PRECISION OF LANDMARK IDENTIFICATION USING SCANNED CEPHALOMETRIC IMAGE

Ruzaini Md Lani, Halim Setan, Zulkepli Majid and Albert K. Chong

Medical Imaging Research Group, Faculty of Geoinformation Science and Engineering
Universiti Teknologi Malaysia, 81310 UTM Skudai, Johor, Malaysia
Tel: +607-5530380
E-Mail: ruzaini@fksg.utm.my

Abstract

This research is focused on the precision of landmark identification using scanned cephalometric images. A sample image was used to generate 5 sets of data for landmark identification. All 5 dataset were measured by the angle SNA, SNB and ArSN. 3D DOCTOR software is used for the landmark identification and the angle measurement. For each set, the angle was measured five (5) times to get the average value. The values are used to create a graph (to show the precision for the angle measurement) and also to calculate the mean and standard deviation using SPSS. The results were consistent and satisfactory.

Key Words: *Landmark Identification*

1.0 INTRODUCTION

Cephalometry has been heavily reliant on radiography since Broadbent (1931) and Hofrath (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).

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.

For the plastic surgeon the most important cephalometric measurements are SNA and SNB angle, which show the anteroposterior relationship of the maxilla, mandible and cranial base. Normally, SNA is 2° - 4° greater than SNB angle (David, 1982). SNA indicates the anteroposterior position of maxillary apical base in relation to cranial base and SNB indicates the anteroposterior position of the mandible apical base in relation to the cranial base (Al-Balkhi, 2003).

2.0 MATERIAL AND METHODS

Cephalometric Image

The sample image used in this research (in tiff format) is obtained from Hospital Universiti Sains Malaysia (HUSM), Kubang Kerian, Kelantan, Malaysia (Figure 1). For precision analysis purpose, 5 sets of data were generated from the same image by repeating the landmark identification 5 times.

Figure 1: Digital cephalometric image

Landmark Identification

3D DOCTOR software is used for landmark identification. The outlines of the images were digitized based on the soft tissue and the bones. The outlines are useful for landmark identification. Table 1 shows the landmarks for cephalometric analysis.

Initial	**Name**	**Description**
Na	*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
ANS	*Anterior Nasal Spine*	The tip of the Anterior Nasal Spine
Or	*Orbitale*	The most inferior point of the bony orbit
Pog	*Pogonion*	The most anterior point on contour of mandible

Me	*Menton*	The lowest point on mandibular symphysis
PNS	*Posterior Nasal Spine*	The tip of Posterior Nasal Spine
Ar	*Articulare*	The intersection of cranial base and posterior surface of mandibular condyle

Table 1: The description of cephalometric landmark

The landmarks were identified based on landmark description from Table 1. These landmarks were identified 5 times (i.e. for 5 sets of data). Each set of data was plotted every 2 days, and 10 days were used for landmark identification process. Figure 2 shows the cephalometric image and locations of the identified landmarks.

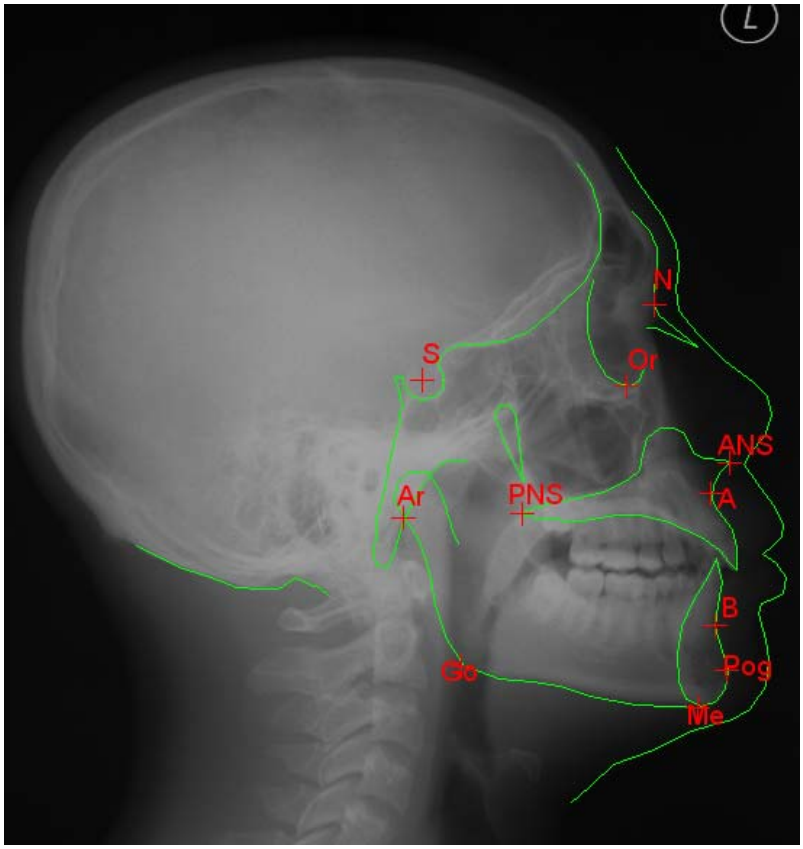

Figure 2: Cephalometric landmarks

Angle Measurements

The study uses angle measurement for precision analysis of the landmarks. This step also used 3D DOCTOR software. The measured angles are SNA, SNB and ArSN. The angle measurements for every set of data (total of 5 sets) were measured 5 times, to get the average value for each set. Table 2 to Table 6 show the angle measurement values for every set of data for angle SNA, SNB and ArSN.

Set 1		
S N A	**S N B**	**Ar S N**
88.18213	82.14424	116.3269
88.52815	82.38332	116.3993
88.48136	82.49745	116.0504
88.62513	82.74342	115.3374
88.92252	82.81026	115.4212

Table 2: Angle measurement value of SNA, SNB and ArSN for Set 1

Set 2		
S N A	**S N B**	**Ar S N**
86.18387	82.02248	116.4719
86.11095	81.84452	116.4021
85.87141	81.87025	116.3959
85.9617	82.0723	116.4525
86.19944	81.98411	116.2458

Table 3: Angle measurement value of SNA, SNB and ArSN for Set 2

Set 3		
S N A	**S N B**	**Ar S N**
86.92032	81.04703	118.2071
86.74419	81.0149	117.9613
86.83717	81.02835	118.2509
86.19214	80.83494	119.1841
86.36243	80.83845	119.3549

Table 4: Angle measurement value of SNA, SNB and ArSN for Set 3

Set 4		
S N A	**S N B**	**Ar S N**
83.31374	80.08594	119.6047
82.66732	79.91797	119.5834
82.83595	79.93792	119.4669
83.02001	79.83219	119.3125
82.98873	79.89281	119.5281

Table 5: Angle measurement value of SNA, SNB and ArSN for Set 4

Set 5		
S N A	**S N B**	**Ar S N**
84.45192	81.67935	116.5401
84.57545	81.87434	116.4386
84.51259	81.68792	116.491
84.57338	81.80177	116.4161
84.53922	81.59565	116.5234

Table 6: Angle measurement value of SNA, SNB and ArSN for Set 5

3.0 ANALYSIS

The analysis aims to determine the precision of the landmark identification. This analysis used SNA, SNB and ArSN angle values. The results for the analysis of angle measurement are shown by the precision graph. Figure 3 to Figure 7 show the graphs.

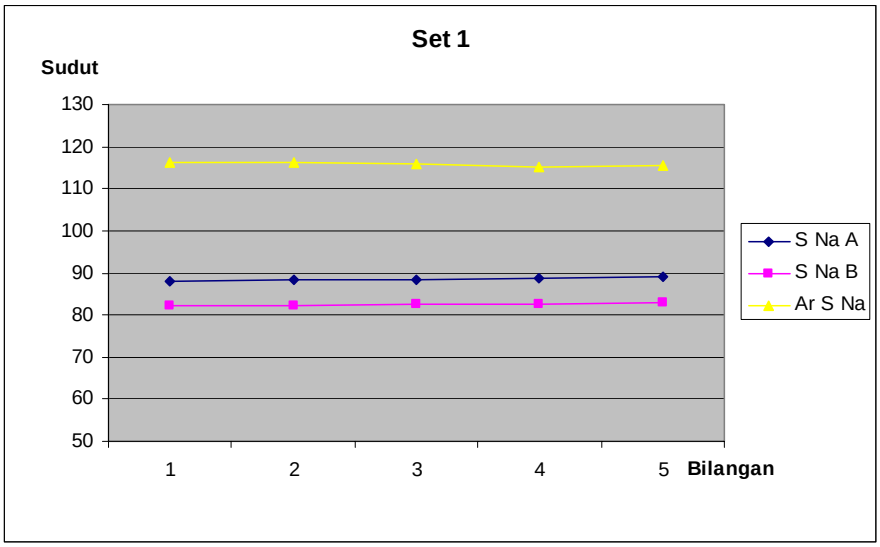

Figure 3: Precision graph for set 1

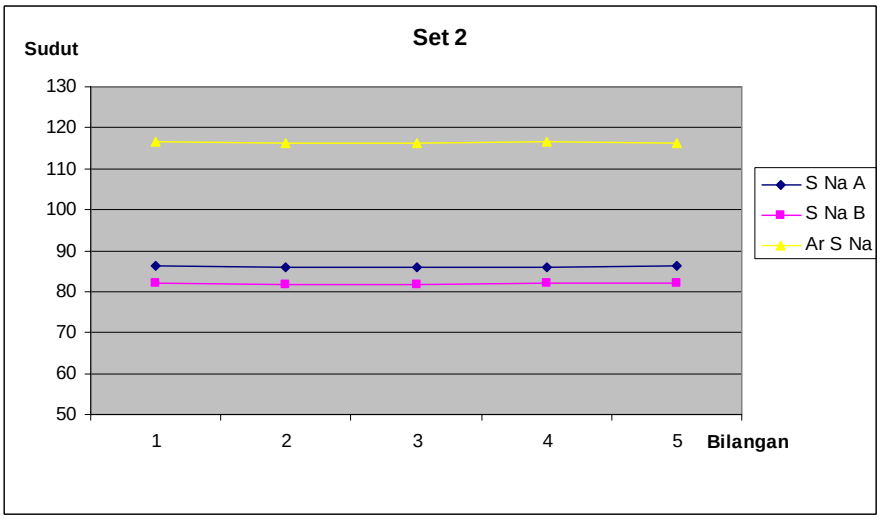

Figure 4: Precision graph for set 2

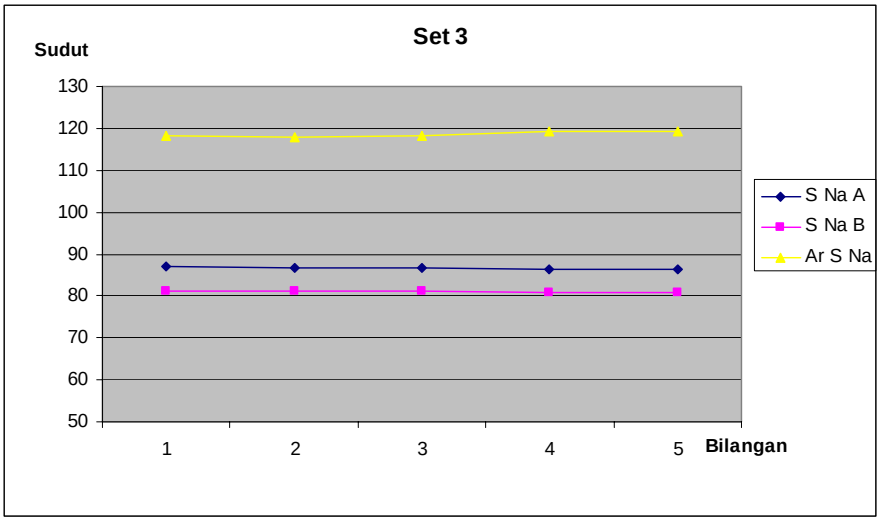

Figure 5: Precision graph for set 3

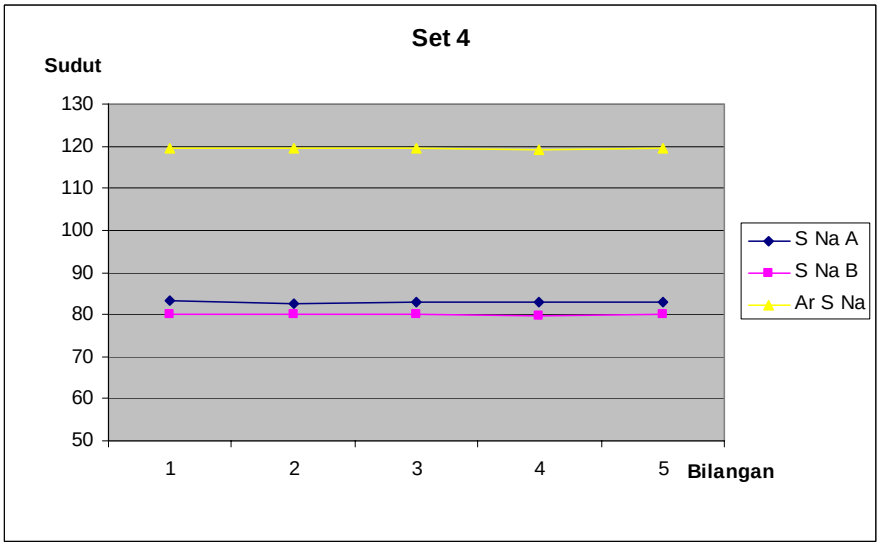

Figure 6: Precision graph for set 4

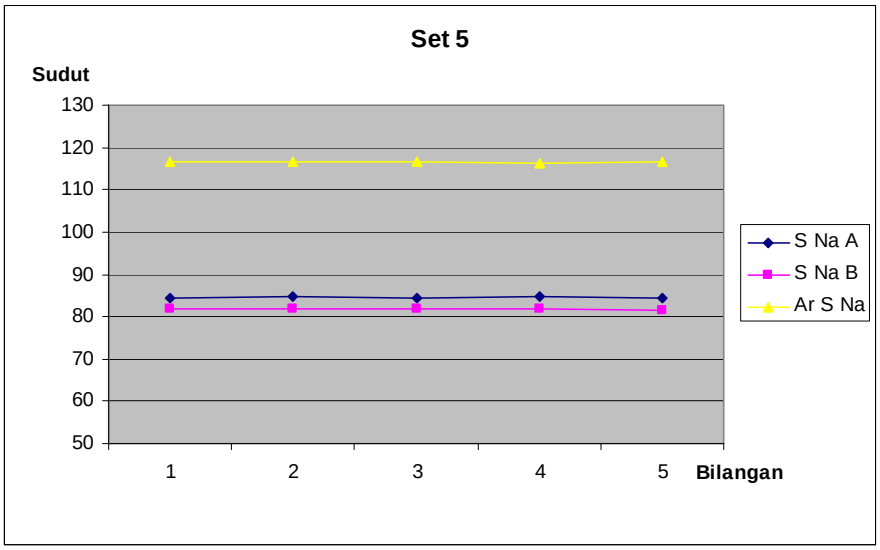

Figure 7: Precision graph for set 5

For statistical evaluation, *t*-test was applied to the repeat measurement. This calculation is done using SPSS statistical software. Table 7 shows the mean, standard deviation and standard error mean for each angle.

Table 7: One-Sample Statistics T-Tests for Angle Measurements

Angle	N	Mean	Std. Deviation	Std. Error Mean
S Na A	25	85.7440	1.94260	.38852
S Na B	25	81.4177	.92494	.18499
Ar S Na	25	117.3747	1.47523	.29505

4.0 RESULT

The graphs from Figure 3 to Figure 7 show that the precision of the angle measurement are quite consistent and satisfactory. The difference between each graph is quite small, with slight increase on set 3 for ArSN angle, and slight decrease on set 1 for ArSN angle. Both differences might because of the difficulty to pick the actual Articulare (Ar) landmark on the intersection of cranial base and posterior surface of mandibular condyle. The SNS angle also has some small differences of the measurement values for the all 5 sets of data. The differences might because of the difficulty on digitizing the curve of intersection of nasal septum and anterior cranial base.

5.0 CONCLUSION

This study is focused on the precision analysis of landmark identification using scanned cephalometric image. The image was digitized 5 times for landmark identification, and produces 5 sets of data. The angle measurement for each set was measured 5 times. The results are quite consistent and satisfactory, with small differences due to digitizing limitation.

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).

REFERENCES

1. Al-Balkhi K.M. Orthodontics Treatment Planning: Do Orthodontics Treat to Cephalometric Norms. The Journal of Contemporary Dental Practice; 2003 Nov; 4(4):012-027.

2. Broadbent B. H. A new x-ray technique and its application to orthodontics. The Angle Orthodontics; 1931; 1:45-66.

3. David D.J., David P., Donald S. The Craniosynostoses: Causes, Natural History and Management. New York 1982. Springer-Verlag Berlin Heidelberg.

4. McNamara J. A. Jr. A method of cephalometric evaluation. American Journal of Orthodontics; 1998; 449-469.

5. Richardson A. A Comparison of Traditional and Computerized Methods of Cephalometric Analysis. European Journal of Orthodontics; 1981; 3:15-20.

6. Sandler P.J. Reproducibility of Cephalometric Measurements. British Journal of Orthodontics; 1988; 15:105-110.

7. Turner P. J. and Weerakone S. An evaluation of the reproducibility of landmark identification using scanned cephalometric images. British Journal of Orthodontics; 2001; 28**:**221-229.