Comparative evaluation of cephalometric data obtained from manual cephalometry versus computer aided cephalometry

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Abstract

Background: Digital cephalometrics is an amalgation of Traditional Cephalometry. The emergence of computerized cephalometry has develop the need to examine the advantages and drawbacks of Traditional method of cephalometric analysis.

Material and Method: The study sample consisted of 25 lateral cephalometric radiographs which were selected randomly from the data files.

Results: The results of this study assessed that hand tracing procedure was by far, the most time consuming, while digital method of tracing were faster and simpler.

Conclusion: The computerised cephalometric tracing method by digitization is more reliable and consistent as compared to manual cephalometric tracing method.

Keywords: Manual cephalometry, Computer aided cephalometry, Nemoceph imaging software, Cephalometric data, Cephalometric analysis

Introduction

The advent of cephalometrics in 1931, by Broadbent and Hofrath simultaneously and independently[1], was a breakthrough in the field of orthodontics with reference to diagnosis, treatment planning, virtual treatment objective planning, growth modification, and surgical treatment planning. Traditional cephalometric analysis was performed by tracing radiographic landmarks on acetate matte sheets and employing these landmarks to measure the required linear and angular values. This traditional manual tracing and measurement process is not only time consuming but the measurements obtained are also prone to greater operator error. Earlier researchers[2,3] have shown that inconsistencies in landmark identification are an important source of error in conventional cephalometry. The other major sources of error in cephalometric analysis are errors related to radiographic film magnification, tracing and recording the measurements.

Many commercially available software programs have been developed to perform computer aided cephalometric analysis. They simplify the task of cephalometric analysis and reduce the time needed to perform cephalometric analysis[7,8,9]. The ease of use and ability to perform several analyses at the same time as well as convenience in generation of treatment predictions have contributed to a shift from manual tracings on acetate paper towards digital computer-aided cephalometry[10].

Computer aided digital cephalometric analysis employs a direct import of the radiograph from the digital Cephalostat to the computerized software tracing and analysis program.

Result

Statistical Analysis

The cephalometric parameters were statistically analyzed by calculating their means and standard deviations i.e. descriptive statistics. Then the means of measurements obtained by manual cephalometric tracings were compared with means of computerized lateral cephalometric tracings with the help of student's unpaired 't' test.

The definitions and formulae for calculating the mean, standard deviation, and tests for significance are given below:-

Mean: It is defined as summing up all observations and dividing the total by the number of observations. It is calculated as,

$$\overline{\boldsymbol{X}} = \frac{\boldsymbol{\Sigma X}}{\boldsymbol{n}}$$

Mean, x

Where,

X = The value of the variables.

$\boldsymbol{\Sigma}$ = Sum of the values.

n = number of observations.

Standard Deviation:- The standard deviation is the most frequently used measure of deviation. It is the most frequently used measure of deviation. It is defined as the root mean square deviation and is denoted by s or SD.

$$s = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(x_i - x)^2} \; -$$

Where,

X = mean

$\boldsymbol{\Sigma}$ = Sum of the values

$\overline{\mathrm{N}}$ = number of observations

Standard Error of Mean: Standard error of mean measures how precisely the population mean is estimated by the mean of the given sample. The standard error various with the size of the standard deviation. Greater the SD, greater the SE>

$SE = \frac{S}{\sqrt{n}}$

Where,

s= Standard deviation

n = number of observations.

Student's "t-test": It is used to test whether the means of two independent samples are significantly different. It is denoted by "t" The formula is

$t = \frac{X_1 - X_2}{sx_1x_2 - \sqrt{\frac{2}{n}}}$

Where in,

$s_{x1x2} = \sqrt{\frac{1}{2}(s^2x_1 + s^2x_2)}$

Where,

S_{x1x2} = combined standard deviation

$\bar{X}_1$ = Mean of the first Sample

$\bar{X}_2$ = Meant of the second sample

n_1 = Sample size of the first sample

n_2 = Sample size of the second sample

s_{x1} = Standard deviation of the first sample

s_{x2} = Standard deviation of the second sample

Discussion

Since the inception of cephalometrics by Hofrath and Broadbent[1], it has been the chief diagnostic tool in orthodontic diagnosis. Though conventional cephalometric analysis is still widely used in orthodontic offices, but the advantages and applications of digital cephalometric analysis is overwhelming in the field of orthodontics. Hand tracing of the cephalogram film depends on correct head posture (orientation to natural head position), proper exposure settings, the accuracy of tracing and intra-operator and inter-operator reproducibility.

Conventional tracing technique has many drawbacks. Moreover the acetate sheet obscures some landmarks making the identification of the landmarks difficult. All the measurements need to be calibrated to eliminate the magnification error in manual tracing which is a tedious process when done manually. There are 5 main factors which contribute to errors in identification of cephalometric points when subjected to manual tracing. These are sharpness, contrast, operator experience, variation in landmark definition and contour of a curved outline.[4,5,6]

Computers have been used for the purpose of clinical computerized cephalometrics since 1960's. Initially the measurements were transferred from a digitizer to a remote central computer using punch cards and magnetic tape. Digitizing tablets were used to record the X-Y co-ordinates of the cephalometric landmarks. A digitizing cursor is used to locate these points on the film placed over the digitizing tablet. There can be 2 modes to record information - point mode and stream mode.

Table 1: Mean, Minimum, Maximum & Standard Deviation of various parameters in Steiner's Analysis

Sl. No.	Parameter	Mean		Minimum		Maximum		Standard Deviation	
		Group A	Group B	Group A	Group B	Group A	Group B	Group A	Group B
1	SNA Angle (degree)	81.9	82.2	72.1	72.9	90.3	91.3	8.2	7.9
2	SNB Angle (degree)	77.8	78.5	70.4	71.4	88.4	89.3	6.9	7.1
3	ANB Angle (degree)	3.6	4.1	-2.1	-2.6	6.8	7.1	3.1	3.8
4	GoGn - SN Angle (degree)	31.2	30.8	27.4	26.4	40.2	41.3	8.7	8.3
5	U1 - NA angular (degree)	24.7	23.4	18.3	17.7	36.1	37.1	5.1	5.3
6	U1 - NA linear (mm)	6.2	6.1	3.7	4.1	8.5	8.8	3.4	3.6
7	L1 - NB angular (degree)	23.9	22.7	17.9	17.3	32.5	33.2	5.6	5.9
8	L1 - NB linear (mm)	5.3	5.9	3.6	3.4	7.1	7.4	2.9	3.1
9	Interincisal angle (degree)	124.5	125.7	111.6	112.5	145.8	146.2	11.8	12.2
10	Occlusal - SN (angular)	14.1	14.9	11.5	12.1	19.2	19.8	3.8	4.1

Key:

Group A: **Manual Cephalometric Tracing Group**

Group B: **Computerized Cephalometric Tracing Group (B)**

Table 2: "t" values for various parameters between Group A and Group B

Sl. No.	Parameter	"t" value	Probability	Significance
1	SNA Angle (degree)	0.74	0.51	NS
2	SNB Angle (degree)	1.13	0.41	NS
3	ANB Angle (degree)	0.64	0.471	NS
4	GoGn - SN Angle (degree)	1.26	0.87	NS

5	U1 - NA angular (degree)	0.34	0.72	NS
6	U1 - NA linear (mm)	6.3	0.1	HS
7	L1 - NB angular (degree)	1.52	0.272	NS
8	L1 - NB linear (mm)	8.31	0.21	HS
9	Interincisal angle (degree)	1.37	0.862	NS
10	Occlusal - SN (angular)	3.24	0.001	HS

Key:
NS: Not Significant
HS: Highly Significant

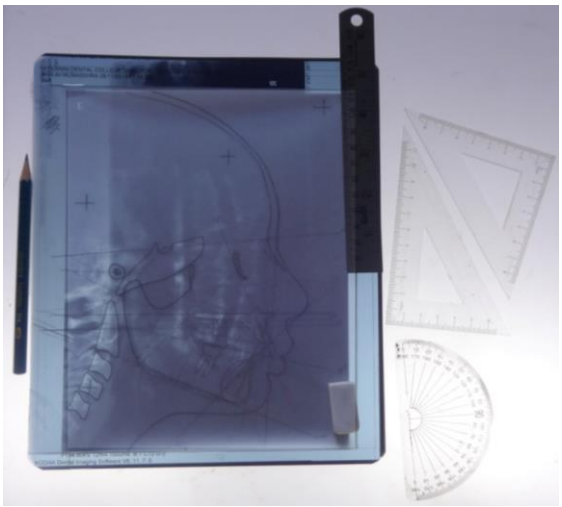

Fig. 1

Armamentarium used for Manual Cephalometric tracing

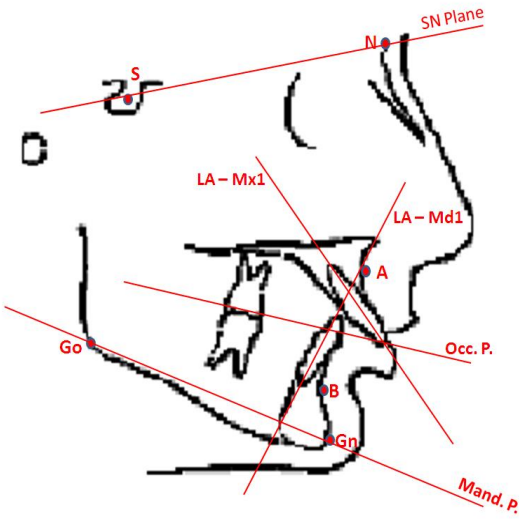

Fig. 2

Various Cephalometric Landmarks and Planes utilized in the study

Legend:

S : Sella
N : Nasion
A : Point A
B : Point B
Gn : Gnathion
Go : Gonion
LA-Mx1: Long Axis of Maxillary Central Incisor
LA-Md1: Long Axis of Mandibul

Conclusion

Conventional lateral cephalometric analysis is widely used in the orthodontic office and the advantages and applications of Digital cephalometric analysis is overwhelming in the field of Orthodontics & Dentofacial Orthopaedics.

Upon evaluation of the comparison between cephalometric data obtained from Traditional and manual cephalometric versus computer aided cephalometric tracing, we conclude that the advantages of Digital imaging such as archiving, transmission and enhancement make it a preferred choice in daily practice and research purposes without loss of quality. There is a distinct advantage of pin pointing the various points and landmarks in the manual method & there are limitations in identifying these points on digital programs and hence a via media is used that is the point and landmarks are first identified manually & then these are measured by computer assisted programs.

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