Original Article

To cite:

Shobhit Saxena, Bhushan BhausingThoke, Anagha Agrawal, Veerendra V. Kerudi, MrunalAley, Shweta Mishra

Comparison of Reference Distance of soft tissues of face using Direct and Indirect method:A cross-sectional study

J Contemp Orthod 2021;5(2): 6-12.

Received on: 20-05-2021

Accepted on: 23-06-2021

Source of Support: Nil

Conflict of Interest: None

Comparison of Reference Distance of soft tissues of face using Direct and Indirect method:A cross-sectional study

[1]Shobhit Saxena, [2]Bhushan Bhavsing Thoke, [3]Anagha Agrawal, [4]Veerendra V. Kerudi, [5]MrunalAley, [6]Shweta Mishra

[1,2]Reader, [3]Senior Lecturer,[4]Professor and Head, [5]Professor, [6]PG Student

[1-6]Department of Orthodontics and Dentofacial Orthopaedics, ACPM Dental College, Sakri Road, Dhule.

ABSTRACT

Background: Orthodontic diagnosis involves development of a comprehensive database of pertinent information which is derived from case history, clinical examination and other diagnostic aids such as study cast radiographs and photographs. One of the most important is to evaluate the soft tissues of the face.

Aim: To classify the reliability of the five reference distances **Sa-Sba** (superior auricula-subauricula), **T-Ex** (tragus-exocanthion) on the profile view, and **Ex-Ex** (exocanthion-exocanthion), **En-En** (endocanthion-endocanthion), and **P-P** (pupil center-pupil center) on the frontal view.

Methodology: Total 100 subjects were included in this cross-sectional study of 18-13 years of age. Direct measurements were taken directly on face using calliper. Indirect measurements were taken on the photographs that were taken and subjected into software for measurement. Measurements taken by both methods were compared using paired t test.

Result: Differences between the direct and indirect measurements of N-Sn, N-Prn, Prn-Sn, Sn-Sto and Sn-Me in both the genders were statistically significant as well as for direct measurements and indirect measurements derived from Sa-Sba reference line.

Conclusion: The findings from this study can be incorporated into routine orthodontic records, diagnosis and treatment planning.

Key words: Reference distance, Soft tissue, Direct method, Indirect method, UTHSCSA-ImageTool.

INTRODUCTION

In orthodontics, diagnosis deals with recognition of various characteristics of malocclusion. It involves collection of pertinent data in a systematic manner to help in identifying the nature and cause of the problem. Orthodontic diagnosis involves development of a comprehensive database of pertinent information. The data is derivedfrom case history, clinical examination and other diagnostic aids such as study cast radiographs and photographs. One of the most important factors in the planning any orthodontic treatment and the assessment of treatment changes is to evaluate the soft tissues of the face.[1]

Soft tissue evaluation of facial tissues has been carried out by means of different methods such as anthropometry, Cephalometry, two or three dimensional photogrammetry, and three-dimensional imaging techniques.Anthropometry meansmeasurement of the face and it has been a widely accepted method for quantitative assessment of facial surface anatomy.[2] But it has several limitations. The technique is restricted to direct measurement of linear distances between landmarks and subject to operator errors from different degrees of deformation of soft tissue by direct contact of instruments. The technique is also inadequate for the task of three-dimensional surface characterisation and shape measurement.[3]

Cephalometry has been used to diagnose, treatment plan and predict hard tissue and soft tissue responses to the orthodontic treatment.[4] Unfortunately, reliance on cephalometric analysis and treatment planning sometimes leads to aesthetic problems.[5]The soft tissue covering the teeth and the bone can vary so greatly that the dento-skeletal pattern may be inadequate in evaluating facial disharmony.[6]Also each cephalometric study examines different measurements as being the key to diagnosis.

Therefore, when different cephalometric analyses are used to examine the same patient, different diagnosis, treatment plans and results can be generated. This is a major limitation of cephalometry.[6]

Recent advances in the field of digital radiography have overcome this problem with the introduction of digital lateral cephalogram. These provide excellent sharp radiographs with good contrast on which anatomic landmarks can be easily identified with great precision. Hence the percentage of error with digital cephalometry is extremely low. However, it still exposes the patient to radiation. Exposure of patient to X-rays carries small amount of risk as dental radiography is supposed to contribute about 1/3rd of all medical exposures.[7]

The problem with 3-D techniques is well known that though it is very accurate in locating and analyzing the soft tissues; but it is very costly and not meant for every group of people in our society.[8]Therefore 2-D imaging techniques are gaining importance in the coming years.Photogrammetryis defined as "the art, science, and technology of obtaining reliable information about physical objects and the environment through processes of recording, measuring, and interpreting photographic images and patterns of recorded radiant electromagnetic energy and other phenomena".[9]

The determination of the reliability of 2-dimensional photogrammetry for soft tissue evaluation might provide clinicians the ability to assess soft tissue from both profile and frontal views after orthodontic treatment. It also has the advantage of being a basic, non-invasive, cost-effective and quick method that requires minimal time and equipment in the assessment of soft tissue.[10]

Most of the studies about soft tissue evaluation on standardized two dimensional life-sized photographs reported the assessment or comparison of racial characteristics, differences between genders and treatment changes.[11] Since then, researchers have never attempted to study the reliability of reference distances that can be used for photogrammetric assessment. Nonetheless, such information is important for clinicians because the reliability of the measurements obtained from the photographs depends on the reliability of the reference distances used on photographs.

Therefore, the aim of our study was to classify the reliability of the five reference distances those were**Sa-Sba** (superior auricula-subauricula), **T-Ex** (tragus-exocanthion) on the profile view, and **Ex-Ex** (exocanthion-exocanthion), **En-En** (endocanthion-endocanthion), and **P-P** (pupil center-pupil center) on the frontal view.

MATERIALS AND METHODS

This study was conducted in the Department Of Orthodontics and Dentofacial Orthopedics, Rural Dental College of Pravara Institute of Medical Sciences, Loni from June 2010 to October 2011. Total 100 (50=male, 50=female) participants were selected according to eligibility criteria from students studying in Rural Dental College of Pravara Institute of Medical Sciences, Loni.The subjects were selected randomly using lottery method. The ethical clearance was obtained from the Institutional Review Board of the PravaraInstitute of Medical Sciences, Deemed University. The participants were given brief information about the study and voluntary written informed consent was taken from them before the commencement of study.

Inclusion Criteria:

1. Participants with 18-23 years of age
2. Participants who agreed to give informed consent
3. Participants who had symmetrical face

Exclusion Criteria:

1. Subjects with history of trauma
2. Subjects with history of previous orthodontic treatment
3. Subjects with craniofacial anomalies

REPRODUCIBILITY

Both direct and indirect measurements were recorded by single examiner (SS). The examiner was calibrated with gold standard examiner (NGT) before commencement of the study and the kappa statistics for the same was 0.68. The intra-examiner reliability was also checked and it came to 0.74. Both direct and indirect measurements were recorded by single examiner (SS).

MEASUREMENTS TAKEN BY DIRECT METHOD

The Direct measurements on each subject's face were done with a millimetric compass- Digital Vernier Callipers (FG-900125-CS-013, ANY). The subjectswere seated on a stool and were told to look straight and not to move the head otherwise the beaks of the calliper could hurt them. All the subjects were positioned in centric relation, relaxed lip posture and natural head orientation. Seven frontal and seven lateral distances were measured directly on subjects face. Each measurement was repeated three times by the same investigator following a one week interval, and then mean values were recorded.

The measurements taken from frontal view were Ex-Ex (right exocanthion-left exocanthion) biocular width, En-En (right endocanthion-left endocanthion) intercanthal width (as shown in Fig 1), P-P (midpoint of right pupil-midpoint of left pupil) interpupillary width, Al-Al (right alare-left alare) alar width, Ch-Ch (right cheilion-left cheilion) mouth width, Go-Go (right gonion-left gonion) gonial width, and Sn-Sto (subnasale-stomion) upper lip height.The measurements taken from profile view were T-Ex (tragus-exocanthion) tragus-exocanthion distance, Sa-Sba (superaurale-subaurale – Fig 2) ear length,Sn-Me (subnasale-menton) inferior facial third,N-Sn (nasion-subnasale) nose height or middle facial third, N-Prn (nasion-pronasale) nasal bridge length, Prn-Sn (pronasale-subnasale) nasal tip protrusion and Sn-Sto (subnasale-stomion) upper lip height.

Fig. 1: Measurements taken by direct method – Intercanthal width.

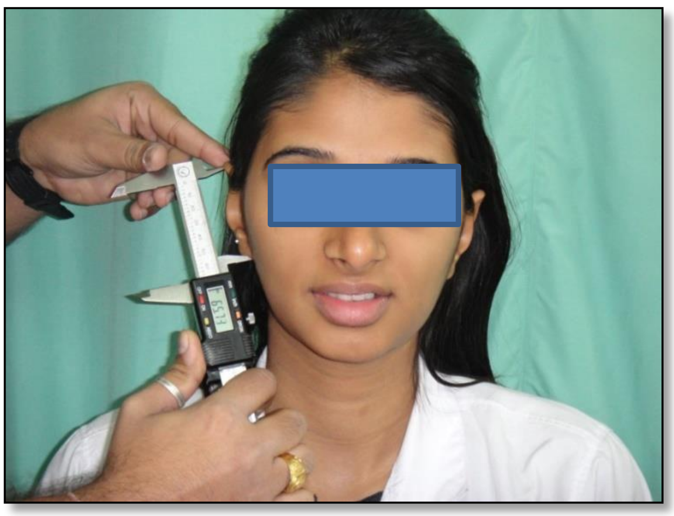

Fig. 2: Measurements taken by direct method - Sa-Sba (superaurale-subaurale).

Measurements taken by indirect method (Fig 3 and 4):

The photographic set up consisted of a tripod supporting digital camera (Sony cybershot DSC-T77 with 10.1-megapixel Super HAD CCD,4x optical zoom with optical steady shot image stabilization,Carl Zeiss Vario-Tessar lens, 3-inch widescreen, touch-panel, clear photo LCD Plus and intelligent scene recognition which could be adjusted to patients height). The tripod controlled the stability and the correct height of the camera according to the subject's body height. This ensured the correct horizontal position of the optical axis of the lens. The camera to subject distance was 60cms. No digital zoom is taken while taking the photographs. Photographs were taken with each subject in natural head orientation, centric relation and relaxed lip posture.

These images were then opened in the software (UTHSCSA, ImageTool, version 3.0, San Antonio, Texas). The image is zoomed and standardized for frontal view according to the reference distances of Ex-Ex, En-En and P-P which were measured using direct method. The remaining four measurements (Al-Al, Ch-Ch, Go-Go and Sn-Sto) were then recorded from the software. Similarly for profile view, Sa-Sba and T-Ex were taken as reference distance and the remaining five measurements (Tri-N, N-Sn, N-Prn, Prn-Sn and Sn-Sto) were recorded from the software.These values were them compared with the direct values obtained from the patients through direct method.

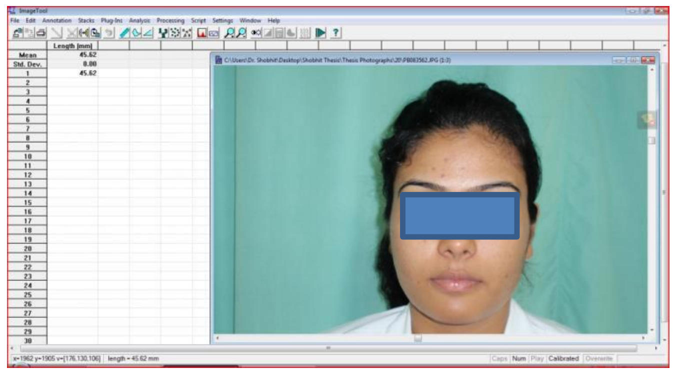

Fig 3: Measurements taken by indirect method – Intercanthal Width.

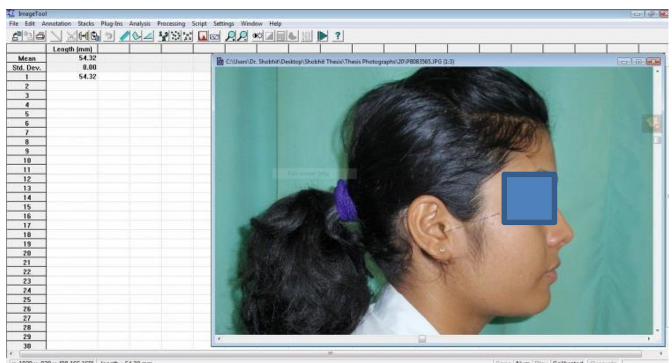

Fig 4: Measurements taken by indirect method – T-Ex distance

When the differences between the indirect values measured according to reference distances and the direct values measured on subjects' faces were no greater than 1 mm, the reference distance was considered reliable.

STATISTICAL ANALYSES

The data was entered into the Microsoft excel sheet and was analyzed using SPSS version18. Descriptive statistics were computed for all the variables. Unpaired t test was used to do comparisons between the genders. One way ANOVA was used to compare the readings got with both indirect and direct methods. To compare between the differences between values derives by direct and indirect method in frontal view in both genders paired t test had been used.

taken from T-Ex reference line the difference is statistically significant only with N-Sn, N-Prn, Prn-Sn and Sn-Me in males whereas in females it is statistically significant only with N-Prn and Sn-Me.

Table 2: Gender wise comparison between the mean values of linear measurements from profile view by direct and indirect methods (in mm)

Parameters	Sex	Direct values (A)	Indirect values according to Sa-Sba (B)	Indirect values according to T-Ex (C)	ANOVA test of comparison for groups		
		Mean ± SD	Mean ± SD	Mean ± SD	ABC	AB	AC
N-Sn	Male	62.30±3.92	56.72±4.25	59.54±3.85	0.05	0.05	0.05
	Female	63.64±3.95	59.41±3.63	60.72±4.09	0.05	0.05	0.59
N-Prn	Male	53.49±10.02	45.13±3.63	48.56±3.42	0.05	0.05	0.05
	Female	50.19±4.84	45.14±4.94	46.65±5.10	0.05	0.05	0.05
Prn-Sn	Male	20.80±2.35	19.36±2.24	20.08±2.29	0.05	0.05	0.05
	Female	20.66±2.91	19.86±2.74	20.82±2.90	0.05	0.05	0.57
Sn-Sto	Male	15.09±2.32	13.36±2.34	14.76±2.32	0.05	0.05	0.91
	Female	12.35±0.99	11.31±1.09	12.21±0.98	0.05	0.05	0.55
Sn-Me	Male	59.57±4.68	50.33±6.04	55.46±5.20	0.05	0.05	0.05
	Female	52.45±2.56	46.32±5.89	49.30±5.22	0.05	0.05	0.05

One way ANOVA, p value < 0.05

RESULTS

The study was conducted on 18-23 year old students from Rural Dental College, Bareilly. Total 100 participants were selected randomly from pool of participants, out of which 50 were female whereas 50 were male.

Table 1: Comparison between mean values of reference lines in males and females (in mm)

Reference line	Male (n=50)	Female (n=50)	Z test value	'p' value
	Mean ± SD	Mean ± SD		
Sa-Sba	65.02±4.86	63.36±2.94	2.07	p<0.05
T-Ex	81.72±3.84	78.40±3.36	4.61	p<0.05
Ex-EX	96.32±3.23	95.20±3.73	1.61	p<0.05
En-En	34.67±2.42	31.33±3.00	9.82	p<0.05
P-P	64.54±2.94	59.83±3.27	7.58	p<0.05

t test, p value < 0.05

Table 1 depicts the comparison between mean values of reference lines in males and females. There was a statistically significant difference between the values of reference lines of males and females. Therefore further analyses were done separately for both the genders.

According to table 2, the differences between the direct and indirect measurements of N-Sn, N-Prn, Prn-Sn, Sn-Sto and Sn-Mein both the genders were statistically significant as well as for direct measurements and indirect measurements derived from Sa-Sba reference line. But when the direct measurements were compared with indirect measurements

Table 3 depicts the gender wise comparison between the mean values of linear measurements from frontal view by direct and indirect methods. The differences in the measurements from frontal view by direct or indirect methods were statistically significant for both the genders and for all three reference lines.

As seen in table 4 and 5, of the four parameters, the indirect values of Ch-Ch according to the Ex-Ex and En-En reference distances were reliable in male subjects. The indirect values measured according to the En-En reference distance were closer to the direct values measured on subjects' faces in both sexes except for two parameters (Al-Al and Sn-Sto) in male and one parameter (Go-Go) in female subjects. The poorest results were obtained according to the P-P reference distance.

DISCUSSION

The analysis of the soft tissue profile of the face was a concern for the pioneers of orthodontics such as Angleand Case at the end of the 19th century and the beginning of the 20th century.[1] Angle took the sculpture of Apollo Belvedereas his canon of corporal and facial beauty. However, its straight, almost concave, profile would be difficult to attain orthodontically with Angle's non-extraction theory; he claimed that the correct occlusion of all teeth in both jaws was necessary to reach an optimum facial appearance.[1]

After the standardization of the radiographic technique in 1931 by Broadbent and Hofrath, the importance of soft tissue facial analysis was downplayed and dentoskeletal relationshipsbecame the deciding factor.

College of Pravara Institute of Medical Sciences, Loni from June 2010 to October 2011.

Table 3: Gender wise comparison between the mean values of linear measurements from frontal view by direct and indirect methods (in mm)

Parameters	Sex	Direct values (A)	Indirect values according to Ex-Ex (B)	Indirect values according to En-En (C)	Indirect values according to P-P (D)	ANOVA test of comparison for groups			
		Mean ± SD	Mean ± SD	Mean ± SD	Mean ± SD	ABCD	AB	AC	AD
A1-A1	**Male**	38.97±4.35	40.64±4.64	41.096±4.31	31.77±4.28	0.05	0.05	0.05	0.05
	Female	36.49±3.37	37.83±3.37	38.19±3.42	31.64±3.41	0.05	0.05	0.05	0.05
Ch-Ch	**Male**	49.56±4.26	50.06±4.25	50.40±4.24	39.47±4.43	0.05	0.05	0.05	0.05
	Female	44.47±5.82	47.12±5.37	47.072±5.33	39.75±5.29	0.05	0.05	0.05	0.05
Go-Go	**Male**	93.61±7.92	91.39±7.97	90.90±8.04	60.16±12.02	0.05	0.05	0.05	0.05
	Female	92.60±4.26	87.73±4.40	86.29±4.32	62.32±4.97	0.05	0.05	0.05	0.05
Sn-Sto	**Male**	15.01±2.20	16.08±2.11	16.51±1.92	10.83±2.24	0.05	0.05	0.05	0.05
	Female	12.35±0.99	13.60±1.00	13.52±0.93	8.76±1.03	0.05	0.05	0.05	0.05

One way ANOVA, p value < 0.05

Photogrammetry is the science of making measurements from photographs, especially for recovering the exact positions of surface points. The method was shown to be sufficiently reproducible since it was simple to achieve in a conventional setting, without the need for special equipment.[9]Photogrammetry can also be thought of as the sciences of geometry, mathematics and physics that use the image of a three-dimensional scene on a twodimensional piece of film to reconstruct a reliable and accurate model of the original three-dimensional scene. Each eye sees a single scene from slightly different perspectives. The brain deciphers the difference, makes a computation, and then conveys the thirddimension.[2]

Current study was conducted in the Department Of Orthodontics and Dentofacial Orthopedics, Rural Dental

The total sample in the study consisted of 100 subjects under two groups:

1) Males (n=50)
2) Females(n=50)

Adult males and females(18-23 years of age) having facial symmetry, having no history of trauma and no craniofacial anomaly were included in this study.Direct measurements on each subject's face were done with a millimetric compass (Digital Vernier Callipers).All the subjects were positioned in centric relation, relaxed lip posture, natural head orientation and in sitting position. Eight frontal and eight lateral distances were measured directly.Standardized lateral and facial photographs of each subject were taken for the indirect measurements.

The photographic records were transferred to the computer and

Table 4: Distribution of mean and SD values of frontal measurements (Difference between the direct and indirect measurements according to Ex-Ex, En-En and P-P reference distance in male subjects)

Measurements	Difference between mean values for direct and indirect measurements (d)	SD
$A1\text{-}A1_{(direct)}\text{-}A1\text{-}A1_{(ex\text{-}ex)}$	-1.67	0.43
$A1\text{-}A1_{(direct)}\text{-}A1\text{-}A1_{(en\text{-}en)}$	-2.126	1.32
$A1\text{-}A1_{(direct)}\text{-}A1\text{-}A1_{(p\text{-}p)}$	7.2	2.35
$Ch\text{-}Ch_{(direct)}\text{-}Ch\text{-}Ch_{(ex\text{-}ex)}$	-0.5	0.1
$Ch\text{-}Ch_{(direct)}\text{-}Ch\text{-}Ch_{(en\text{-}en)}$	-0.84	0.45
$Ch\text{-}Ch_{(direct)}\text{-}Ch\text{-}Ch_{(p\text{-}p)}$	10.09	2.76
$Go\text{-}Go_{(direct)}\text{-}Go\text{-}Go_{(ex\text{-}ex)}$	2.22	0.98
$Go\text{-}Go_{(direct)}\text{-} Go\text{-}Go_{(en\text{-}en)}$	2.71	0.87
$Go\text{-}Go_{(direct)}\text{-} Go\text{-}Go_{(p\text{-}p)}$	33.45	5.76
$Sn\text{-}Sto_{(direct)}\text{-}Sn\text{-}Sto_{(ex\text{-}ex)}$	-1.07	0.76
$Sn\text{-}Sto_{(direct)}\text{-} Sn\text{-}Sto_{(en\text{-}en)}$	-1.5	0.54
$Sn\text{-}Sto_{(direct)}\text{-} Sn\text{-}Sto_{(p\text{-}p)}$	4.18	1.01

Paired t test, p value < 0.05

analyzed with the software for Windows,Image Tool version **3.0.**The parameters used in the direct method were measured on the profile view (**SaSba, T-Ex**) and three reference distances on the frontal view (**Ex-Ex, En-En, P-P**).The arguments for using the ear and eye are that the main development of these parts of the face occurs in the early ages and are stable during growing.

Table 5: Distribution of mean and SD values of frontal measurements (Difference between the direct and indirect measurements according to Ex-Ex, En-En and P-P reference distance in female subjects)

Measurements	Difference between mean values for direct and indirect measurements (d)	SD
A1-A1$_{(direct)}$-A1-A1$_{(ex-ex)}$	-1.34	0.21
A1-A1$_{(direct)}$-A1-A1$_{(en-en)}$	-1.7	0.14
A1-A1$_{(direct)}$-A1-A1$_{(p-p)}$	4.85	1.20
Ch-Ch$_{(direct)}$-Ch-Ch$_{(ex-ex)}$	-2.65	0.98
Ch-Ch$_{(direct)}$-Ch-Ch$_{(en-en)}$	-2.60	0.99
Ch-Ch$_{(direct)}$-Ch-Ch$_{(p-p)}$	4.72	1.20
Go-Go$_{(direct)}$-Go-Go$_{(ex-ex)}$	4.87	1.48
Go-Go $_{(direct)}$- Go-Go $_{(en-en)}$	6.37	2.03
Go-Go $_{(direct)}$- Go-Go $_{(p-p)}$	30.28	4.56
Sn-Sto$_{(direct)}$-Sn-Sto$_{(ex-ex)}$	-1.25	0.45
Sn-Sto $_{(direct)}$- Sn-Sto $_{(en-en)}$	-1.17	0.14
Sn-Sto $_{(direct)}$- Sn-Sto $_{(p-p)}$	3.59	1.03

Paired t test, p value < 0.05

In this study, **Sa-Sba**, **T-Ex**, **Ex-Ex**, **En-En**, and **P-P** distances were different between male and female subjects. Therefore, we assessed the subjects separatelyas male and female. Of the five parameters obtained from the profile views, the difference between direct and indirect measurements of **Prn-Sn** and **Sn-Sto** were less than**1 mm** in both sexes according to the **T-Ex** line.

The highest difference was seen in **Sn-Me** (**3.72 mm**) for the male group and in **N-Prn** (**3.03 mm**) for the female group when the **T-Ex** reference distance was used. However, the differences between direct and indirect measurements were higher (**1.48–9.32 mm**) when the **Sa-Sba** reference distance was used. The poorest results were obtained with the **Sa-Sba** reference distance. The results for the profile measurements showed that the indirect measurements according to **T-Ex** distance were closer to direct measurements than the indirect measurements according to the **Sa-Sba** distance for both sexes. The elasticity of the ear might account for some error during the assessment.

Of the four parameters obtained from the frontal views, the difference between direct and indirect measurements of **Ch-Ch** was less than **1** mm in male subjects according to the **Ex-Ex** and **En-En** reference distances**.** In contrast to the results of this study, **Farkas et al** and **Tanner** and **Weine**r showed that the difference between the indirect and direct measurements for **Ch-Ch** parameter was more than **1** mm. The difference in the other remaining parameters was less than **2** mm except for the parameter **Go-Go** in female subjects.[3]

The differences between direct and indirect measurements were dramatically higher when **P-P** reference distance was used. It must be kept in mind that allsubjects were asked to look straight ahead to a distant point at eye level during the assessment. The use of a stable point might eliminate possible errors resultingfrom pupils and might give different results. **Ras et al**in a similar study found that the best reference line among four reference distances (exocanthion-exocanthion, endocanthion-endocanthion, superalare-superalare, and cheilion-cheilion) was formed by the one which is perpendicular and bisects the line that connects the landmarks exocanthion.

However, **Farkas et al** found that **Ex-Ex** was not reliable while **En-En** was reliable. In this study, the distortion caused by photographing, measuring without previously indicated landmarks on the face, might have accounted for the unreliability of reference distances. **Farkas et al** stated that the magnitude of the error depends on the thickness of the soft tissue covering the bony landmark, and measurements of some landmarks (eg, **Al, Sa, Sba**) may not be precise if photographs are not sharp enough to allow accurate identification of these landmarks.

CONCLUSION

- The findings from this study can be incorporated into routine orthodontic records,diagnosis and treatment planning.
- The minimum use of armamentarium makes it a very simple and easy to perform procedure in day-to-day life.
- Both frontal and lateral soft tissue parameters can be assessed in a single go.
- The reference points used for the study are easy for identification.
- The treatment changes after orthodontic treatment can also be seen to assess the results achieved in a specific case.

REFERENCES

1. Frankel R, Frankel C. Orthodontics in orofacial region with help of function regulators.Inf OrthodKieferorthop 1988; 20(3): 277-309
2. Chiarella S, Dellavia C, Dolci C, Donetti E,Ferrario VF. A Quantitative Three-Dimensional Assessment of Abnormal Variations in the Facial Soft Tissues of Individuals with

Down syndrome. Cleft Palate-Craniofacial Journal 2005; 42(4): 410-16

3. Uzun A, Akbas H, Bilgic S, Emirzeoglu M, Bostanci O, Sahin B, Bek Y. The average values of the nasal anthropometric measurements in 108 young Turkish males. Auris Nasus Larynx 2006;33: 31–35
4. Guerra da Silva MB, Sant'Anna EF. The evolution of cephalometric diagnosis in Orthodontics. Dental Press J Orthod [online] 2013; 18(3): 63-71. Accessed athttp://www.scielo.br/scielo.php?script=sci_arttext&pid=S2176-94512013000300011. Accessed on 23/10/15 at 12.09am.
5. Michiels LYF, Tourne LPM. Nasion True Vertical: A proposed method of testing the clinical validity of cephalometric measurements applied to a new cephalometric reference line. Int Jr Adult OrthodOrthogSurg 1990;5(1):43-52
6. Burstone CJ. The Integumental profile. Am J Orthod Dentofacial Orthop 1967; 44: 1-25
7. Agarwal N, Bagga DK, Sharma P. A comparative study of cephalometric measurements with digital versus manual methods. J Ind Orthod Soc 2011; 45(2): 84-90
8. Karatas OH, Toy E. Three-dimensional imaging techniques: A literature review. Eur J Dent 2014; 8(1): 132-40
9. Good S, Edler R, Wertheim D, Greenhill D. A computerized photographic assessment of the relationship between skeletal discrepancy and mandibular outline asymmetry. Eur J Orthod 2006; 28:97–102
10. Nechala P, Mahoney J, Farkas LG. Digital two-dimensional photogrammetry: a comparison of three techniques of obtaining digital photographs. PlastReconstrSurg 1999; 103: 1819–1825
11. Leong SC, White PS. A comparison of aesthetic proportions between the Oriental and Caucasian nose. Clin Otolaryngol Allied Sci 2004; 29:672–676