Research Article

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Comparison of Steiner's Cephalometric Analysis Values Between Conventional Manual and App Aided Tracings

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ABSTRACT

Background: To compare mean value of Steiner's Cephalometric Analysis values of skeletal & dental parameters between conventional manual and app-aided tracings.

Materials and methods: Pre-treatment lateral cephalometric radiographs of 20 skeletal Class I patients were randomly selected. Five skeletal and five dental Steiner's parameters were measured by 1 operator using 2 methods: App-aided tracing using the OneCeph beta 9 app (nxs@nxs.co.in, Hyderabad, Telangana, India), and manual tracings were performed by 2 operators to eliminate tracing errors. Inter-group comparisons were made with one-way analysis of variance.

Results: Mean value comparison of Steiner's skeletal parameters between conventional manual and app-aided cephalometrics in which there were no significant difference between the mean value SNA, SNB, ANB and mandible plane angle ($p \leq 0.68$, $p \leq 0.53$, $p \leq 0.75$ and $p \leq 0.96$ respectively) and there was significant difference present between the mean values of occlusion plane angle $p \geq 0.018$. Mean value comparison of Steiner's dental parameters between conventional manual and app-aided cephalometrics in which there were no significant difference between the mean value UI to NA (angle), UI to NA (linear), LI to NB (angle), LI to NB (linear) and 1/1 angle ($p \leq 0.92$, $p \leq 0.70$, $p \leq 0.84$, $p \leq 0.76$and $p \leq 0.55$ respectively).

Conclusion: Mean value comparison of Steiner's Cephalometric Analysis parameters between conventional manual and app-aided cephalometrics in which there were no significant difference were found except significant difference present between the mean values of occlusion plane angle $p \geq 0.018$.

Keywords: Steiner's skeletal parameters, Steiner's dental parameters, conventional manual tracings, app-aided tracings, Oneceph android app.

INTRODUCTION

Discovery of X-ray brought revolutionary change in medical and dental diagnostic field. Various diagnostic tools developed and improvised with the time. In orthodontics cephalometry is one of the main diagnostic tools. It provides details regarding craniometry which helps to clinician to derive more accurate diagnosis. Similarly hand wrist radiograph and cervical vertebrae radiograph helps to assess remaining skeletal growth in patient.

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Orthopantomogram helps to assess development stage of teeth.[1, 2]

Digital radiography has advantages over old methods, including reduced radiation dose, immediate radiographic image, darkroom removal and saving time and cost, storage and easy switching, facilitating consultation with other professionals, and the ability to improve images to meet specific needs. These benefits can help in choosing a standard method for future cephalometric measurements.[3, 4]

Cephalometric tracings can be achieved by manual and/or computerized methods. The manual method was previously the only available method used for achieving and procuring cephalometric tracings and angular and linear measurements required for their interpretation. The main drawback of this method was in the fact that it was more time-consuming, particularly for orthodontists and was subjected to a high degree of operator error.[5, 6]

Murali and Sukumar[7] conducted a study in 2011 on 80 patients with the aim of evaluating the accuracy of skeletal, dental, and soft tissue parameters in digital radiography using manual and computerized tracing techniques. According to the results of this study, most measurements between two manual tracing methods and the computer are not different.

The OneCeph android app was developed by nxs@nxs.co.in, Hyderabad, Telangana, India. It provides an alternative way to run cephalometric tracing without the use of conventional cephalometric radiographs. The aim of this study was to compare the conventional manual cephalometry with app-aided (OneCeph android app), which is provided by the Institute of Dental Education and Advanced Studies archive in Gwalior.

MATERIALS AND METHODS

Pre-treatment lateral cephalometric radiographs of 20 skeletal Class I patients (10 males, 10 females, mean age: 17.0 ± 4 years) were randomly selected from the archive of the "Institute of Dental Education and Advanced Studies", Department of Orthodontics, Gwalior, Madhyapradesh. The cephalometric images were taken with the patient in the upright standing position with the Frankfort plane parallel to the floor, keeping the teeth in centric relation and the lips relaxed. All the lateral cephalometric radiographs were taken using the same cephalometric radiography machine by the same technician with a magnification factor of 1.1. The exclusion criteria were poor quality of cephalograms with artifacts that could interfere with the anatomical point identification, all teeth till second molar should present, no unerupted or partially erupted teeth preventing incisor apex identification, and craniofacial deformities.

To optimize landmark identification, the same operator undertook all the digital and manual tracings, and to identification of landmarks, 1 additional manual operator was included. To determine the intra-operator error, 20 radiographs were retraced by the same operator after an interval of 1 month. Steiner's cephalometric analysis was performed by conventional manual tracing and app-aided tracing method.

Manual Tracing

Manual tracing was performed on the printed image using a 0.35-mm lead pencil. All the hard tissue and soft tissue landmarks were traced and double images were centered to form a single landmark. A ruler and protractor were used to measure the angular and linear parameters (Figure 1).

App-aided Tracing

For the app tracing method, the OneCeph beta 9 app (nxs@nxs.co.in, Hyderabad, Telangana, India) was used. All the digital radiographs were uploaded as .jpeg files using a standard computer. The files were in grayscale format, and the image properties of the film were 1319×944 pixels, 150 dpi, and 24 bits. The radiographs were imported to the OneCeph app using an android smartphone. The same calibration procedure (20 mm) was performed for the cephalometric films. Landmark identification was carried out manually on a smartphone screen using the index finger. The zoom-in/zoom-out function was used when needed (Figure 1).

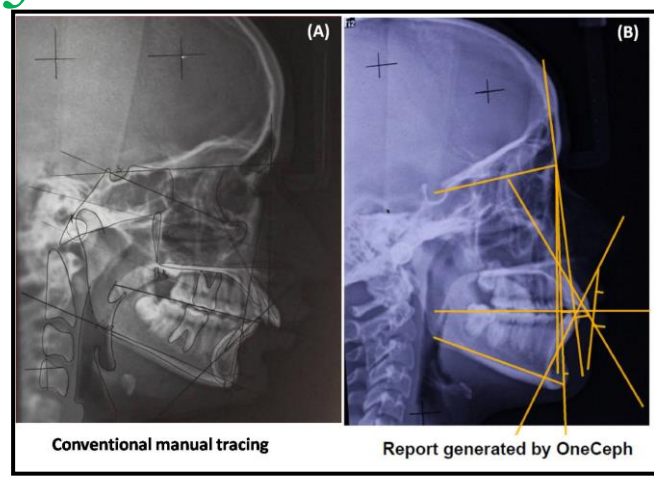


Fig 1: Conventional manual tracing and App-aided (Oneceph App) tracing.

RESULTS

Table 1 shows mean value comparison of Steiner's skeletal parameters between conventional manual and app-aided cephalometrics in which there were no significant difference between the mean value SNA, SNB, ANB and mandible plane angle (p≤0.68, p≤0.53, p≤0.75 and p≤0.96) and there was significant difference present between the mean value of occlusion plane angle p≥0.018.

Table 1 Mean value comparison of Steiner's skeletal parameters between conventional manual and app-aided cephalometrics

	Conventional cephalometrics	App-aided cephalometrics	STD. DEV	95% Confidence Interval of the Difference		
				Lower	Upper	P value
SNA	81.05	81.08	.38	-.21420	.14420	.68(NS)
SNB	78.70	78.79	.63	-.38944	.20944	.53(NS)
ANB	2.35	2.32	.34	-.13775	.18775	.75(NS)
Occlusion plane angle	16.0	16.22	.38	-.40650	-.04350	.018(s)
Mandible plane angle	33.45	33.43	1.72	-.79224	.82224	.96(NS)

Graph 1 shows mean value comparison of Steiner's skeletal parameters between conventional manual and app-aided cephalometrics in which mean value SNA, SNB, ANB and mandible plane angle are approximately 50% in both cephalometrics, which means there was no significant difference and mean value of occlusion plane angle mean value of app-aided cephalometrics was more than 55% which there was difference in both cephalometrics value.

Graph 2 shows mean value comparison of Steiner's dental parameters between conventional manual and app-aided cephalometrics in which mean value UI to NA(angle), UI to NA (linear), LI to NB (angle), LI to NB (linear) and 1/1 angle are approximately 50% in both cephalometrics, which means there was no significant difference in both cephalometrics value.

Graph 1 Mean value comparison of Steiner's skeletal parameters between conventional manual and app-aided cephalometrics.

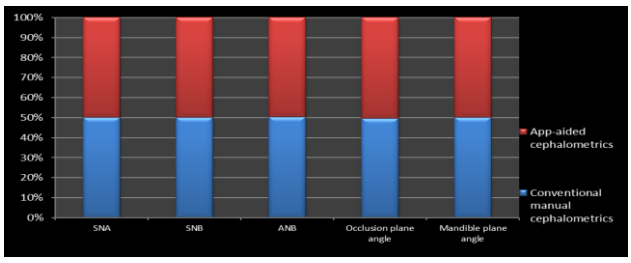
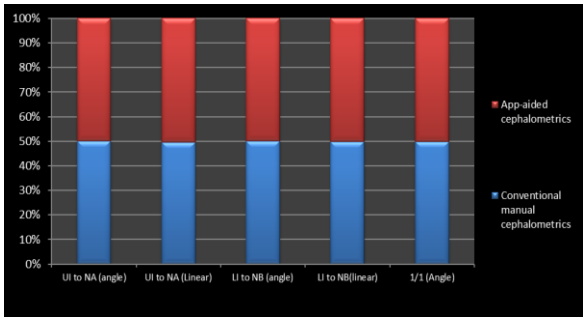


Table 2 shows mean value comparison of Steiner's dental parameters between conventional manual and app-aided cephalometrics in which there were no significant difference between the mean value UI to NA (angle), UI to NA (linear), LI to NB (angle), LI to NB (linear) and 1/1 angle (p≤0.92, p≤0.70, p≤0.84, p≤0.76and p≤0.55).

Table 2: Mean value comparison of Steiner's dental parameters between conventional manual and app-aided cephalometrics

	Conventional manual cephalometrics	App-aided cephalometrics	STD. DEV	95% Confidence Interval of the Difference		
				Lower	Upper	P VALUE
UI to NA (angle)	25.27	25.26	.43	-.19535	0.21535	0.92(NS)
UI to NA (Linear)	6.32	6.41	.99	-.54888	0.37888	0.70(NS)
LI to NB (angle)	27.20	27.16	.76	-.32281	0.39281	0.84(NS)
LI to NB(linear)	5.80	5.87	1.04	-.55711	0.41711	0.76(NS)
1/1 (Angle)	122.85	123.16	2.36	-1.42057	0.79057	0.55(NS)

Graph 2- Mean value comparison of Steiner's dental parameters between conventional manual and app-aided cephalometrics



DISCUSSION

The aim of this study was to compare the accuracy of cephalometric readings of conventional manual tracing of cephalograms to digital android app-aided tracing. The manual method is not only time-consuming but also allows more measurement errors caused by clinicians. The reproducibility of cephalometric points in conventional manual method on paper in comparison to the analysis of digital image was controversial for a long time. Nowadays, due to the technology advancement and necessity of data mobility, the manual method is becoming a handicap. Nowadays, digitizing X-rays has become the preferred method to perform cephalometric measurements. As technology evolves, it becomes increasingly easier for professionals to adapt to the many routine tasks of clinical practice. [8] Linear measurements may be altered by the inclination of the reference line, and angular measurements cannot indicate correctly the jaw relationship in the case of extreme facial divergence. The cephalometric radiographs used in this study were randomly chosen and portrayed the quality of daily routine work. The variables used in this study were commonly used cephalometric variables for orthodontic diagnosis, treatment planning, and evaluation of treatment results. Steiner's analysis is commonly used for orthodontic investigation, treatment planning, and evaluation of orthodontic treatment.[9, 10]

Landmark identification is greatly affected by operator experience, which is just as crucial as the tracing method itself. Because inter-operator error has in general been found to be greater than intra-operator error as stated by Sayinsu *et al.*[11] to reduce the error, all measurements in this study were carried out by the same examiner. In this study, the analysis of the results obtained when correlating the cephalometric measurements recorded in app-aided digital and conventional manual tracings revealed values that showed statistically no significant differences except in occlusion plane angle p≥0.018. These findings reinforce those of Chen *et al.*[12] and Bruntz *et al.*[13] Meric and Naomova[14] found in his study that automatic analysis with CephX needs to be more reliable. However, CephX analysis with manual correction is promising for use in clinical practice because it is comparable to CephNinja and Dolphin, and the analyzing time is significantly shorter. In our study also we found that OneCeph required less armamentarium and time to perform cephalometric analysis in comparison to conventional manual tracing.

Table 3: Clinical Parameters

S. NO.	METHOD	PARAMETERS									
		SNA	SNB	ANB	Occlusal plane angle	Mand. plane angle	UI to NA (angle)	UI to NA (linear)	LI to NB (angle)	LI to NB (linear)	1/1 angle
1.	A	78	76	2	20	39	26	8	28	7	127
	B	77.9	76.1	1.8	19.8	39.2	26.1	8.2	27.9	6.8	127.6
2.	A	81	78	3	18	37	26	7	27	7	124
	B	81.3	78.1	3.2	18.3	37	25.8	6.9	27.1	7.1	124.3
3.	A	82	79	3	19	38	27	7.5	29	8	121
	B	82.4	79.6	2.8	19.1	37.9	27.1	7.6	29.2	8.1	120.9
4.	A	79	77	2	16	34	23	6	26	5	130
	B	79.1	77.2	2.1	16.3	33.9	23.2	5.9	26.1	5.1	130.2
5.	A	83	81	2	16	34	25	6	27	5	125
	B	83	80.8	2.2	16.3	34.1	24.9	6.2	26.9	4.9	125.3
6.	A	79	77	2	17	35	31	9	30	9	115
	B	78.6	76.9	1.7	17.2	34.9	31.1	9.1	30.6	9.2	115.8
7.	A	80	78.5	1.5	13	29.5	19	2.5	21	3	147
	B	79.9	78	1.9	12.5	29.8	19.2	2.6	20.8	2.8	146.8
8.	A	83	81	2	19	38	26	10	31	9	112
	B	82.6	80.7	1.9	18.9	38.1	25.9	9.8	30.6	8.7	112.8
9.	A	82	79	3	20	41	28	8.5	31	7.5	118
	B	82.4	79.6	2.8	20.6	40.8	27.8	8.9	31.7	8.1	113.9
10.	A	84	82	2	18.5	37.5	25	7	28	6.5	126
	B	83.7	81.4	2.3	18.9	36.9	24.8	6.7	27.6	6.9	126.1
11.	A	80	78.5	1.5	11	28	21	3	26	3.5	148
	B	80.4	78.7	1.7	11.9	27.9	20.7	2.9	25.8	3.3	147.7
12.	A	84	81	3	17	36	25.5	6.5	27.5	6	128
	B	84.2	81.3	2.9	16.8	35.9	25.8	6.9	26.8	5.8	127.9
13.	A	81	79	2	11	27	20	2.5	22.5	2	110
	B	80.8	78.6	2.2	12.1	26.4	18.9	2.7	21.9	1.9	111.7
14.	A	81	78	3	12.5	29	19	2	21	2.5	115
	B	81	77.9	3.1	12.8	28.6	18.7	2.1	20.8	1.9	118.6

15.	A	82	80	2	18	36	27	7	26	6	125
	B	82.1	80.5	1.6	18.4	36.8	27.2	7.3	25.7	6.8	125.4
16.	A	82	79	3	11	26	35	9	32	7	108
	B	81.9	79.3	2.6	11.2	26.8	35.2	9.2	32.5	7.2	108.5
17.	A	77	75	2	18	32	25	6	21	4	129
	B	77.5	75.7	2.2	18.3	31.9	25.2	6.1	20.8	4.2	129.2
18.	A	82	80	2	15	29	23	7	32	8	116
	B	81.8	79.6	2.2	14.6	28.8	23.2	7.1	32.3	8.3	116.6
19.	A	81	78	3	15	34	22	4	30	5	122
	B	81.1	78.4	2.7	15.3	34.2	22.4	4.1	30.2	5.2	122.6
20.	A	80	77	3	15	29	32	8	28	5	111
	B	80	77.4	2.6	15.2	28.8	32.1	7.9	28	5.1	111.4

The differences in the values were most probably due to the difficulty in identification of landmarks in the digital version of the radiograph due to change in image quality and morphing of the radiographs as well as differences in measurements of the values for the analysis due to inaccurate landmark identification. The ease of identification of anatomical landmarks in the analog radiographs as well as the reliability of manual recordings of the analysis values makes manual tracings a more accurate and dependable method for cephalometric analysis.

CONCLUSION

Cephalometric analysis can be performed faster and more reliably with the help of different digital cephalometrics tool like cephalometric computer software (Dolphin and NemoCeph etc.) and android cephalometric app (OneCeph) and IOS cephalometric app (CephNinja). On the basis of the results from this study, it can be concluded that mean value comparison of Steiner's Cephalometric Analysis parameters between conventional manual and app-aided cephalometrics in which there were no significant difference were found except significant difference present between the mean values of occlusion plane angle $p \geq 0.018$. So we can conclude that app-aided cephalometrics are as reliable as conventional manual cephalometrics.

CONFLICTS OF INTEREST

The authors declare they have no potential conflict of interests regarding this article.

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