

AN EVALUATION OF THE CEPHALOMETRIC SOFT AND HARD TISSUE CENTROID REFERENCE LINE IN A HETEROGENOUS SAMPLE

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ABSTRACT

The study assessed the applicability of utilizing a newly introduced non-anatomical soft and hard tissue centroid line (S&H centroid) in differentiating between sagittal and vertical cephalometric skeletal intermaxillary relationship in a heterogeneous sample. The sample consisted of 87 lateral cephalometric radiographs size 12" x 14" of subjects with a mixed sagittally; skeletal Class I, II and III and vertically; skeletal horizontal and steep mandibular planes. The mean values of the sagittal and vertical maxillary and mandibular measurements were established and statistically investigated. Pearson correlation co-efficient was used to assess the reliability. One Way ANOVA and Tukey Multiple Comparison Post Hoc test with significant level at $P < 0.05$ were also used. The findings were also statistically compared to a previously reported findings of a homogenous sample, using independent t-test at $P < 0.05$. The results indicated high intra examiner reliability, with correlation co-efficient between 0.00 – 1.00. The centroid based reference line has the ability to evaluate and statistically differentiate between the sagittal and vertical intermaxillary relationships in both heterogeneous and homogenous samples. In conclusions the findings tend to confirm the applicability or usefulness of the (S&H centroid) line in the cephalometric skeletal evaluation.

INTRODUCTION

The introduction of the centroid in cephalometry was reported almost fifty years ago.¹ However, the technical establishment of the area centroid of the whole cephalometric anatomical skull was difficult and impractical for orthodontists. Therefore, limited studies were reported.¹⁻¹¹ Some studies were introduction of the concept of the centroids in cephalometry and basic research.^{1-5,9-13} Very few were clinical evaluation studies.^{6,7,8} Such clinical studies modified and simplified establishing the centroid by representing the actual cephalometric image of the skull and/or its major-cranium, maxilla, mandible-components into simple geometrical shapes. The centroid was then established for that geometrical shape(s). However, with the general advancement of computer technology a recent study introduced a new soft and hard tissue centroid (S&H Centroid) line.¹² The applicability of such S&H centroid line was investigated in a homogenous skeletal Class I sample with normal occlusion and pleasing profile.¹³ A Centroid-Nasion (C-N) reference line was

created utilizing the newly introduced S&H centroid line. It was concluded that such C-N reference line was as applicable or useful as the conventionally used S-N cephalometric plane in such homogenous sample. The aim of the present study was to investigate the reliability and applicability of the cephalometric S&H centroid line in a larger heterogeneous sample consisted of skeletal; sagittal Class I, II and III, as well as vertical; steep and horizontal mandibular planes.

MATERIALS AND METHODS

The sample consisted of seventy eight lateral cephalometric radiographs size 12" x 14" obtained from adult subjects with the following criteria:

- Adult with permanent dentition
- Head in natural head posture, with lip at rest
- Heterogeneous sample with different malocclusions, sagittally and vertically; ($-4^{\circ} > ANB > 7^{\circ}$ and $23^{\circ} > MP > 48^{\circ}$) respectively

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- No previous orthodontic treatment
- No functional mandibular shifts resulted from extensive restorations, severe dental attrition, ectopic tooth eruption and /or missing teeth

From those lateral cephalometric radiographical images, the S&H centroid line was created using the customized computer software program (m-file) as reported by Al-Balkhi 2008⁽¹²⁾. The C-N cephalometric reference line was established and compared to the conventionally used S-N line as being conducted and reported by Al-Shahrani⁽¹³⁾ in his homogenous skeletal Class I sample. The reliability and the applicability of the cephalometric S&H centroid line in the present heterogeneous sample was investigated utilizing the exact study method, variables and statistical tests reported by Al-Shahrani⁽¹³⁾ as well as using the statistical independent t-test to analyze the statistical difference between the subtracted mean values of the two studies. A perpendicular line dropped from point Nasion (N) to the S&H centroid (Point C), to form the N-C cephalometric reference line. The sagittal maxillary and mandibular measurements utilizing the N-C reference line were established and compared to those established by utilizing the conventional S-N cephalometric line (Figure 1). Likewise the vertical maxillary and mandibular measurements utilizing the N-C reference line were established and compared to those established by the conventional S-N reference line (Figure 2). The measurements and standard deviations of the sagittal and vertical maxillary and mandibular measurements for the centroid (C-N based) and the conventional (S-N based) cephalometric angles were calculated. Statistical comparison between the centroid and the conventional angles were conducted utilizing one-way ANOVA and Tukey multiple comparison post Hoc test, with significance was level set at $P < 0.05$. The findings of the present study was also statistically compared to those reported by Al-Shahrani⁽¹³⁾, using independent t-test at $P < 0.05$. Statistical analysis were performed using the SPSS 12 Program (SPSS Inc., Chicago, Illinois USA) for windows.

RESULTS

The results indicated high intra examiner reliability with correlation coefficient ranged between 0.99 – 1.00. The mean and standard deviation of the C-N based, the conventional S-N based, and the subtracted difference values of the investigated sagittal and vertical variables were presented (Table 1). The one way ANOVA and the Tukey multiple comparison post Hoc

tests showed statistical difference between the four sagittal and vertical subtracted mean values. The two sagittal variables were statistically different than the two vertical variables ($P=0.000$) (Table 2). However, no statistical difference was found between the subtracted mean values within the sagittal and vertical group variables ($P=1.00$ and $P=0.93$ respectively (Table 3). No statistical difference was also found between the mean values of the investigated subtracted differences of the heterogeneous sample of the present

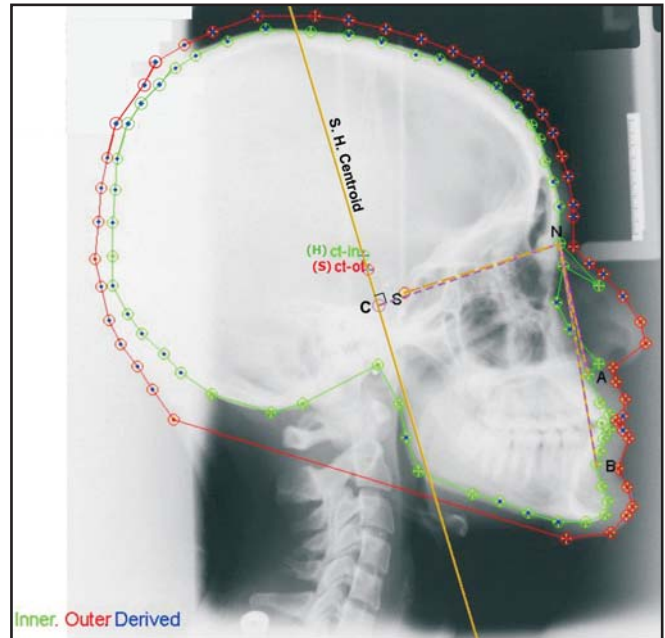


Fig 1: The centroid and conventional sagittal variables

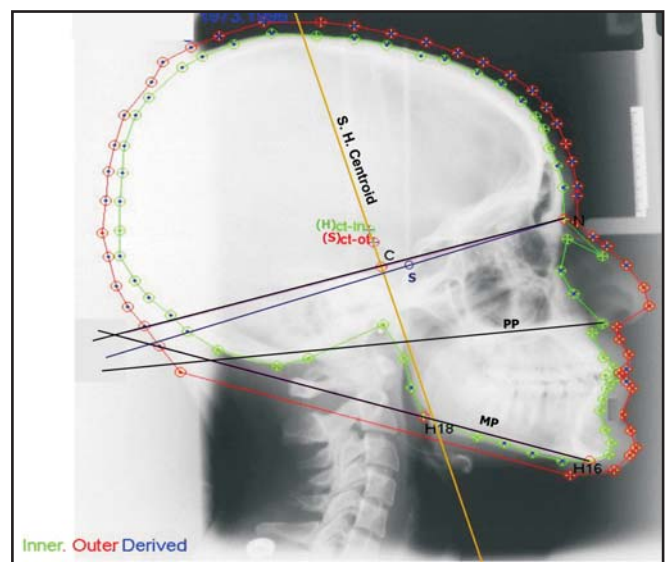


Fig 2: The centroid and conventional vertical variables

TABLE 1: MEAN AND STANDARD DEVIATION FOR THE VALUES OF THE SAGITTAL AND VERTICAL CENTROID AND CONVENTIONAL VARIABLES WITH THE SUBTRACTED DIFFERENCE

Centroid (C-N based) Analysis			Conventional (S-N based) Analysis			Centroid (-) Conventional Subtracted Difference		
Variable Analysis	Mean	SD	Variable Analysis	Mean	SD	Variable	Mean	SD
C-N-A	87.45	7.77	S-N-A	82.41	3.76	D-C-S-A	5.05	7.43
C-N-B	84.49	7.85	S-N-B	79.42	4.00	D-C-S-B	5.07	7.43
A-N-B	2.98	2.31	A-N-B	2.98	2.31	N/A	N/A	N/A
C-N/MP	27.96	5.40	S-N/MP	34.67	5.46	D-C-S/MP	-6.71	2.93
C-N/PP	3.15	7.83	S-N/PP	8.20	4.11	D-C-S/PP	-5.05	7.43
PP/MP	26.47	5.01	PP/MP	26.47	5.01	N/A	N/A	N/A

TABLE 2: ONE WAY ANOVA TO COMPARE THE SAGITTAL AND VERTICAL SUBSTRACTED C-N AND S-N BASED ANGLES

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	Sig.
D-C-S-A	D-C-S-B	-.01736	1.00092	1.000
	D-C-S/MP	11.76023*	1.00092	.000
	D-C-S/PP	10.09598*	1.00092	.000
D-C-S-B	D-C-S-A	.01736	1.00092	1.000
	D-C-S/MP	11.77759*	1.00092	.000
	D-C-S/PP	10.11333*	1.00092	.000
D-C-S/MP	D-C-S-A	-11.76023*	1.00092	.000
	D-C-S-B	-11.77759*	1.00092	.000
	D-C-S-PP	-1.66425	1.00092	.345
D-C-S/PP	D-C-S-A	-10.09598*	1.00092	.000
	D-C-S-B	-10.11333*	1.00092	.000
	D-C-S-PP	-1.66425	1.00092	.345

*The mean difference is significant at the .05 level.

Sig. = Significant; I = the tested individual subtracted sagittal or vertical C-N and S-N based angles;

J = the remaining three subtracted sagittal or vertical C-N and S-N based angles that were tested against.

TABLE 3: TUKEY MULTIPLE COMPARISON POST HOC TEST

Group	N	Subset for alpha - .05	
		1	2
D-C-S-A	87		5.0478
D-C-S-B	87		5.0652
D-C-S/MP	87	-6.7124	
D-C-S/PP	87	-5.0482	
Sig.		.345 NS	1.000 NS

NS = Not significant

TABLE 4 : MEAN AND STANDARD DEVIATION OF THE SUBSTRACTED DIFFERENCES OF THE HOMOGENOUS AND HETEROGENEOUS SAMPLES OF THE TWO STUDIES

Variables	Present Study Heterogeneous sample N = 87		Al-Dhahran Study Homogenous sample N = 57		Sig.
	Mean	SD	Mean	SD	
D-C-S-A	5.05	7.43	5.31	7.73	NS
D-C-S-B	5.07	7.43	5.34	7.73	NS
D-C-S/MP	-6.71	2.93	-6.09	2.80	NS
D-C-S/PP	-5.05	7.43	-5.32	7.73	NS

Sig. = Significant P<0.05, NS = Not significant

study, compared to the previously reported homogeneous sample (Table 4).

DISCUSSION

As it was expected, the reliability of the digitization technique, the method used for cephalometric landmark identification and data collection were not affected by altering the homogeneity of the sample. The reliability of the study was significantly high, which was in agreement with other reports.¹³⁻¹⁷ The C-N based analysis and the conventional S-N based analysis both have the same ability to evaluate and establish the sagittal as well as the vertical intermaxillary relationship in a heterogeneous sample.

In table 1-3, the findings of the subtracted mean values related to the sagittal and vertical variables in the present heterogeneous sample showed the same behavior, to the subtracted mean values of the homogeneous sample reported by Al-Shahrani¹³. The subtracted mean values for the sagittal variables were almost the same (5.05) and (5.07), and the subtracted mean values for the vertical variables were also almost similar (-6.71) and (-5.05). The statistical significant difference found between the two groups - the sagittal group variables vs the vertical group variables -, and the no statistical difference between the values within each of the two individual groups - the two variables within the sagittal group or the two variables within the vertical group -, indicated that the values of the sagittal variables and the vertical variables could be considered as a constant, with the positive or negative sign reflecting the sagittal or vertical group respectively.

Further studies are recommended to support the investigation of the applicability of the S&H centroid line. It may be of interest to study the variations or changes in the spacial inclination of the S&H centroid line in cases with different sagittal - Class I, II, III - and vertical - horizontal, normal, vertical - skeletal relationships. Also, it may be of interest to study longitudinally the stability or changes in the inclination of the S&H centroid line, from childhood to adulthood.

If the results of such future studies support the reliability of the S&H centroid line as being the least variable non anatomical cephalometric line, as well as, confirming its applicability to differentiate between the different skeletofacial growth patterns, then such non anatomical reference line could be considered a logical cephalometric reference line for evaluating craniofacial growth, and/or malocclusion, compared to the reported centroids in the literature.^(1-6,18) However, at present such study is still limited by; the inaccessibility of the customized software program, the cost and the possible clinical unavailability of the hardware tools including the large size (12" x 14") film/cassette, and

finally the time consuming to digitize the numerous soft and hard tissue anatomical landmarks.

CONCLUSION

The homogeneity or heterogeneity of the sample did not affect the reliability of the method, nor the applicability of the "S&H centroid" line. The created C-N reference line utilizing the S&H Centroid has the ability to differentiating between sagittal as well as vertical maxillo-mandibular relationships.

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