SOFT TISSUE CEPHALOMETRICS: AN OVERDUE EVALUATION

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The purpose of this study was to compare the accuracy of cephalometric soft tissue linear measurements obtained from conventionally traced cephalograms with those taken directly on patients. This study was conducted on 11 orthodontic patients. Small pieces of orthodontic wire were fixed on five soft tissue landmarks in the midline of the face of each patient. Five linear measurements were taken directly on each patient's face using an electronic Boley gauge reading to the nearest 0.05 mm. Also, a lateral cephalogram was taken of each patient with the aforementioned wires still in place. Using the same gauge, the same linear measurements were taken from the tracings of all cephalograms. The two sets of readings were statistically analyzed using the concordance correlation coefficient and Pearson correlation coefficient. The study concluded that soft tissue measurements on lateral cephalometric radiographs do not give reliable values. A single magnification factor cannot be applied for lateral cephalometric soft tissue measurements in all patients, nor within the same patient.
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Key words: *lateral cephalometry, soft tissue, linear measurements, profile*

Cephalometric radiography is important for both clinicians and researchers, especially those studying craniofacial growth.[1] Over the years, a variety of methods have been established for the analysis of lateral cephalograms.[2–5] A cephalogram is a 2D representation of a 3D object. Thus, due to the laws of projection, the images are displaced vertically and horizontally. The amount of displacement is proportional to the focus/object/film or recording plane distance.[6]

Moreover, cephalometric analyses are based on the hypothesis that accurate superimposition of the right and left sides occurs on the midsagittal plane. Perfect superimposition is seldom observed because facial symmetry is rare, but more so because of relative image displacement. These inherent method limitations do not allow an accurate assessment of craniofacial abnormalities and facial asymmetries.[6]

Another important factor in this issue is the significant amount of external error, known as radiographic projection error, which is associated with image acquisition. These errors comprise magnification, incorrect positioning, as well as projective distortion.[7] In addition, manual data collection and processing in cephalometrics have been shown to have low accuracy.[7] Despite these limitations, countless cephalometric analyses have been developed to help diagnose skeletal malocclusions and dentofacial deformities.

The aim of this study was to evaluate the accuracy of cephalometric soft tissue measurements.

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Fig 1 Patient on whom short sections of orthodontic wire were fixed with clear adhesive tape on five soft tissue landmarks.

Fig 2 Direct linear measurement on the patient's face using an electronic Boley gauge.

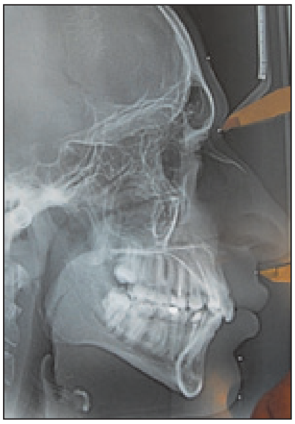

Fig 3 Linear measurement on a cephalometric radiograph using the same electronic Boley gauge.

MATERIAL AND METHODS

Small pieces of orthodontic wire (Ormco) (0.016 × 0.022-inch stainless steel, 3-mm long) were fixed with clear surgical tape horizontally to the floor in the midline of the faces of 11 randomly selected orthodontics patients on five soft tissue landmarks in the midsagittal plane (Fig 1). These landmarks were:

- G, glabella = most anterior point of the forehead
- N, soft tissue nasion = deepest point of the concavity between the forehead and the nose
- SLS, superior labial sulcus = deepest point of the concavity of the upper lip between subnasale and labrale superius
- ILS, inferior labial sulcus = deepest point of the concavity of the lower lip between labrale inferius and soft tissue pogonion
- Me, soft tissue menton = lowest point on the contour of the soft tissue chin

Five linear measurements (G-N, N-SLS, N-ILS, N-Me, and SLS-Me) were taken directly on each patient's face and on each cephalometric radiograph using an electronic Boley gauge, which was read to the nearest 0.05 mm (Figs 2 and 3).

To ensure measurement reliability, all measurements were made by the same observer. His reliability was also tested by repeating all measurements 1 day after the first set of measurements was attained.

The data were collected, tabulated, and analyzed with a reproducibility index, called the concordance correlation coefficient (CCC), introduced by Lin.[8] It evaluates the agreement between two readings (from the same sample) by measuring the variation for the 45-degree line through the origin (the concordance line).[9,10] The CCC contains the measurements of accuracy and precision. It was used to evaluate the equivalence and association between the direct and cephalometric measurements. Also, the reproducibility of all measurements was assessed with the CCC statistical test.

RESULTS

The results and consequent comparison between the direct and cephalometric measurements are represented in Table 1 and Fig 4.

The CCC showed that of the five linear measurements, three agreed poorly and two fairly between the two modalities. Error assessment between repeated measurements, as represented in Table 2 and Fig 5, depicted an excellent correlation.

The percentage of magnification was not constant among patients, nor within the same patient (Table 3).

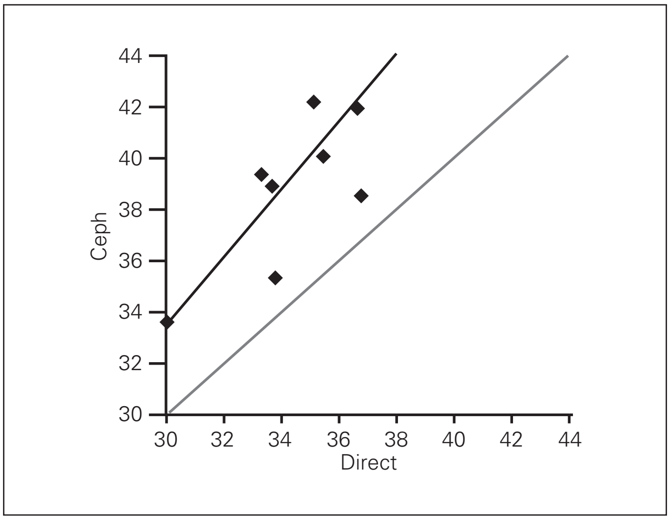

Fig 4 Graphic representation of the CCC for the direct (clinical) and cephalometric (ceph) linear measurements.

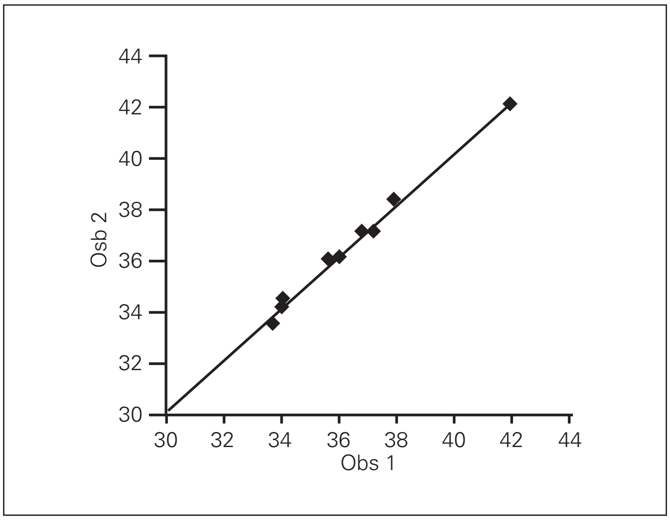

Fig 5 Graphic representation of the CCC for the intraobserver error assessment between the first (Obs 1) and second (Obs 2) measurement of both direct and cephalometric linear parameters.

Table 1 Mean, standard deviation (SD), and concordance correlation coefficient (CCC) test for the direct clinical (DC) and cephalometric (CEPH) measurements (mm)

	Mean	SD	CCC
G-N			
DC	34.931	4.103	0.633**
CEPH	39.148	5.197	
N-SLS			
DC	56.715	4.009	0.306***
CEPH	65.132	4.750	
N-ILS			
DC	90.425	6.616	0.342***
CEPH	102.713	7.214	
N-Me			
DC	112.283	7.948	0.108***
CEPH	120.895	18.054	
SLS-Me			
DC	58.360	5.223	0.486**
CEPH	64.656	4.981	

** = .40 > *P* < .75 (fair agreement).
*** = *P* < .40 (poor agreement).

Table 2 Mean, standard deviation (SD), and concordance correlation coefficient (CCC) test of intraobserver difference between the first (Obs 1) and second (Obs 2) measurement (mm)

	Mean	SD	CCC
G-N			
Obs 1	34.93	4.103	0.995*
Obs 2	35.07	3.999	
N-SLS			
Obs 1	56.71	4.009	0.978*
Obs 2	56.74	3.919	
N-ILS			
Obs 1	90.42	6.616	0.998*
Obs 2	90.43	6.595	
N-Me			
Obs 1	112.28	7.948	0.992*
Obs 2	112.37	7.717	
SLS-Me			
Obs 1	58.36	5.223	0.986*
Obs 2	58.15	5.322	

*= *P* > .75 (excellent agreement).

Table 3 Percentage of magnification between the direct and cephalometric measurements (mm)

Subject	G-N	N-SLS	N-ILS	N-Me	SLS-Me
1	14.21	8.20	10.69	12.33	10.52
2	3.03	15.78	10.27	8.79	2.88
3	9.98	12.98	13.23	10.94	10.45
4	9.54	14.79	13.93	13.47	10.10
5	14.43	14.79	13.92	14.19	13.64
6	10.66	11.19	12.52	12.01	10.62
7	11.61	11.53	6.92	7.79	3.26
8	13.3	14.34	11.80	10.90	13.07
9	11.19	12.94	13.20	12.47	10.64
10	14.78	11.05	10.91	11.10	9.96
11	3.39	14.15	14.13	12.53	12.14

DISCUSSION

In contemporary orthodontics, systematic quantitative measurements based on hard and soft tissue landmarks determined on cephalometric films are used on a daily basis. Precision and reproducibility in data obtained from cephalograms are important for the orthodontist. Errors in conventional methods arise from image acquisition, landmark identification, and measurement method.[11–13]

In cephalometry, the validity of the measurements must be ascertained by comparing the measurements from cephalograms with measurements made directly on the same skull in the case of hard tissue measurements and directly on the same face in the case of soft tissue measurements.[14] In this study, the accuracy was tested by comparing the linear measurements obtained on cephalograms and directly on the same patients' faces.

All five selected soft tissue landmarks were in the midline of the face so as to avoid superimpositions. Moreover, only linear measurements were tested because angular measurements would be more difficult to acquire and should be relatively independent of the measurement method.

Magnification, inherent to radiographic projection, must be considered when comparing cephalometric data from various sources. This applies to only linear dimensions, because angular values would not be affected.

Although the number of individuals was limited to 11, the results obviate the need to expand the sample size.

CONCLUSIONS

From this study, the following conclusions could be drawn:

- Soft tissue analysis showed that linear soft tissue measurements extracted from lateral cephalometric radiographs do not represent the true values to be found in a particular patient.
- A single magnification factor cannot be applied as a correction factor for the lateral cephalometric soft tissue measurements.

REFERENCES

1. Broadbent BH Sr. A new x-ray technique and its application to orthodontia. Angle Orthod 1931;1:45–66.
2. Tweed CH. The Frankfort-mandibular plane angle in orthodontics. Am J Orthod 1946;32:175–230.
3. Downs WB. Variations in facial relationship: Their significance in treatment and prognosis. Am J Orthod 1948;34:812–840.
4. Graber TM. New horizons in case analysis—Clinical cephalometrics. Am J Orthod 1952;38:603–624.
5. Ricketts RM. Cephalometric synthesis. Am J Orthod 1966;46:647–673.
6. Athanasiou AE. Orthodontic Cephalometry. London: Mosby-Wolfe, 1997.
7. Adams GL, Gansky SA, Miller AJ, Harrell WE Jr, Hatcher DC. Comparison between traditional 2-dimensional cephalometry and a 3-dimensional approach on human dry skulls. Am J Orthod Dentofacial Orthop 2004;126:397–409.
8. Lin LI. A concordance correlation coefficient to evaluate reproducibility. Biometrics 1989;45:255–268.
9. Lin LI. Assay validation using the concordance correlation coefficient. Biometrics 1992;48:599–604.
10. Lin L, Torbeck LD. Coefficient of accuracy and concordance correlation coefficient: New statistics for methods comparison. PDA J Pharm Sci Technol 1998;52:55–59.
11. Houston WJB, Maher RE, McElroy D, Sherriff M. Sources of error in measurements from cephalometric radiographs. Eur J Orthod 1986;8:149–151.
12. Forsyth DB, Shaw WC, Richmond S. Digital imaging of cephalometric radiography, Part 1: Advantages and limitations of digital imaging. Angle Orthod 1996;66:37–42.
13. Forsyth DB, Shaw WC, Richmond S, Roberts CT. Digital imaging of cephalometric radiographs, Part 2: Image quality. Angle Orthod 1996;66:43–50.
14. Potter JW, Meredith HV. A comparison of two methods of obtaining biparietal and bigonal measurements. J Dent Res 1948;27:459–466.