CEPHALOMETRIC MEASUREMENTS: COMPARISON BETWEEN ANALOG X-RAY FILM AND DIGITAL CEPHALOMETRIC IMAGE

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ABSTRACT

This research is focused on the comparison of measurements between analog x-ray film and digital cephalometric image. This study is designed to determine the best measurement method between manually tracing and using computer software. Two (2) types of data from the same patient were used in this research. The data is analog x-ray film and digital cephalometric image (obtained from scanned x-ray film). A total of ten landmarks were used for comparison. All landmarks on the film and digital cephalometric image were traced using manual method (via tracing paper) and computerized method (via Rhinoceros 2.0 software) respectively. The landmarks were identified five times for each method to ensure the precision of the landmark identification. The results of landmark identification for both manual and computerize methods were compared by measurement of angle SNA, SNB, ANB and MMPA, and linear distance between Po-Or, PNS-ANS and Go-Me. This comparison gives the value of mean and standard deviation to show the best measurement method between manual and computerized approaches.

Keywords: Cephalometric Measurements, Computerized Landmark Identification.

1. Introduction

Cephalometric is an overlay drawing traced over a two (2) dimension of craniofacial lateral x-ray that shows specific structures and landmarks that provided a basis for orthodontic therapy. Cephalometry has been heavily reliant on radiography since Broadbent (1931) first introduce cephalometric radiography into orthodontics. Cephalometric radiograph taken under standardized conditions have provided valuable clinical and research information about craniofacial morphology. Lateral cephalograms may be traced manually but more recently computers have been used. Cephalometry is useful in showing the facial deformity and in determining the true relationship of the maxilla and mandible to each other and to the skull base (David, 1982).

Three techniques are commonly used to identify and record landmarks in cephalometric studies. These are (Turner & Weerakone, 2001):-

1. Overlay tracing of the lateral skull radiograph on an x-ray viewer, followed by direct measurement of cephalometric lines and angles on the tracing paper using a ruler and protector.
2. Overlay tracing of the radiograph to identify anatomical and constructed point followed by transfer of the tracing to a digitizer link to a computer.
3. Direct digitization of the lateral skull x-ray using a digitizer link to a computer.

Several studies have examined the accuracy and reproducibility of landmark identification using different method. Direct digitization of radiograph is reported to be the

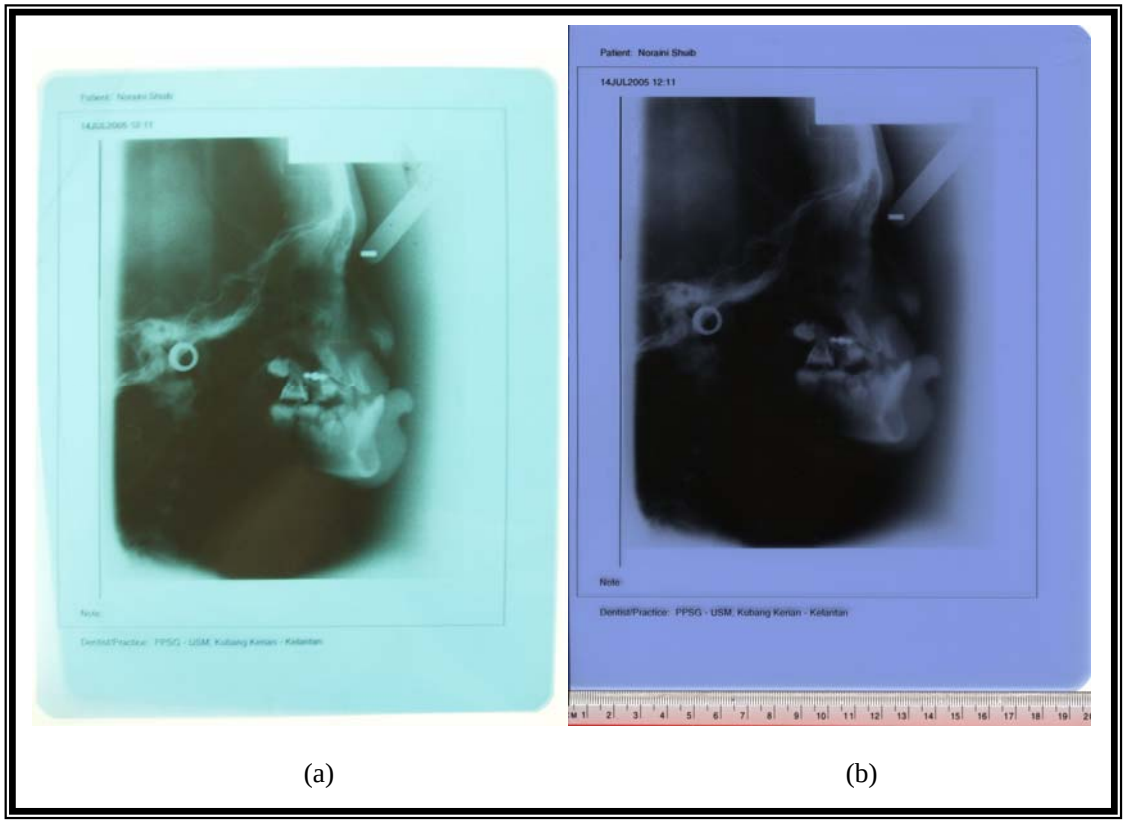
most reproducible and therefore the most accurate method (Richardson, 1981; Sandler, 1988). Direct digitization is easier than other method because it does not use a lot of things to identify the landmarks and doing the measurement.

This research is focused on the comparison of measurements between analog x-ray film and digital cephalometric image. This study is designed to determine the best measurement method between manually tracing and using computer software.

2. Materials and Methods

This study used two (2) types of data from the same patient. The data is x-ray film and digital cephalometric image. The sample data (x-ray film) used in this research is obtained from Hospital Universiti Sains Malaysia (HUSM), Kubang Kerian, Kelantan, Malaysia.

The digital cephalometric image was get from the x-ray film that scanned using UMAX PowerLook 2100XL with 200dpi resolution. The ruler was put together with x-ray film for easier to scaling the image in Rhinoceros 2.0 software. Figure 1 shows the x-ray film and the image that has been scanned from the x-ray film.



(a) (b)

Figure 1: The data for this study (a) x-ray film and; (b) scanned cephalometric image

2.1 Landmarks Identification

There are 10 landmarks used for this research. Table 1 and Figure 2 show the list of landmarks with the descriptions and the location.

Initial	Name	Description
N	*Nasion*	The intersection of nasal septum and anterior cranial base.
S	*Sella*	The midpoint of the cavity of sella turcica.
Go	*Gonion*	Most outward inferior point on the angle of mandible.
A	*Point A*	The innermost point of the contour of the premaxilla between the anterior nasal spine (ANS) and the incisor tooth.
B	*Point B*	The innermost point on the contour of the mandible between the incisor tooth and the bony chin.
Or	*Orbitale*	The most inferior point of the bony orbit.
P	*Porion*	Upper most point on bony external auditory meatus.
Me	*Menton*	The lowest point on mandibular symphysis.
ANS	*Anterior Nasal Spine*	The tip of the Anterior Nasal Spine.
PNS	*Posterior Nasal Spine*	The tip of Posterior Nasal Spine.

Table 1: Cephalometric landmarks

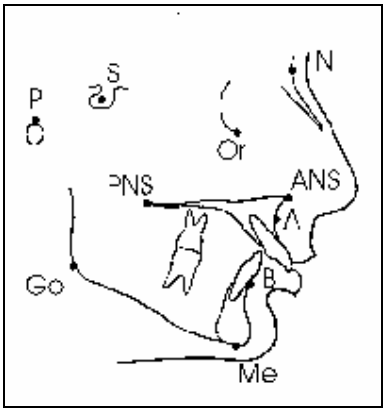


Figure 2: Cephalometric landmarks location

2.1.1 Manually Tracing

The manual tracing technique used a tracing paper to trace the outline and the landmarks. The outlines of the image were digitized based on the soft tissue and the bones of the landmarks position. The outlines are useful for the landmark identification. The landmark identification was done by using the landmarks description for references. Figure 3 shows the manually tracing for the landmark identification using tracing paper.

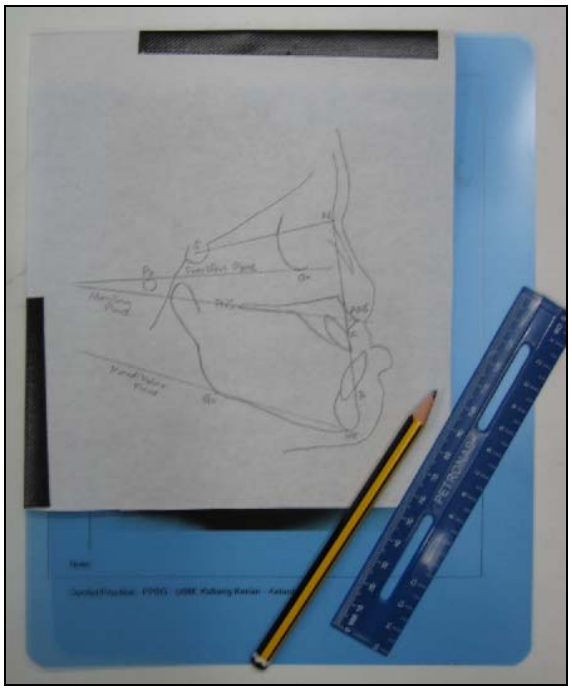


Figure 3: Manually tracing for landmarks identification using tracing paper

2.1.2 Computerized Landmark Identification

The computerized landmark identification technique was done using Rhinoceros 2.0 software. The cephalometric image that scanned from the x-ray film was digitized in this software. Same with the manually tracing, the outlines were digitized for easily to identify the landmarks.

The landmarks were identified based on the landmarks description in Table 1. The landmarks were identified 5 times to get 5 measurement values for the analysis. Figure 4 shows the landmark identification using the computer software (Rhinoceros 2.0).

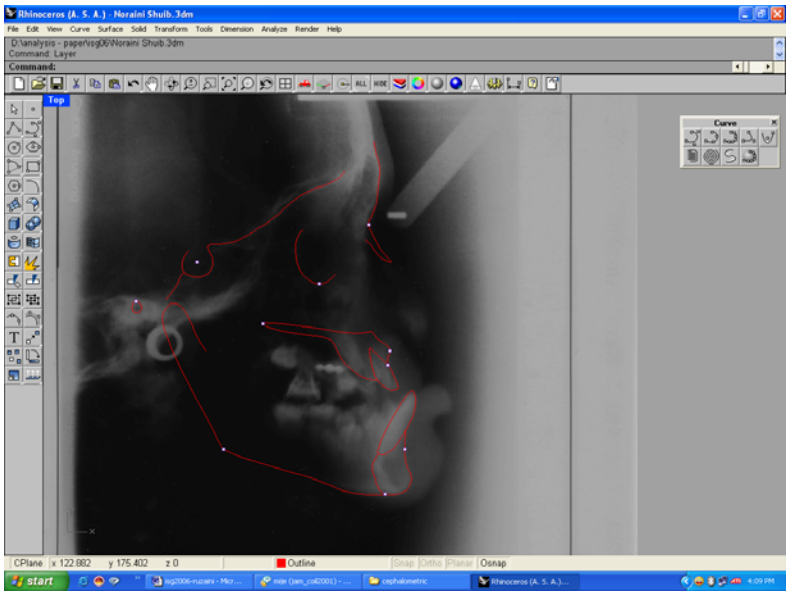


Figure 4: Landmark identification using the computer software (Rhinoceros 2.0).

2.2 Measurement

The landmarks were measured 5 times for both technique (manually and computerized). Each technique gives 7 measurements. Table 2 shows the measurement descriptions for the cephalometric analysis measurement.

Measurement	Description	Type
Po – Or	*Frankfort Horizontal Plane* – Equivalent to the true horizontal when patient is standing upright.	Linear
PNS – ANS	*Maxillary Plane* – Gives inclination of maxilla relative to other lines/planes.	
Go – Me	*Mandibular Plane* – Gives inclination of mandible relative to other lines/planes.	
SNA	Indicates relative position of maxilla/mandible to each other and to the cranial base	Angular
SNB	Indicates anteroposterior position of mandible apical base and the relationship with cranial base.	
ANB	Indicates relation of anteroposterior apical base between mandible and maxilla	
MMPA (*Maxilla Plane* to *Mandibular Plane*)	Gives an inclination of the maxilla relative to the mandible, this in turn indicates the relative proportions of face height and acts as an indicator for future growth direction.	

Table 2: Cephalometric measurements

The 7 measurements were measured 5 times to get the averages. The computerized method used computer software (Rhinoceros 2.0) to measure the distances and angles; and the manually tracing method used the caliper (linear) and protector (angular) for measurement. Table 3 shows the averages values of 7 measurements for computerized and manually measurement.

Technique	Measurement	1	2	3	4	5	Average
Computerized	SNA (°)	85.41	85.77	85.35	85.76	85.38	**85.534**
	SNB (°)	86.9	87.27	86.88	87.2	86.97	**87.044**
	ANB (°)	1.49	1.5	1.53	1.43	1.6	**1.51**
	MMPA (°)	3.45	4.08	4.32	4.71	3.81	**4.074**
	Po–Or (mm)	55.719	55.864	56.013	56.288	56.007	**55.9782**
	PNS–ANS (mm)	39.372	39.336	39.293	39.254	39.363	**39.3236**
	Go–Me (mm)	50.756	50.987	51.232	50.934	51.09	**50.9998**
Manually Tracing	SNA (°)	84	85	85	85	84	**84.6**
	SNB (°)	84	84	85	84	84	**84.2**
	ANB (°)	0	1	0	1	0	**0.4**
	MMPA (°)	9	10	9	9	10	**9.4**
	Po–Or (mm)	58	58.7	58.5	58.55	58.35	**58.42**
	PNS–ANS (mm)	46.45	46.65	46.4	46.35	46.55	**46.48**
	Go–Me (mm)	53.65	53.5	53.35	54.1	53.75	**53.67**

Table 3: The measurements for computerized landmark identification and manually tracing

3. Analysis

For statistical evaluation, *t*-test was applied to the repeat measurement. This calculation is done using SPSS statistical software. Table 4 shows the comparison of mean, standard deviation and standard error mean for each measurement.

	N	Mean		Std. Deviation		Std. Error Mean	
		Manually	Computerized	Manually	Computerized	Manually	Computerized
SNA	5	84.6000	85.5340	0.54772	0.21197	0.24495	0.09479
SNB	5	84.2000	87.0440	0.44721	0.17925	0.20000	0.08016
ANB	5	0.4000	1.5100	0.54772	0.06205	0.24495	0.02775
MMPA	5	9.6000	4.0740	0.54772	0.48066	0.24495	0.21496
Po-Or	5	58.4200	55.9782	0.26599	0.21109	0.11895	0.09440
PNS-ANS	5	46.4800	39.3236	0.12042	0.04957	0.05385	0.02217
Me-Go	5	53.6700	50.9998	0.28417	0.17747	0.12708	0.07937

Table 4: Comparison of mean, standard deviation and standard error mean for manually and computerized landmark identification

Table 4 shows the value of mean, standard deviation and standard error mean for both measurement methods (manual and computerized). From the statistical calculation using SPSS software, it shows the mean, standard deviation and standard error mean of computerized method are smaller than manual method. For the graphic comparison, Figure 5 shows the comparison measurement method between manual and computerized landmark identification by the graph.

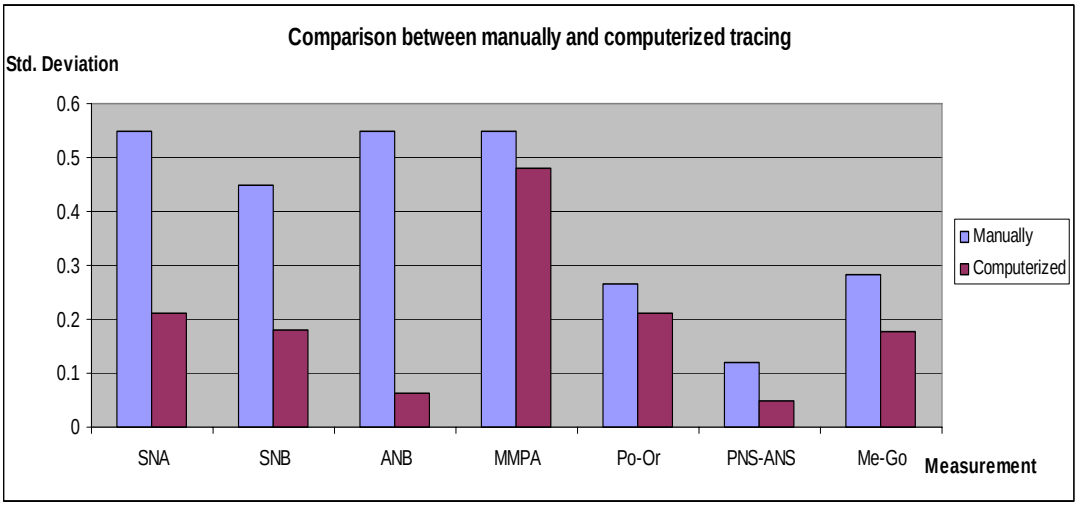


Figure 5: Comparison measurement method between manual and computerized landmark identification

The graph in Figure 5 easily shows the computerized method is better and more precise than manual method. All of the computerized measurements have a lower standard deviation value than manually method. This is might because the computer software can calculate the distances or angles very accurate by the coordinates but the using of caliper (linear measurement) and protector (angular measurement) are depend on the observer. The computer software can gives the accuracy up to 0.001mm for linear measurement and 0.01^{o} for angular measurement but the caliper can gives the accuracy only 0.01mm for linear

measurement and the protector gives 1^o for angular measurement. So, the computerized method for cephalometric measurement can gives more precise than conventional method using tracing paper.

4. Result

The analysis from chapter 3 shows the comparison between analog x-ray film and digital image for cephalometric measurement. The lower standard deviation values of computerized method give the conclusion that this method is better than manually tracing. The large differences between both methods on angles SNA, SNB and ANB are because the accuracy of the protector that used for the angular measurement. This is because the 1^o of accuracy is not satisfying for a good measurement.

The graph in Figure 5 shows that the computerized landmark identification method is better than the conventional method using tracing paper. This is proved by the statistical analysis to determine the smaller standard deviation value between these 2 methods. The smaller value of standard deviation shows the best method.

5. Conclusion

This research is focused on the comparison of measurements between analog x-ray film and digital cephalometric image. The study is designed to determine the best measurement method between manually tracing and using computer software. Each method had been measured 7 measurements (3 linear and 4 angular) for 5 times to get the averages. The measurements of both methods are compared by standard deviation values from a calculation using SPSS statistical software. This is to show the best method for cephalometric measurement between manually tracing and computerized method.

The computerized method gives the smaller standard deviation value than the conventional (manual) method. The result from this study shows that the computerized landmark identification using digital cephalometric image is more precise than using analog x-ray film.

Acknowledgements

This research is part of a Prioritized Research IRPA Vot 75437 sponsored by Ministry of Science Technology & Innovation (MOSTI) Malaysia, between Universiti Teknologi Malaysia (UTM), Standard & Industrial Research Industrial Malaysia (SIRIM), and Universiti Sains Malaysia (USM).

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