानूनी तौर पर प्रतिनिधि का हस्ताक्षर/ अंगूठे का निशान ..... दिनांक.....

APPENDIX-V

Babu Banarasi Das College of Dental Sciences
(A constituent institution of BabuBanarasi Das University)
BBD City, Faizabad Road, Lucknow – 227105 (INDIA)

Participant Information Document (PID)

1. **Study title**

   Assessment of software assisted treatment planning in soft tissue prediction following fixed orthodontic treatment.

2. **Invitation paragraph**

   You are being invited to take part in a research study. It is therefore important for

   you to understand why the study is being done and what it will involve. Please take time to read the following information carefully. Ask us for any clarifications or further information. Whether or not you wish to take part is your decision.

3. **What is the purpose of the study?**

   The purpose of this study is to assess and compare the aesthetic outcome after prediction tracing and actual post treatment cephalometric tracing.

4. **Why have I been chosen?**

   Not applicable

5. **Do I have to take part?**

   Not applicable.

6. **What will happen to me if I take part?**

   Not applicable

7. **What do I have to do?**

   Not applicable

8. **What is the procedure that is being tested?**

To compare the changes in the soft tissue parameters between prediction tracing and actual post treatment cephalometric tracing done.

9. What are the interventions for the study?

The purpose of this study is to assess and compare the aesthetic outcome after prediction tracing and actual post treatment cephalometric tracing.

10. What are the side effects of taking part?
Not applicable

11. What are the possible disadvantages and risks of taking part?

Not applicable

12. What are the possible benefits of taking part?

As changes in soft tissue profiles can vary with differentiation patterns, it can , therefore be considered during orthodontic diagnosis and treatment planning to achieve optimal soft tissue profiles.

13. What if new information becomes available?

Not applicable

14. What happens when the research study stops?

Not applicable

15. What if something goes wrong?

If any severe adverse event occurs, or something goes wrong during the study, the complaints will be handled by reporting to the institution (s), and Institutional ethical committee.

16. Will my taking part in this study be kept confidential?

Yes it will be kept confidential.

17. What will happen to the results of the research study?

Result is the soul properties of the department of the Orthodontics BBDCODS Lucknow.Your identity will be kept confidential in case of any report/publications.

18. Who is organizing the research?

This research study is organized by Department of Orthodontics and Dentofacial

Orthopaedics, BBDCODS Lucknow.

19. Will the results of the study be made available after study is over?

Yes.

20. Who has reviewed the study?

The study has been reviewed and approved by the Head of the Department of Orthodontics and Dentofacial Orthopaedics, and the (IEC) (IRC) of the institution.

Contact for further information

Dr Rigzing O.Lepcha
PG student
Department of Orthodontics and
Dentofacial Orthopedics
BabuBanarasi College of Dental
Sciences.
Lucknow-226028
Email rigzing3001@gmail.com
Mob -9800921280

Dr. Lakshmi Bala,
Member Secretary IEC
Babu Banarasi College of
Dental Sciences.
Lucknow
bbdcods.iec@gmail.com

Signature of PI…….
Name……
Date ……

APPENDIX-VI

बाबू बनारसी दास कॉलेज ऑफ़ डेंटल साइंस
•बाबू बनारसी दास विश्व विद्यालय के एक घटक संस्था• •
बीबीडी सिटी••फैजाबाद रोड••लखनऊ •••••••••भारत• •
प्रतिभागी जानकारी दस्तावेज़ •पीआईडी• •

आपको कुछ नही होगा•केवल एकसरे के उपयोग की अनुमति देना होगा

•••अध्यन्न ख़िताब

सॉफ्ट टिशू प्रेडिक्शन में फिक्स्ड ऑर्थोडोंटिक ट्रीटमेंट के बाद सॉफ्टवेयर असिस्टेड ट्रीटमेंट प्लानिंग का आकलन।

I

•••निमंत्रण पैरा

आपको इस शोध में भाग लेने के लिए आमंत्रित किया जा रहा है••इसलिए यह समझना आवश्यक है की यह अध्यन्न क्यों किया जा रहा है और इसमें क्या शामिल होगा •कृपया निम्न जानकारी को सावधानी पूर्वक पढ़ें •किसी भी स्पष्टीकाण के लिए हमें पूछे •आप भाग लेना चाहते है या नहीं आपका निर्णय है •

•••अध्यन्न का उद्देश्य क्या है ••

इस अध्ययन का उद्देश्य भविष्यवाणी ट्रेसिंग और वास्तविक पोस्ट ट्रीटमेंट सेफेलोमेट्रिक ट्रेसिंग के बाद सौंदर्य परिणाम का आकलन और तुलना करना है।

•••मैं क्यों चुना गया हूँ ••

आपने हमारे विभाग में दॉत उखाड कर तारों का इलाज कराया है जिसके लिए आपके एकसरे•ट्रीटमेंट से पहले और ट्रीटमेंट संपनन होने के बाद लिए गए थे जिनका उपयोग इस अधयन में होगा।

•••क्या इसमें मुझे भाग लेना चाहिए

अपने एकसरे को इसतेमाल करने की अनुमति दे कर आप इस अधयन में सहयोग कर सकते हैं

•••क्या होगा यदि मैं इस अध्यन्न में भाग लेता हूँ ••

आपको कुछ नही होगा,केवल एकसरे के उपयोग की अनुमति देना होगा

••मुझे क्या करना होगा••

केवल आपसे अनुमति चाहिए

•••किस प्रक्रिया का परीक्षण किया जा है ••

पृडिकशन ट्रेसिंग और वास्तविक पोस्ट ट्रीटमेंट सेफेलोमेट्रिक ट्रेसिंग के बीच किए गए नरम ऊतक मापदंडों में परिवर्तन का तुलनातमक अधयन होगा

•••इस शोध में कौन से हस्तक्षेप दिए जायेंगे ••

इस अध्ययन का उद्देश्य भविष्यवाणी ट्रेसिंग और वास्तविक पोस्ट ट्रीटमेंट सेफेलोमेट्रिक ट्रेसिंग के बाद सौंदर्य परिणाम का आकलन और तुलना करना है।

•••इस अध्यन्न में भाग लेने का क्या दुष्प्रभाव है ••

इस अध्यन्न के मरीजो पर कोई दुष्प्रभाव नही होते है ।

••••इस अध्यन्न में भाग लेने के संभावित जोखिम और नुक्सान क्या है••

इस अध्यन्न में भाग लेने में कोई जोखिम या संभावित नुकसान नही है ।

••••भाग लेने के संभावित लाभ क्या है ••

पृडिकशन ट्रेसिंग से तारों के इलाज के बाद होने वाले बदलाव को पहले जानने से मरीज को समझाना आसान होगा

••••यदि कोई नयी जानकारी उपलब्ध हो जाती है ••

यदि अनुसंधान के दौरान अतिरिक्त जानकारी उपलब्ध हो जाती है तो आपको इनके बारे में बताया जाएगा और आप अपने शोधकर्ता के साथ चर्चा करने के लिए स्वतंत्र हैं, आपका शोधकर्ता आपको बताएगा कि क्या आप अध्ययन को जारी रखना चाहते हैं। यदि आप तय करते हैं तो वापस लेने, आपका शोधकर्ता आपके वापसी के लिए व्यवस्था करेगा अगर तुम अध्ययन में जारी रखने का निर्णय लेते हैं, तो आपको एक अद्यतन सहमति फॉर्म पर हस्ताक्षर करने के लिए कहा जा सकता है।

••••जब शोध अध्यन्न बंद हो जाता है तो क्या होता है••

अध्यन्न बंद हो जाता है ••निर्धारित समय से पहले ख़त्म हो जाता है मरीज ••स्वयंसेवक के लिए समझाया जाएगा ।

••••क्या कुछ गलत हो सकता है••

ऐसा होने की कोइ समभावना नही है•केवल आपके एकसरे का उपयोग होगा

••••इस अध्ययन में मेरे हिस्से को गोपनीय रखा जाएगा••

हाँ••यह गोपनीय रखा जाएगा।

••••शोध अध्ययन के परिणामों का क्या होगा••

परिणाम ऑर्थोडान्टिक्स और डेंटोफेसियल ऑर्थोपेडिक्स दन्त चिकित्सा विज्ञानं के बाबू बनारसी दास कॉलेज लखनऊ के विभाग की कॉपी होगी । किसी भी रिपोर्ट / प्रकाशन के मामले में आपकी पहचान को गोपनीय रखा जाएगा।

Curiginal

Document Information

Analyzed document	rigzing Thesis pleg.pdf (D131778206)
Submitted	2022-03-28T12:09:00.0000000
Submitted by	Kamna srivastava
Submitter email	dramitn99@bbdu.ac.in
Similarity	5%
Analysis address	dramitn99.bbduni@analysis.urkund.com

Sources included in the report

W	URL: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3238557/ Fetched: 2020-02-06T04:49:18.4270000	5
SA	**plag CSJ.doc** Document plag CSJ.doc (D121558490)	1
W	URL: https://mansapublishers.com/index.php/jofr/article/download/1685/1304/3570 Fetched: 2020-12-02T12:16:41.2470000	5
W	URL: http://saspublisher.com/wp-content/uploads/2019/01/SJAMS-612-4876-4881c.pdf Fetched: 2020-12-02T12:16:42.3370000	1
SA	**Dr SANGEETHA R V.pdf** Document Dr SANGEETHA R V.pdf (D113083977)	3
SA	**26. Appendix 7.pdf** Document 26. Appendix 7.pdf (D92440440)	2
SA	**final thesis (4).docx** Document final thesis (4).docx (D124042468)	1
SA	**SOFT TISSUE ANALYSIS edited.docx** Document SOFT TISSUE ANALYSIS edited.docx (D63505141)	2

MASTER CHART

S.No	Name of patient	Soft tissue parameters				
		Facial convexity angle			Nasal base length(NB-TVL)	
		Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement
1	Neha Singh	164.7	163.5	1.2	-5.5	-4.7
2	Priyanka singh	162.9	159	3.9	-2.6	-3.5
3	Manish kumar	159.8	156.8	3	-4.5	-4.5
4	Reena Pradhan	168.3	164.8	3.5	-1	-2.7
5	Dakshita pandey	160.7	165	-4.3	-3.4	-3.1
6	Tausif khan	165.6	166.7	-1.1	-2	-1.8
7	Shivam kumar	160.9	167.1	-6.2	-3.3	-3.2
8	Simpi Singh	160.6	160.6	0	-1.4	-2
9	Shivam kumar	161.5	167.1	-5.6	-3.9	-4.6
10	Tejasvani Prakash	161.3	162.5	-1.2	-5.6	-4.6
11	Shalini Singh	158.6	158.3	0.3	-4.8	-4.3
12	Neetu Verma	165.4	165.7	-0.3	-2.1	-1.5
13	Akash Puniya	164.3	164.7	-0.4	-3.3	-2.7
14	Arti singh	160.7	163.8	-3.1	-6.7	-2.9
15	Ashutosh Kumar	159.3	159.8	-0.5	-4.8	-5.3
		162.2636364	162.8545455		-3.454545455	-3.545454545
		2.863310227	3.702799923		1.581368797	1.072719569

	Nasal projection(NT-TVL)			Nasolabial angle(Cm-Sn-Ls)		
Difference	Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement	Difference
-0.8	7.6	5.7	1.9	129.8	138.1	-8.3
0.9	9.2	8.3	0.9	113	111.6	1.4
0	7.6	7.4	0.2	122.1	124	-1.9
1.7	8.4	6.8	1.6	104.3	133.1	-28.8
-0.3	8.7	13.6	-4.9	129.2	124.5	4.7
-0.2	10.1	8.6	1.5	119.1	116.7	2.4
-0.1	10	7.7	2.3	111.9	102.5	9.4
0.6	7.5	7.3	0.2	123.5	128.1	-4.6
0.7	8.6	6.3	2.3	106.2	102.5	3.7
-1	7.7	7.9	-0.2	107.8	114.2	-6.4
-0.5	7.8	7.4	0.4	118.8	118	0.8
-0.6	7.6	7.7	-0.1	116.9	124	-7.1
-0.6	7.1	6.8	0.3	128.5	133.6	-5.1
-3.8	7.6	10	-2.4	115.1	114.4	0.7
0.5	5.7	8.4	-2.7	115.4	112.8	2.6
	8.472727273	7.909090909		116.8818182	119.3909091	
	0.954034495	2.065165633		8.905146622	11.5264439	

Nasomental angle			Interlabial gap		
Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement	Difference
26.5	132.8	-106.3	8.3	2.2	6.1
119.9	125.6	-5.7	5.2	0.7	4.5
122	116.7	5.3	4.6	1	3.6
131.5	127.5	4	4	0.3	3.7
127.8	123.1	4.7	5.1	1.6	3.5
124.5	128	-3.5	0.4	2.2	-1.8
123.9	132.1	-8.2	0.6	0.8	-0.2
122.4	125.4	-3	4.1	2.1	2
123.8	132.1	-8.3	1.4	0.8	0.6
122.3	132.3	-10	0.3	0.2	0.1
121.2	119	2.2	4.8	2.5	2.3
130.1	127.9	2.2	2.9	1.2	1.7
130.2	132.6	-2.4	7.1	1.2	5.9
129.2	129.9	-0.7	1.0	3.3	-2.3
117.1	121.6	-4.5	2.2	2.3	-0.1
115.0727273	126.7818182		3.527272727	1.309090909	
29.55449512	5.516306406		2.542868817	0.833612075	

Upper lip length			Lower lip length		
Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement	Difference
15.4	12.8	2.6	33.2	28	5.2
11.5	12.2	-0.7	27.5	29.2	-1.7
13	13.1	-0.1	29.9	30.4	-0.5
11.7	13.6	-1.9	20.6	24.3	-3.7
12.7	16.5	-3.8	28.5	41.5	-13
15.5	13.4	2.1	36.4	31.5	4.9
12.9	15	-2.1	29	32.2	-3.2
10.7	11.7	-1	23.3	26.7	-3.4
15.1	15	0.1	35.4	32.2	3.2
11.2	11.7	-0.5	25.9	28.2	-2.3
13.5	14.8	-1.3	24.3	26.6	-2.3
11.8	11.3	0.5	23.3	26.1	-2.8
11.3	13.5	-2.2	31.8	36.3	-4.5
10.6	12.4	-1.8	23.4	25.7	-2.3
13.4	13.7	-0.3	26.8	28.7	-1.9
13.01818182	13.61818182		28.54545455	30.07272727	
1.709864428	1.54519784		4.991465443	4.550844078	

Upper lip thickness			Lower lip thickness		
Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement	Difference
7.6	8.1	-0.5	10.8	6.8	4
7.9	9.3	-1.4	9.9	7.6	2.3
7.1	7.1	0	7.5	8.3	-0.8
6.1	7.3	-1.2	8.5	6.6	1.9
7.2	11.9	-4.7	8.4	8.4	0
8.3	9	-0.7	8.7	8.9	-0.2
9.1	10.4	-1.3	6.9	8	-1.1
6.3	6.8	-0.5	6	6.6	-0.6
8.2	10.4	-2.2	8.6	8	0.6
5.2	7.2	-2	8.6	6.1	2.5
7.2	8.5	-1.3	7	9.5	-2.5
6.4	7.6	-1.2	8.5	7.4	1.1
9	7.5	1.5	11.2	9.3	1.9
5.8	7.6	-1.8	6.3	9.9	-3.6
6.8	6.4	0.4	9.5	6.9	2.6
7.290909091	8.727272727		8.263636364	7.709090909	
1.113960992	1.650509563		1.369870598	1.072804312	

Upper lip protrusion			Lower lip protrusion		
Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement	Difference
5.3	4.1	1.2	-3.1	-3.5	0.4
1.7	2.6	-0.9	-0.3	-3	2.7
0.8	3.3	-2.5	-3.4	-4.6	1.2
0.9	1.2	-0.3	-1.5	-1.1	-0.4
-1.4	3	-4.4	-0.2	-1.3	1.1
1.9	3.1	-1.2	-2.8	-2.2	-0.6
0.6	3.7	-3.1	1	-2.4	3.4
1.5	2.9	-1.4	-3.3	-3.4	0.1
0.8	2.6	-1.8	-2	-1.8	-0.2
-1.5	0.3	-1.8	1.3	0.9	0.4
3.4	4.7	-1.3	-3.6	-5.5	1.9
2.6	2.4	0.2	-3.9	-2.2	-1.7
-2.2	1.8	-4	-1.6	-3.9	2.3
1.7	4.4	-2.7	-2.2	-5.3	3.1
0.7	1.5	-0.8	0.8	-0.3	1.1
1.272727273	2.863636364		-1.627272727	-2.536363636	
1.929813934	1.238767716		1.811127223	1.760836578	

Lip protrusion to Rickett's E line			Upper lip protrusion to TVL		
Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement	Difference
0.6	2.1	-1.5	3	2.5	0.5
-1.9	-0.2	-1.7	-6.3	1.2	-7.5
-0.5	1.3	-1.8	-0.7	1.5	-2.2
-0.9	-0.9	0	0.1	0.5	-0.4
-2.6	-4.2	1.6	-2.7	2.1	-4.8
-1.6	-1.2	-0.4	0.4	2.5	-2.1
-4.3	-1.1	-3.2	-7.2	2.7	-9.9
0.6	0.5	0.1	0.2	1.7	-1.5
-1.4	-1.1	-0.3	-0.8	1.3	-2.1
-4.7	-3.9	-0.8	-3.1	-1	-2.1
1.1	2.1	-1	1.7	3.3	-1.6
0.8	-0.9	1.7	1.3	1.6	-0.3
-1.1	-0.1	-1	-2.9	1.5	-4.4
0.1	2.1	-2	0.8	3.2	-2.4
-3.8	-2.2	-1.6	-1.5	-0.5	-1
-1.418181818	-0.6		-1.4	1.663636364	
1.906209947	2.106181379		3.163858404	1.190187151	

Lower lip protrusion to TVL			Merrifield Z angle		
Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement	Difference
-2	-0.1	-1.9	66	61.7	4.3
-1.5	-9.9	8.4	74.6	67.1	7.5
-0.8	1	-1.8	74	66	8
-0.5	-0.1	-0.4	71.2	69.8	1.4
-3.5	-0.9	-2.6	78.2	81	-2.8
-0.7	0.9	-1.6	72.8	72.2	0.6
-4.5	0.6	-5.1	74.9	70.8	4.1
-0.3	0.8	-1.1	62.6	62.4	0.2
-0.9	0.8	-1.7	65.6	70.8	-5.2
-4	-3.4	-0.6	84	82.6	1.4
-1	1.5	-2.5	60.4	57.4	3
0.3	0.4	-0.1	57.6	65.3	-7.7
-1.2	2.2	-3.4	77.6	73.5	4.1
-2.2	-5.3	3.1	62.7	64.1	-1.4
-5.3	-2.9	-2.4	85.2	81.9	3.3
-1.790909091	-0.8		71.3	69.25454545	
1.508280177	3.302423353		7.052517281	7.678719117	

Chin thickness at menton			Chin thickness at pogonion		
Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement	Difference
5.8	4.6	1.2	9.7	9.4	0.3
4.4	3.8	0.6	7.1	6.7	0.4
3.1	2.1	1	4.8	4.4	0.4
2.6	3.6	-1	6	7.2	-1.2
4	3.3	0.7	6.8	12.4	-5.6
7	5.9	1.1	9.6	8.4	1.2
5.3	5.9	-0.6	8.6	7.6	1
2.5	2.4	0.1	3.3	3.5	-0.2
6.3	5.9	0.4	5.5	7.6	-2.1
5	6.2	-1.2	10.5	10.3	0.2
3.6	3.2	0.4	5.6	5.4	0.2
3.3	3.5	-0.2	5.8	5.7	0.1
2.4	3	-0.6	5.2	7.6	-2.4
2.8	4.1	-1.3	5.6	5.9	-0.3
6.8	6.9	-0.1	8.4	9.1	-0.7
4.509090909	4.263636364		7.045454545	7.536363636	
1.50695358	1.508822539		2.294063485	2.588927472	

Inferior labial sulcus			Soft tissue pogonion to TVL		
Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement	Difference
-4.8	-3.7	-1.1	-7.9	-6.4	-1.5
-4.8	-4.2	-0.6	-4.6	-5.9	1.3
-2.3	-1.3	-1	-6.8	-7.4	0.6
-3.1	-3.9	0.8	-2.9	-2.2	-0.7
-3.4	-6.5	3.1	-7	-3.2	-3.8
-4.6	-5.6	1	-5.9	-2.2	-3.7
-5	-4.5	-0.5	-6.5	-3.4	-3.1
-0.8	-0.8	0	-6.9	-4.9	-2
-3	-4.5	1.5	-6.3	-4.8	-1.5
-4.6	-3.6	-1	-4.8	-4.6	-0.2
-3.8	-3.7	-0.1	-7.5	-5.9	-1.6
-2.5	-2.3	-0.2	-5.5	-3.3	-2.2
-2.9	-3.1	0.2	-4.7	-1.6	-3.1
-2.3	-4.5	2.2	-3.7	-4.8	1.1
-4.7	-5.3	0.6	-7	-5.7	-1.3
-3.654545455	-3.845454545		-6.1	-4.627272727	
1.304885923	1.642171511		1.468332387	1.717609332	

Soft tissue Point A' to TVL			Soft tissue Point B' to TVL		
Prediction measurement	Post treatment measurement	Difference	Prediction measurement	Post treatment measurement	Difference
0.9	0.5	0.4	-8.5	-6.3	-2.2
-1	-1.9	0.9	-7.9	-6.4	-1.5
-0.9	-1.2	0.3	-5.6	-4	-1.6
0.4	-0.7	1.1	-4.5	-4.9	0.4
-1.5	-0.8	-0.7	-7.9	-8.2	0.3
-0.5	-0.2	-0.3	-6.8	-6.2	-0.6
-2.6	-1.1	-1.5	-10.3	-5.1	-5.2
-0.1	-1	0.9	-3.1	-2.1	-1
0.6	-1.5	2.1	-5.6	-6.5	0.9
-1	-2.1	1.1	-9	-7.5	-1.5
0.3	-0.3	0.6	-8.2	-6.2	-2
-0.4	-0.9	0.5	-4.4	-3.4	-1
-0.9	-0.5	-0.4	-4.6	-1.1	-3.5
-0.5	0.6	-1.1	-3.5	-4.6	1.1
-1.6	-2.2	0.6	-10.3	-9.3	-1
-0.490909091	-0.936363636		-7.036363636	-5.763636364	
1.041589694	0.760621755		2.135543363	1.68182801	