World Journal of Biology Pharmacy and Health Sciences
eISSN: 2582-5542
Cross Ref DOI: 10.30574/wjbphs
Journal homepage: https://wjbphs.com/

(RESEARCH ARTICLE)

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# Comparative study of soft tissue parameters reliability by digital and manual tracing method: A cephalometric study

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World Journal of Biology Pharmacy and Health Sciences, 2025, 21(03), 145-160

Publication history: Received on 05 January 2025; revised on 24 February 2025; accepted on 27 February 2025

Article DOI: https://doi.org/10.30574/wjbphs.2025.21.3.0189

## Abstract

**Aim**: To compare and evaluate soft tissue linear and angular measurements reliability between Digital and Manual Tracing method

**Objectives**: The objective of the study is to conclude that digital and manual tracing method for soft tissue measurements are reliable and comparable to each other

**Materials & methods**: Lateral Cephalograms of 35 patients who reported for Orthodontic Treatment irrespective of the type of malocclusion were taken. A total of 24 measurements were taken with 17 Linear Soft Tissue Measurements and 7 Angular Soft Tissue Measurements respectively. The digital images of each cephalogram was directly imported to Nemoceph Software for digital tracing whereas for manual tracing compatible printed images were used.

**Results**: Soft Tissue Chin Thickness, Lower Lip Thickness, A'- B', Sn'-Pog', Upper Lip Length, Upper Lip Protrusion, Upper Lip Anterior - Lower Lip Anterior showed statistically significant difference between the two techniques among linear measurements but were clinically acceptable (difference between the digital and manual technique were less than 2 units ie 1 unit = 1mm for linear measurement and 1 degree for angular measurements). Throat Length also showed statistically significant difference between the two techniques for linear measurement but was not clinically acceptable as it exceeded 2mm difference. Amongst the Angular measurement only Z-Angle Upper Lip showed statistically significant difference between the two techniques but was clinically acceptable.

**Conclusion**: Digital measurements were found to be reliable and comparable to manual tracing method for all soft tissue linear and angular measurements except Throat Length.

**Keywords:** Nemoceph; Soft Tissue Parameters; Cephalogram; Digital Tracing; Manual Tracing; Reliability

## 1. Introduction

One of the most important tool in orthodontics is cephalometric analysis as it plays a key role in diagnosis, treatment planning, growth prediction, treatment results evaluation. Hand tracing has been the go to method for orthodontists for a while but now there is a shift from conventional method of hand tracing to the digital tracing as we evolve with

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technology.[1] We know that manual tracing method is a tedious process even though its been used since long time as it is time consuming, fatigue of the operator, incorrect identification of landmarks and therefore leading to errors in measurements.[2-5] Now as we evolve with technology the patient's concerns have also evolved ie they are more aware and concerned about the esthetic point of view so due to which soft tissue analysis is gaining popularity among orthodontists as it also plays a key role in treatment planning and diagnosis.[6] There could be a possibility at times when hard tissue cephalometric criteria does not necessarily ensure overlying soft tissue will drape in a harmonious manner therefore not resulting in a pleasing profile so therefore highlighting the importance of soft tissues.[7] It is reported that very few studies have been evaluated on soft tissue landmarks due to the uncertainty in identifying it.[8] It is also reported that digitally acquired cephalometric imaging has numerous advantages ie elimination of chemical processing and dark room, reduced radiation exposure, improved landmark identification through image enhancement techniques, faster cephalometric data acquisition, efficient storage and archiving.[6,9,10] Some of the cephalometric software programs used are Quick ceph [10], Dolphin [6,11], Vista-dent [12], Nemoceph [13].

### 1.1. Need for the study

To compare and evaluate soft tissue parameters both digitally and manually in order to check the reliability of digital tracing of soft tissue in comparison to manual tracing to provide the best possible treatment for the patient.

### 1.2. Null hypothesis

Digital tracing method is not reliable and comparable to manual tracing method for soft tissue linear and angular measurements

### 1.3. Alternative hypothesis

Digital tracing method is reliable and comparable to manual tracing method for soft tissue linear and angular measurements.

### 1.4. Aim

To compare and evaluate soft tissue linear and angular measurements reliability between Digital and Manual Tracing method

*Objectives*

- To Evaluate Linear and Angular Soft tissue measurements for digital tracing method
- To Evaluate Linear and Angular Soft tissue measurements for manual tracing method
- To Compare Linear and Angular Soft tissue measurements between digital and manual tracing method

## 2. Material and methods

Ethical clearance was obtained for the study from the Institutional Ethics Committee, A.J. Institute of Dental Sciences. Pre-treatment Lateral Cephalograms of 35 patients (both hard and soft copies) who reported for Orthodontic treatment from Department of Orthodontics and Dentofacial Orthopedics, AJ Institute of Dental Sciences, Mangalore were taken irrespective of the type of malocclusion and gender.

The inclusion criteria for this study were as follows

- All Radiographs should be taken from the same machine with same magnification
- Lateral Cephalograms should be obtained in natural head position
- Only Soft Tissue Linear and Angular Parameters were measured taken from Arnett, COGS Soft Tissue Analysis and Tweed-Merrifield Analysis

The exclusion criteria were as follows

- Patients with Trauma, Craniofacial deformity, syndromes

Following are the materials used for performing the study

- Pre Treatment Lateral Cephalogram both Hard and Soft Copy

- Acetate Tracing Sheet
- Sharp 3H 0.5mm Drawing Pencil
- Vernier Caliper
- Protractor
- Nemoceph Cephalometric Software

For Manual Tracing, Soft tissue landmarks were traced on a acetate tracing sheet using sharp 3H 0.5mm drawing pencil using transilluminated light in a dark room and is made sure that no light radiations were present around the radiograph so that all landmarks were identified as accurately as possible. First the 3 registration crosses are marked ie 2 of them in the cranium and 1 near the cervical vertebrae region on the hard copies [14]. Using smooth continuous pressure on the pencil, tracing is done without stopping ie continuous freehand and also erasures are avoided as much as possible. Average between the left and right outlines were taken when there was lack of superimposition between them to mark the landmarks. Once all the outlines were drawn and landmarks were identified, the Linear and Angular measurements were done using parameters only from Arnett, COGS Soft Tissue Analysis and Tweed Merrifield Analysis [15,16,17]. Angular measurements were taken using protractor and for linear measurements a digital vernier caliper was used to give an accurate measurement.

The same lateral cephalograms were stored as soft copies and then transferred to Nemoceph Software to perform digital tracing. The image was saved in the software with patient's details for future references. First the image was calibrated by identifying 2 points which are 10 mm apart. Then, the software guides us to identify all the individual cephalometric landmarks so as to avoid confusions and to be as accurate as possible with the help of mouse. After identifying all the landmarks readjustment was done to correct all the outlines and points so as to increase the accuracy of the measurements. The software calculated automatically all the measurements for the parameters which we used for the study. Whichever parameters were to be measured it was checked whether its present in any of the 3 analysis (Arnett, COGS Soft tissue, Tweed Merrifield) so therefore that particular analysis was used to find out the measurements of the required parameter. Once all the parameters were measured digitally for angular and linear measurements the values were noted down so as to compare it with manual tracing measurements. Statistical Analysis was performed for all the data obtained.

### 2.1. Measurements taken were as follows

*2.1.1. Linear soft tissue measurement*

- Soft Tissue Chin Thickness (Pog-Pog')
- Upper Lip Thickness
- Lower Lip Thickness
- Menton - Menton'
- Ga' – Pog'
- Ga' – Pt. A'
- Pt. A' – Pt. B'
- Inter-labial Gap
- Throat Length
- Pt. B' – Pog'
- Na' – Me'
- Sn' – Pog'
- Upper Lip Length (Sn - ULI)
- Lower Lip Length (LLS - Me')
- Upper Lip Anterior to Lower Lip Anterior (ULA - LLA)
- Upper Lip Protrusion
- Lower Lip Protrusion

*2.1.2. Angular soft tissue measurements*

- Soft Tissue Facial Angle (G'- Sn - Pog')
- Upper Lip Angle
- Lower Face Throat Angle (Sn - Gn) & (C - Gn)
- Nasolabial Angle (C – Sn - ULA)
- Z - Angle (Upper Lip)
- Z - Angle (Lower Lip)

- Facial Convexity Angle (G-Sn) & (Sn – Pog')

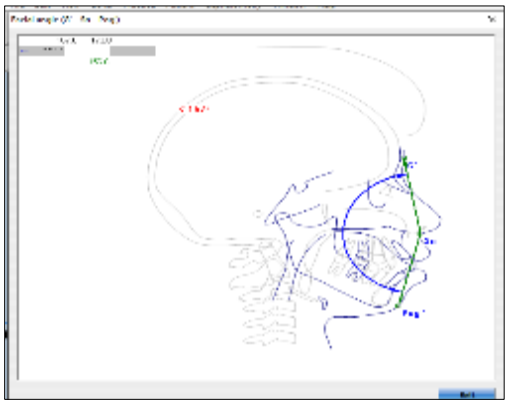
A Total of 24 parameters were taken with 17 Linear Measurements and 7 Angular Measurements

The measurements between Manual and Digital tracing were considered to be clinically acceptable if the mean measurement difference between them were less than 2 units (1 unit = 1 mm for linear measurements and 1 degree for angular measurements). [9,18]

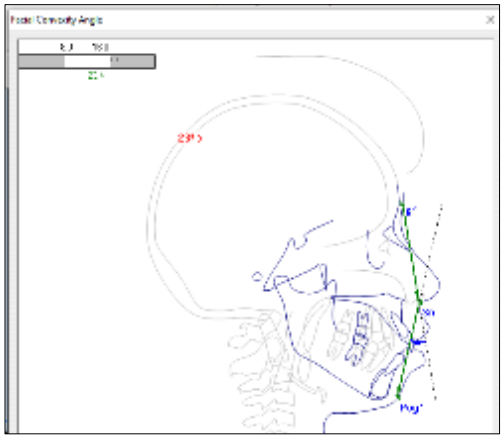
### 2.2. Statistical analysis

Intra examiner error was measured by randomly repeating 10 selected radiographs. The measurement difference between the two sets of reading was statistically non-significant.

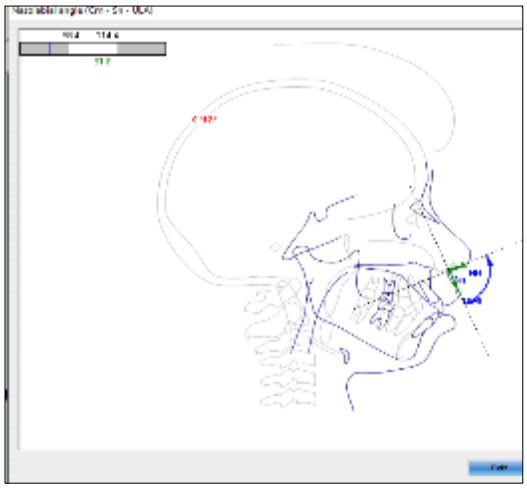
The measurement between digital and manual tracing was subjected to paired t-tests for statistical analysis with $p<0.05$ deemed statistically significant

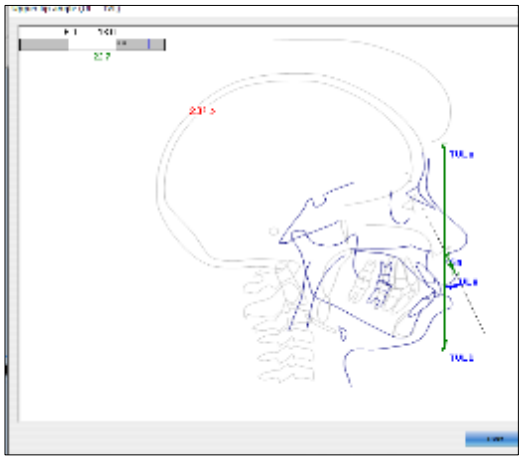
FACIAL ANGLE



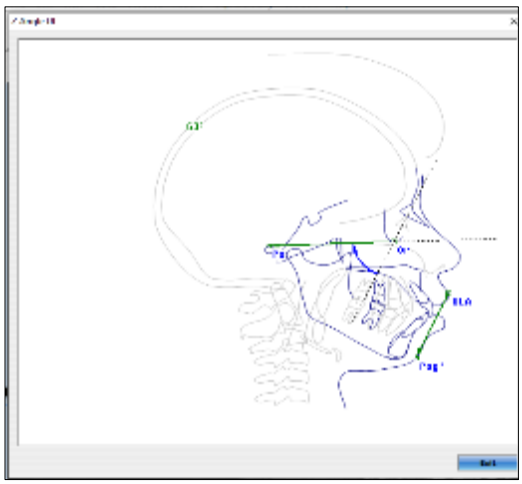
FACIAL CONVEXITY ANGLE



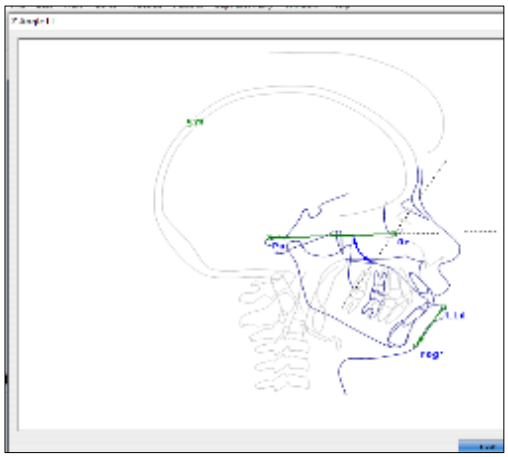
NASOLABIAL ANGLE



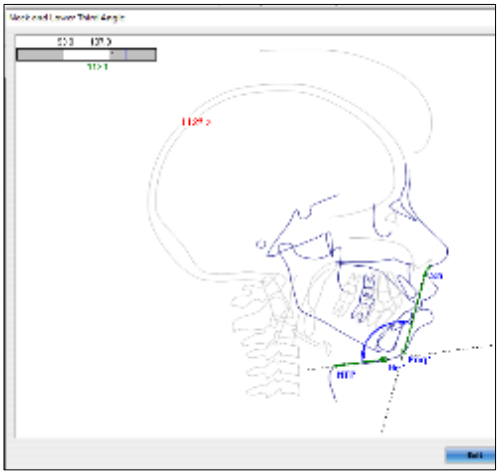
UPPER LIP ANGLE



Z-ANGLE UL

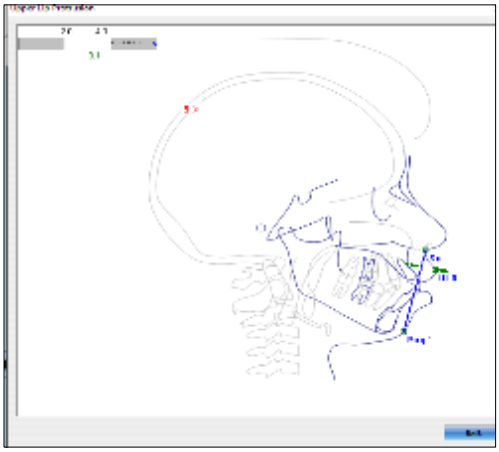


Z-ANGLE LL

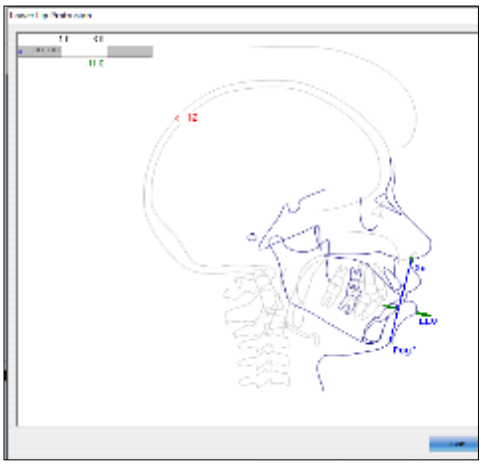


LOWER FACE THROAT ANGLE

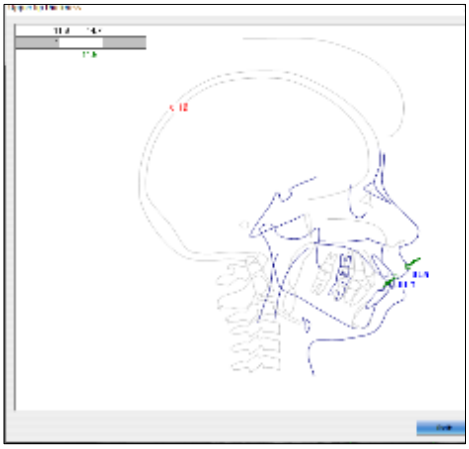
## LINEAR MEASUREMENTS



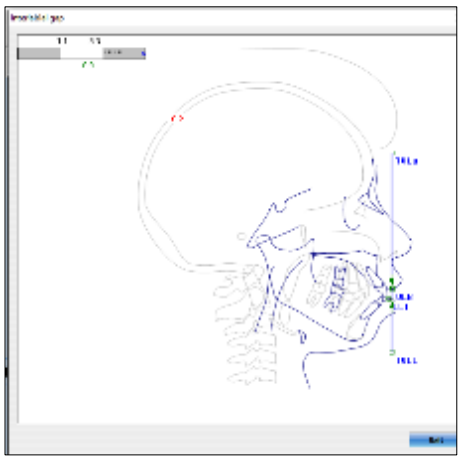
UPPER LIP PROTRUSION



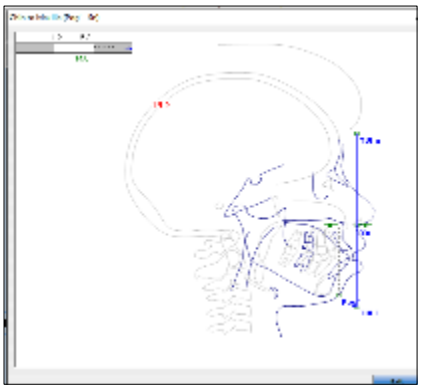
LOWER LIP PROTRUSION



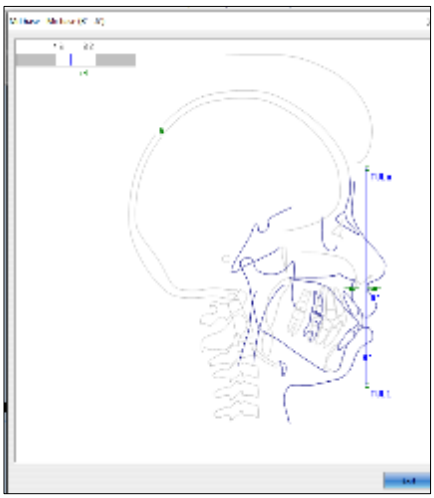
UPPER LIP THICKNESS



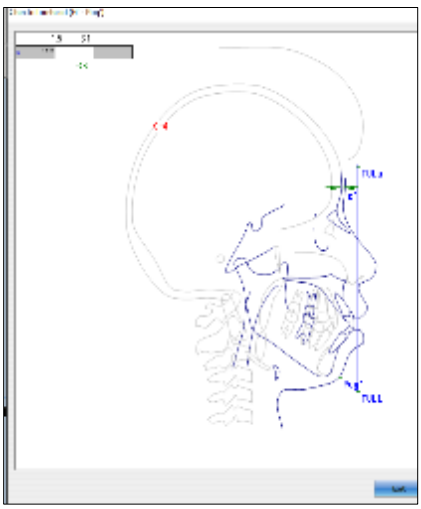
INTERLABIAL GAP



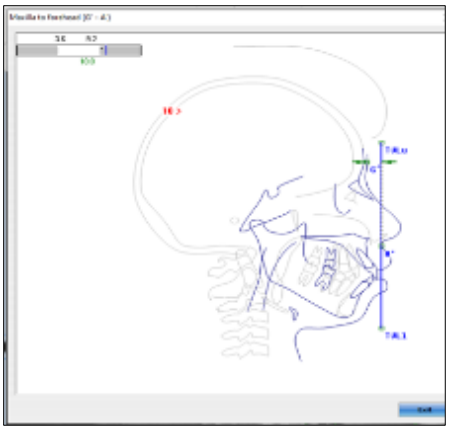
SN'-POG'



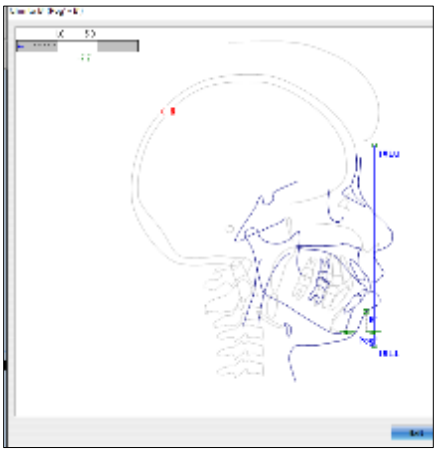
B'-A'



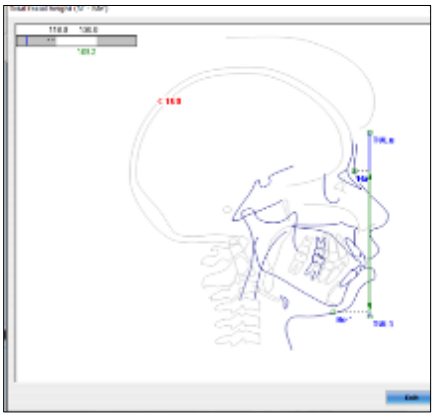
G'-POG'



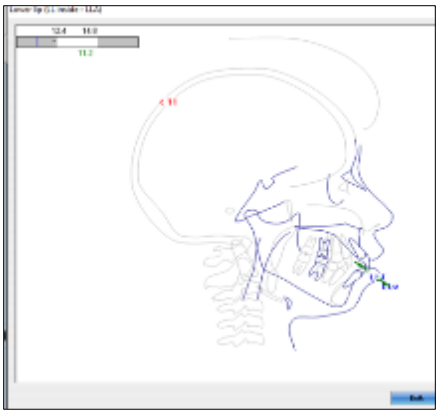
G'-A'



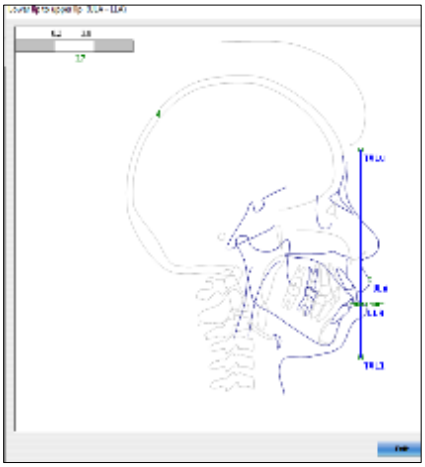
POG'-B'



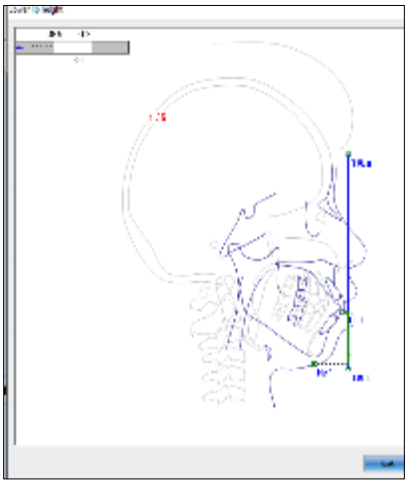
N'-ME'



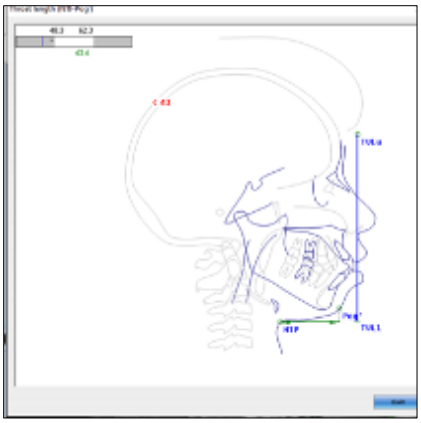
LOWER LIP THICKNESS



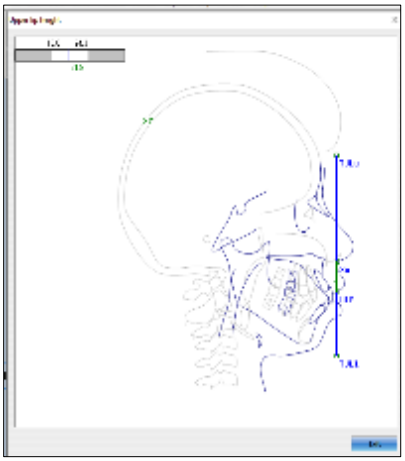
ULA-LLA



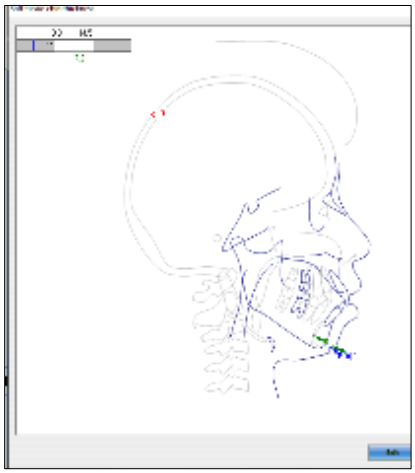
LOWER LIP LENGTH



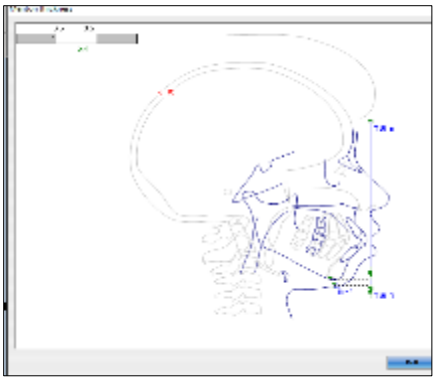
THROAT LENGTH



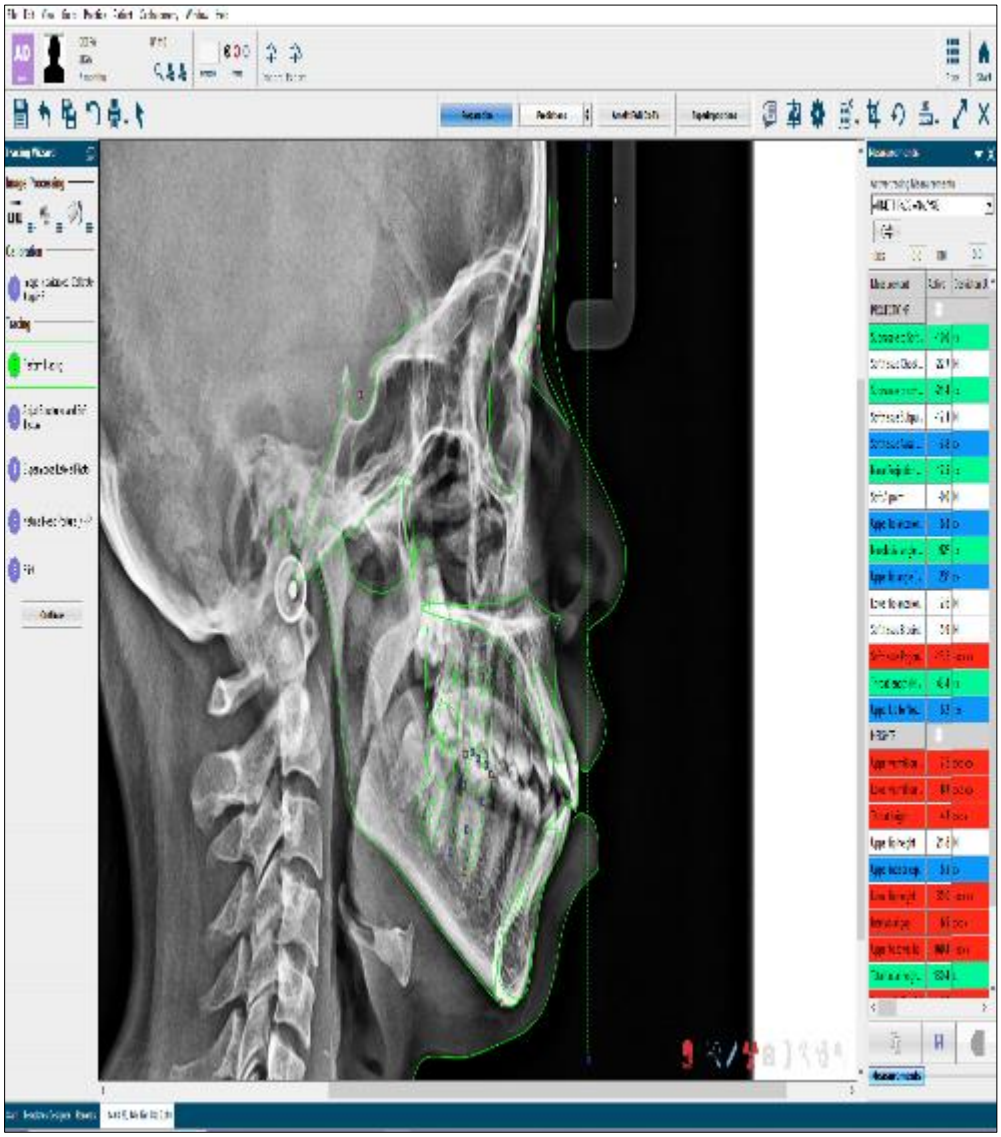
UPPER LIP LENGTH



SOFT TISSUE CHIN THICKNESS



MENTON THICKNESS



DIGITAL TRACING METHOD

## 3. Results

Statistical Analysis was done between Manual and Digital Measurements for Linear and Angular Soft tissue parameters. Soft Tissue Chin Thickness, Lower Lip Thickness, A'- B', Sn'-Pog', Upper Lip Length, Upper Lip Protrusion, Upper Lip Anterior - Lower Lip Anterior and Throat Length showed statistically significant difference between the two techniques among linear measurements. Amongst the Angular measurement only Z-Angle Upper Lip showed statistically significant difference between the two techniques. Measurements obtained by digital technique were higher in comparison to manual technique for all parameters except Me - Me', Ga'- A', B'- Pog' for linear measurements whereas for angular measurements digital measurements showed higher values for nasolabial angle, upper lip angle, lower face throat angle and z angle lower lip. Facial Convexity angle and z angle upper lip showed higher values for manual measurements.

**Table 1 C**omparison of linear measurements between digital and manual tracing

| SL NO | LINEAR MEASUREMENTS | NEMOCEPH VALUE | MANUAL TRACING VALUE | P VALUE |
|---|---|---|---|---|
| 1) | CHIN THICKNESS | 09.84 ± 2.15 | 09.39 ± 1.96 | 0.017 |
| 2) | UPPER LIP THICKNESS | 11.02 ± 1.36 | 10.70 ± 1.19 | 0.064 |
| 3) | LOWER LIP THICKNESS | 13.16 ± 1.56 | 12.51 ± 1.80 | 0.006 |
| 4) | Me-Me' | 04.79 ± 1.10 | 04.96 ± 1.02 | 0.243 |
| 5) | Ga'-Pog' | 03.33 ± 2.24 | 03.14 ± 2.11 | 0.594 |
| 6) | Ga'-A' | 08.07 ± 3.38 | 08.33 ± 3.26 | 0.168 |
| 7) | A'-B' | 07.21 ± 2.48 | 06.34 ± 2.06 | 0.016 |
| 8) | INTER LABIAL GAP | 04.71 ± 2.79 | 04.68 ± 2.62 | 0.885 |
| 9) | THROAT LENGTH | 47.24 ± 5.26 | 44.27 ± 4.62 | 0.025 |
| 10) | B'-Pog' | 01.64 ± 2.20 | 01.67 ± 1.82 | 0.909 |
| 11) | Na'-Me' | 108.03 ± 5.56 | 107.79 ± 6.49 | 0.775 |
| 12) | Sn-Pog' | 08.72 ± 3.23 | 07.49 ± 3.38 | 0.054 |
| 13) | UPPER LIP LENGTH | 19.07 ± 1.61 | 18.44 ± 1.32 | 0.006 |
| 14) | LOWER LIP LENGTH | 38.15 ± 1.96 | 37.87 ± 2.41 | 0.302 |
| 15) | ULA TO LLA | 03.31 ± 1.51 | 02.61 ± 1.37 | 0.012 |
| 16) | UPPER LIP PROTRUSION | 05.86 ± 2.12 | 05.20 ± 2.28 | 0.002 |
| 17) | LOWER LIP PROTRUSION | 05.41 ± 2.83 | 05.41 ± 2.68 | 1.00 |

**Table 2** Comparison of angular measurements between digital & manual tracing

| SL NO | ANGULAR MEASUREMENTS | NEMOCEPH VALUES | MANUAL TRACING VALUES | P VALUE |
|---|---|---|---|---|
| 1) | NASOLABIAL ANGLE | 100.60 ± 14.92 | 99.00 ± 10.97 | 0.341 |
| 2) | SOFT TISSUE FACIAL ANGLE | 161.00 ± 04.80 | 162.00 ± 4.52 | 0.692 |
| 3) | UPPER LIP ANGLE | 19.80 ± 04.78 | 19.00 ± 5.29 | 0.598 |
| 4) | LOWER FACE THROAT ANGLE | 107.10 ± 11.52 | 106.60 ± 10.95 | 0.563 |
| 5) | FACIAL CONVEXITY ANGLE | 18.20 ± 04.80 | 18.40 ± 3.98 | 0.705 |
| 6) | Z ANGLE (UL) | 71.70 ± 05.08 | 73.50 ± 5.36 | 0.003 |
| 7) | Z ANGLE (LL) | 68.00 ± 07.76 | 66.80 ± 8.31 | 0.325 |

## 4. Discussion

There have been many studies conducted to compare hard tissue cephalometric parameters between manual and digital tracing but in terms of soft tissue parameters the amount of studies is comparatively lesser because of the uncertainty in identifying soft tissue landmarks.[8] The soft tissue parameters selected for the study were taken from 3 analysis as described previously barring Holdaway's analysis as the analysis wasn't available in the Nemoceph software. The results of the study showed that among linear measurements Soft Tissue Chin Thickness, Lower Lip Thickness, A'- B', Sn'-Pog', Upper Lip Length, Upper Lip Protrusion, Upper Lip Anterior - Lower Lip Anterior and Throat Length showed statistically significant difference between the two techniques. In comparison to this study Agarwal et al [8] found significant difference for Upper Lip Length which is similar to the findings here but Celik et al [12] did not find any statistical significant difference which is in contrast to the result here. In this study Lower Lip Thickness, Upper Lip Protrusion, Upper Lip Anterior - Lower Lip Anterior also showed statistically significant difference which could be because the lip prominence points are poor landmarks to identify according to Cooke and Wei.[19] Among the linear measurements which showed statistically significant difference all were said to be clinically acceptable except Throat Length. The criteria for clinically acceptable difference was stated by Chen et al [9] and Schultze et al [18]. According to the criteria if difference between the digital and manual technique were less than 2 units ie 1 unit = 1mm for linear measurement and 1 degree for angular measurements then it is clinically acceptable.

For angular measurements only Z angle Upper Lip showed statistically significant difference but is clinically acceptable. Upper Lip Angle showed no significant difference in this study similar to the findings by Agarwal et al [8]. Nasolabial Angle was found to be not significant here in contrast to the findings by Agarwal et al [8] and Celik et al [12]. Facial Convexity Angle showed no statistical significance in this study which supports the finding of Kublashvili et al [20] while Agarwal et al [8] found statistically significant difference between the two methods which is in contrast to the findings here. Throat Length is the only variable that did not show clinical acceptability which supports the finding that Throat Point landmark showed moderate reliability along one of the axes between manual and digital method [6]. Since most of the findings were within clinically acceptable range ie less than 2 units it can be stated that digital method is comparable and reliable to manual method so therefore digital method can be used in clinical practice as it has its own advantages.

### 4.1. Future research in this field

Since not many studies have been done for soft tissue parameters, this study can be used to compare with the results that will be obtained in future by other researchers with increased sample size with many more parameters and probably come up with something new which can have an impact on future research in this field and also it may help the Software providers to get a fair idea on how they can improve every detail of their software so as to make it more effective for the orthodontists to use

## 5. Conclusion

Digital measurements were found to be reliable and comparable to manual tracing method for all soft tissue linear and angular measurements except Throat Length which showed clinically significant difference between digital and manual tracing method.

Soft Tissue Chin Thickness, Lower Lip Thickness, A'- B', Sn'- Pog', Upper Lip Length, Upper Lip Protrusion, Upper Lip Anterior - Lower Lip Anterior showed statistically significant difference between the two techniques among linear measurements but were clinically acceptable.

Amongst the Angular measurement only Z-Angle Upper Lip showed statistically significant difference between the two techniques but was clinically acceptable.

Measurements obtained by digital technique were higher in comparison to manual technique for all parameters except Me - Me', Ga'- A', B'- Pog' for linear measurements whereas for angular measurements digital measurements showed higher values for nasolabial angle, upper lip angle, lower face throat angle and z angle lower lip. Facial Convexity angle and z angle upper lip showed higher values for manual measurements.

## Compliance with ethical standards

*Disclosure of conflict of interest*

No conflict of interest to be disclosed.

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