PRECISION OF LANDMARK IDENTIFICATION USING SCANNED CEPHALOMETRIC IMAGE

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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.
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.

<table>
<thead>
<tr>
<th>Initial</th>
<th>Name</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na</td>
<td>Nasion</td>
<td>The intersection of nasal septum and anterior cranial base.</td>
</tr>
<tr>
<td>S</td>
<td>Sella</td>
<td>The midpoint of the cavity of sella turcica</td>
</tr>
<tr>
<td>Go</td>
<td>Gonion</td>
<td>Most outward inferior point on the angle of mandible</td>
</tr>
<tr>
<td>A</td>
<td>Point A</td>
<td>The innermost point of the contour of the premaxilla between the anterior nasal spine (ANS) and the incisor tooth</td>
</tr>
<tr>
<td>B</td>
<td>Point B</td>
<td>The innermost point on the contour of the mandible between the incisor tooth and the bony chin</td>
</tr>
<tr>
<td>ANS</td>
<td>Anterior Nasal Spine</td>
<td>The tip of the Anterior Nasal Spine</td>
</tr>
<tr>
<td>Or</td>
<td>Orbitale</td>
<td>The most inferior point of the bony orbit</td>
</tr>
<tr>
<td>Pog</td>
<td>Pogonion</td>
<td>The most anterior point on contour of mandible</td>
</tr>
</tbody>
</table>
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](image)

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

<table>
<thead>
<tr>
<th>Set 1</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S N A</td>
<td>S N B</td>
<td>Ar S N</td>
<td></td>
</tr>
<tr>
<td>88.18213</td>
<td>82.14424</td>
<td>116.3269</td>
<td></td>
</tr>
<tr>
<td>88.52815</td>
<td>82.38332</td>
<td>116.3993</td>
<td></td>
</tr>
<tr>
<td>88.48136</td>
<td>82.49745</td>
<td>116.0504</td>
<td></td>
</tr>
<tr>
<td>88.62513</td>
<td>82.74342</td>
<td>115.3374</td>
<td></td>
</tr>
<tr>
<td>88.92252</td>
<td>82.81026</td>
<td>115.4212</td>
<td></td>
</tr>
</tbody>
</table>

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

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S N A</td>
<td>S N B</td>
<td>Ar S N</td>
<td></td>
</tr>
<tr>
<td>86.18387</td>
<td>82.02248</td>
<td>116.4719</td>
<td></td>
</tr>
<tr>
<td>86.11095</td>
<td>81.84452</td>
<td>116.4021</td>
<td></td>
</tr>
<tr>
<td>85.87141</td>
<td>81.87025</td>
<td>116.3959</td>
<td></td>
</tr>
<tr>
<td>85.9617</td>
<td>82.0723</td>
<td>116.4525</td>
<td></td>
</tr>
<tr>
<td>86.19944</td>
<td>81.98411</td>
<td>116.2458</td>
<td></td>
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</table>

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

<table>
<thead>
<tr>
<th>Set 3</th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S N A</td>
<td>S N B</td>
<td>Ar S N</td>
<td></td>
</tr>
<tr>
<td>86.92032</td>
<td>81.04703</td>
<td>118.2071</td>
<td></td>
</tr>
<tr>
<td>86.74419</td>
<td>81.0149</td>
<td>117.9613</td>
<td></td>
</tr>
<tr>
<td>86.83717</td>
<td>81.02835</td>
<td>118.2509</td>
<td></td>
</tr>
<tr>
<td>86.19214</td>
<td>80.83494</td>
<td>119.1841</td>
<td></td>
</tr>
<tr>
<td>86.36243</td>
<td>80.83845</td>
<td>119.3549</td>
<td></td>
</tr>
</tbody>
</table>

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

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S N A</td>
<td>S N B</td>
<td>Ar S N</td>
<td></td>
</tr>
<tr>
<td>83.31374</td>
<td>80.08594</td>
<td>119.6047</td>
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</tr>
<tr>
<td>82.66732</td>
<td>79.91797</td>
<td>119.5834</td>
<td></td>
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<tr>
<td>82.83595</td>
<td>79.93792</td>
<td>119.4669</td>
<td></td>
</tr>
<tr>
<td>83.02001</td>
<td>79.83219</td>
<td>119.3125</td>
<td></td>
</tr>
<tr>
<td>82.98873</td>
<td>79.89281</td>
<td>119.5281</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Set 5</th>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>S N A</td>
<td>S N B</td>
<td>Ar S N</td>
<td></td>
</tr>
<tr>
<td>84.45192</td>
<td>81.67935</td>
<td>116.5401</td>
<td></td>
</tr>
<tr>
<td>84.57545</td>
<td>81.87434</td>
<td>116.4386</td>
<td></td>
</tr>
<tr>
<td>84.51259</td>
<td>81.68792</td>
<td>116.491</td>
<td></td>
</tr>
<tr>
<td>84.57338</td>
<td>81.80177</td>
<td>116.4161</td>
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</tr>
<tr>
<td>84.53922</td>
<td>81.59565</td>
<td>116.5234</td>
<td></td>
</tr>
</tbody>
</table>

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
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>
<thead>
<tr>
<th>Angle</th>
<th>N</th>
<th>Mean</th>
<th>Std. Deviation</th>
<th>Std. Error Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>S Na A</td>
<td>25</td>
<td>85.7440</td>
<td>1.94260</td>
<td>.38852</td>
</tr>
<tr>
<td>S Na B</td>
<td>25</td>
<td>81.4177</td>
<td>.92494</td>
<td>.18499</td>
</tr>
<tr>
<td>Ar S Na</td>
<td>25</td>
<td>117.3747</td>
<td>1.47523</td>
<td>.29505</td>
</tr>
</tbody>
</table>

### 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


