3CT

2002

.
114
145
137
135
2002. 6
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3 CT

1. Vworks (Cybermed Inc., Seoul, Korea) is commonly used for CT scans. Vmorph (Cybermed Inc., Seoul, Korea) is another option for CT scans.

2. 3 CT scans include Supraorbitale, Lateral orbital margin, Infraorbitale, Nasion, ANS, A point, Zygomaticomaxilla, Upper incisor, Lower incisor, B point, Pogonion, Menton, PNS, Condylar inner margin, Condylar outer margin, Porion, Condylion, Gonion1, Gonion2, Gonion3, Sigmoid notch, Basion.

3. CT scans include Endocanthion, Exocanthion, Soft tissue Nasion, Pronasale, Alare lateralis, Upper nostril point, Lower nostril point, Subnasale, Upper lip point, Cheilion, Stonion, Lower lip center, Soft tissue B, Pogonion, Menton, Preaurale.

Vworks uses 3 CT scans commonly for medical purposes.
3 ते 3 CT अतिरिक्त योग्यता, उपयोग, क़सूर
3  CT  

(  :  )

1

Broadbent$^1$  3  Orientator  2  4  -internal orientation error, external orientation error, geometric error, association error- $^2$  5  .  $^2$  

1931

Athanathio$^2$  3  2  2  2  .
Broadbent " Orientator\(^1\), Wylie " Compensator\(^5\), Vogel " modified compensator\(^6\) for the dental practitioner who desires a more simplified approach to panoramic film analysis. Grayson \(^7,8,9\) has described a vector intercept with averaging algorithm\(^7\) for the analysis of three-dimensional data.

Brown & Abbott\(^10\) described the use of three-dimensional analysis in radiographic interpretation. Photogrammetric equation \( \text{Eq. } 3 \) for the position of points \( x, y, z \) was described.

Baumind \(^11\) described the use of special face bows for the analysis of dental arches. Kusnoto\(^12\) described the use of Computed Tomography \( \text{CT} \) for the analysis of dental anatomy. CT \( \text{3D} \) for the analysis of dental arches.

3 \( \text{D} \) CT for the analysis of dental arches. Carlsson \(^13\) Darling \(^14\) 3 \( \text{D} \) CT for the analysis of dental arches.

3 \( \text{D} \) CT for the analysis of dental arches.
2. Works

2.1 Introduction

2.1.1 Methods

1) N(asion) : (a a a a (a a a a)
2) O(orbital e) : (a a a a (a a a a)
3) P(rioron, (a a a a)
4) A(anterior nasal spine) : (a a a a (a a a a)
5) A(subspinale) : (a a a a Prosthion a a a a)
6) P(osterior nasal spine) : (a a a a (a a a a)
7) B(basi on) : (a a a a (a a a a (a a a a)
8) G(goni on) : (a a a a (a a a a (a a a a)
9) C(ondyli on) : (a a a a (a a a a (a a a a)
10) Me (menton) : .setHeader
11) B (supraneal) : .setHeader infradental e

 pogoni on .setHeader
12) Pog (pogoni on) : .setHeader
13) Zn (zygomatico maxillary) : .setHeader

![Figure 1. Landmarks for dry skull](image)

2.1.2 .setHeader 1 .setHeader 3 .setHeader CT .setHeader 5 .setHeader 2 .setHeader 2 .setHeader

2.2 .setHeader

2.2.1 .setHeader 3 .setHeader CT .setHeader 4 .setHeader 5 .setHeader 6 .setHeader 7 .setHeader

2.2.1.1 .setHeader

Figure 2 .setHeader 5 .setHeader 2 .setHeader 2 .setHeader 1 .setHeader 4 .setHeader 3 .setHeader 0.01mm .setHeader

N-Ba .setHeader craniometer .setHeader 1 .setHeader 2 .setHeader 3 .setHeader 4 .setHeader 5 .setHeader

2.2.1.1.1 .setHeader
1) N- Ba : cranial base length
2) N- Me : anterior facial height
3) N- ANS : upper facial height
4) ANS- Me : lower facial height
5) N- Go : facial depth
6) Go- Me : mandibular body length
7) Co- Go : ramus height
8) Co- Me : mandibular length
9) ZmLt- ZmRt : maxillary width
10) GoLt- GoRt : mandibular width
11) ANS- PNS : palatal length
12) Co- Pog : mandibular body length 2
13) CoRt- CoLt : intercondylar length
14) OrRt- OrLt : interorbital width

Figure 2. Measurements for dry skull

2.2.1.2 Frankfort plane

Frankfort plane: 20mm above the upper lip wax. From the Frankfort plane, the line which passes through the intercanthal plane, is drawn towards the nasal spine.
Figure 3. Dry skull is fixed in the acrylic box full of water. The acrylic box is positioned on the CT Hispeed Advantage.

CT Hispeed Advantage (GE Medical System, Milwaukee, U.S.A.) uses a high-resolution bone algorithm, 15cm field of view (FOV), 200mA, 120kV, scanning time 1 , 2mm slice thickness, 0.625mm spacing. Gantry rotation 0°. Reconstruction matrix 512×512 pixels.

2.2.1.3. 3D Image Processing

Images were post-processed using Vworks (Cybermed Inc., Seoul, Korea). Vworks allows 3D reconstruction. A 0.625mm, 0.5mm, 0.3mm, 0.1mm, 0.01mm resolution was used. Figure 4 shows a 2D, a 2D slice, and a 3D view. (Figure 4)

2.2.1.4. CT Volume Analysis

Using Vworks, CT volume analysis was performed. Figure 5 shows a 3D CT reconstruction.
Figure 4. A process of 3-Dimensional measurement using Vworks program
A: Formation of three-dimensional image
B: Removal of unnecessary structure, expansion, rotation
C: Reformation of the three-dimensional image
D: Measurement of the distance of N- Go.Rt.
   The value appears on the right side of monitor.

2.2.2 3-D CT 구조 익기 프로세스
2.2.2.1 CT 작업
   조립 브래킷 CT 구조 익기 프로세스
   Frankfort  브래킷 CT 구조 익기 프로세스
   Hispeed Advantage  브래킷 CT 구조 익기 프로세스

2.2.2.2 3-D CT 구조 익기
Vworks 3 26 (Figure 5) 37 2 26 (Figure 5)

Vmorph-proto 3 3 3 Microsoft excel program (Figure 6, 7)

2.2.2.1

1) Supraorbitale(Sup. Or) : Supraorbital foramen

2) Lateral orbital margin(Lat. Or. Margin)

3) Infraorbitale(Inf. Or)

4) Nasion(N)

5) Anterior nasal spine(ANS)

6) Subpinale(A) : prothion

7) Upper incisor(Prosthion, UI)

8) Lower incisor(Infradentale, LI)

9) Supramentale(B) : infradentale, Pog

10) Pogonion(Pog)

11) Menton(Me)

12) Posterior nasal spine(PNS)

13) Inner condylar margin(Con.in)
14) Outer condylar margin (Con.out) : 
15) Porion (Por) : 
16) Condylion (Con) : 
17) Upper gonion (Go1) : 
18) Middle gonion (Go2) : 
19) Lower gonion (Go3) : 
20) Antegonial notch (Ant.Go-notch) : 
21) Sigmoid notch (S) : 
22) Basion (Ba) : 

2.2.2.2 

1) Endocanthion (EN) : 
2) Exocanthion (EX) : 
3) Soft tissue Nasion (N') : 
4) Pronasale (Prn) : 
5) Alare lateralis (AL) : 30 
6) Upper nostril point (UNP) : 
7) Lower nostril point (LNP) : 
8) Subnasale (Sn) : 
9) Upper lip point (ULP) : 
10) Cheilion (Ch) : 
11) Stomion (St) : 
12) Lower lip center (LLC) : 
13) Soft tissue B (B') : 
14) Soft tissue Pogonion (Pogr) : 
15) Soft tissue Menton (Me') : 
16) Preaurale (Pre) : 
17) Soft tissue gonion (Go') : 

9
Figure 5. Three dimensional landmarks
A : Skeletal landmarks
B : Soft tissue landmarks
Figure 6. Asymmetry patient
Skeletal and soft tissue landmarks of asymmetry patient in Vmorph- proto program. X, Y, Z value of each landmark appears on the left side of monitor.

Figure 7. Normal adult
Skeletal and soft tissue landmarks of normal adult in Vmorph- proto program. X, Y, Z value of each landmark appears on the left side of monitor.

2.2.3. Micro soft excel program
Micro soft excel program is used to calculate x, y, z values of each landmark. The calculated values are used to calculate the differences.
3  

3.1  

3.1 Table 1. Comparison the direct measurement and the 3- dimensional measurement in Vworks program (unit : mm)

<table>
<thead>
<tr>
<th>measurement</th>
<th>3- D CT</th>
<th>Direct</th>
<th>Difference</th>
<th>Exp. rate(%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N- Ba</td>
<td>100.74</td>
<td>98.73</td>
<td>2.01</td>
<td>2.03</td>
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<tr>
<td>N- Me</td>
<td>116.10</td>
<td>115.62</td>
<td>0.48</td>
<td>0.42</td>
</tr>
<tr>
<td>N- ANS</td>
<td>49.53</td>
<td>50.57</td>
<td>1.04</td>
<td>2.06</td>
</tr>
<tr>
<td>ANS- Me</td>
<td>68.05</td>
<td>66.51</td>
<td>1.54</td>
<td>2.32</td>
</tr>
<tr>
<td>ANS- PNS</td>
<td>51.94</td>
<td>49.78</td>
<td>2.16</td>
<td>4.34</td>
</tr>
<tr>
<td>Co- Pog(Rt)</td>
<td>113.81</td>
<td>112.59</td>
<td>1.22</td>
<td>1.08</td>
</tr>
<tr>
<td>Co- Pog(Lt)</td>
<td>116.68</td>
<td>114.81</td>
<td>1.87</td>
<td>1.63</td>
</tr>
<tr>
<td>N- Go(Rt)</td>
<td>121.97</td>
<td>122.66</td>
<td>0.68</td>
<td>0.56</td>
</tr>
<tr>
<td>N- Go(Lt)</td>
<td>121.48</td>
<td>120.51</td>
<td>0.97</td>
<td>0.80</td>
</tr>
<tr>
<td>Go- Me(Rt)</td>
<td>85.82</td>
<td>83.47</td>
<td>2.35</td>
<td>2.81</td>
</tr>
<tr>
<td>Go- Me(Lt)</td>
<td>86.83</td>
<td>85.78</td>
<td>1.05</td>
<td>1.23</td>
</tr>
<tr>
<td>Co- Go(Rt)</td>
<td>50.62</td>
<td>50.65</td>
<td>0.03</td>
<td>0.06</td>
</tr>
<tr>
<td>Co- Go(Lt)</td>
<td>51.07</td>
<td>50.95</td>
<td>0.13</td>
<td>0.25</td>
</tr>
<tr>
<td>Co- Me(Rt)</td>
<td>116.25</td>
<td>113.91</td>
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<td>2.05</td>
</tr>
<tr>
<td>Co- Me(Lt)</td>
<td>117.98</td>
<td>116.59</td>
<td>1.38</td>
<td>1.19</td>
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<td>ZmL- ZmR</td>
<td>92.98</td>
<td>92.11</td>
<td>0.87</td>
<td>0.94</td>
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<td>GoL- GoR</td>
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<td>94.94</td>
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<td>1.60</td>
</tr>
<tr>
<td>Or- Or</td>
<td>59.51</td>
<td>60.63</td>
<td>-1.12</td>
<td>-1.85</td>
</tr>
<tr>
<td>Co- Co</td>
<td>120.24</td>
<td>118.35</td>
<td>1.89</td>
<td>1.60</td>
</tr>
</tbody>
</table>

Average 0.99 1.04

Figure 8. Differences between the direct and the 3- dimensional measurement in Vworks program
2. Parameters

CT values were between 0.99mm - 2.0mm in thickness. The
parameters analyzed were N- Ba, ANS- PNS, Go- Me(Rt). Co-
Me(Rt) 1.0mm, N-Me, N- Go(Rt, Lt), Co- Go(Rt, Lt), ZmRt- ZmLt.

Gutta percha 3 was noted to be 1.04%

3.2 3 CT values were obtained (Table 2, 3)

<table>
<thead>
<tr>
<th>X</th>
<th>Y</th>
<th>Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>1.0</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>11</td>
<td>5</td>
<td>3</td>
</tr>
</tbody>
</table>

0.5 was noted in the following parameters: Go2, Go3, antegonial notch. B - Pog 1, z 2, Por 1 0.5 was noted in the following parameters: M 2, Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was noted in the following parameters: Por 1 0.5 was not
Table 2. Comparison of the reproducibility of skeletal landmark (unit : mm)

<table>
<thead>
<tr>
<th>Skeletal landmark</th>
<th>Facial asymmetry</th>
<th>normal</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Rt. Sup. Orbitale</td>
<td>0.43</td>
<td>0.20</td>
</tr>
<tr>
<td>Rt. Lat. Or. margin</td>
<td>0.23</td>
<td>0.43</td>
</tr>
<tr>
<td>Rt. Inf. Orbitale</td>
<td>0.44</td>
<td>0.15</td>
</tr>
<tr>
<td>Lt. Sup. Orbitale</td>
<td>0.60</td>
<td>0.13</td>
</tr>
<tr>
<td>Lt. Lat. Or. margin</td>
<td>0.23</td>
<td>0.50</td>
</tr>
<tr>
<td>Lt. Inf. Orbitale</td>
<td>0.67</td>
<td>0.20</td>
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<tr>
<td>Nasion</td>
<td>0.31</td>
<td>0.11</td>
</tr>
<tr>
<td>ANS</td>
<td>0.14</td>
<td>0.03</td>
</tr>
<tr>
<td>A</td>
<td>0.17</td>
<td>0.09</td>
</tr>
<tr>
<td>Upper incisor</td>
<td>0.26</td>
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<td>Lower incisor</td>
<td>0.22</td>
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</tr>
<tr>
<td>B</td>
<td>0.40</td>
<td>0.86</td>
</tr>
<tr>
<td>Pog</td>
<td>0.55</td>
<td>0.27</td>
</tr>
<tr>
<td>Me</td>
<td>0.77</td>
<td>0.73</td>
</tr>
<tr>
<td>PNS</td>
<td>0.16</td>
<td>0.17</td>
</tr>
<tr>
<td>Rt. Con. in</td>
<td>0.23</td>
<td>0.25</td>
</tr>
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<td>Rt. Con. out</td>
<td>0.16</td>
<td>0.53</td>
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<td>Lt. Con. in</td>
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<td>0.38</td>
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<tr>
<td>Lt. Con. out</td>
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<td>Rt. Por</td>
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<tr>
<td>Rt. Go1</td>
<td>0.22</td>
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<td>Rt. Go2</td>
<td>0.39</td>
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<td>Lt. Zm</td>
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<td>Basion</td>
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<td>0.25</td>
</tr>
<tr>
<td><strong>Average of S.D.</strong></td>
<td>0.36</td>
<td>0.50</td>
</tr>
<tr>
<td>Soft tissue landmark</td>
<td>Facial asymmetry</td>
<td>Normal</td>
</tr>
<tr>
<td>---------------------</td>
<td>-----------------</td>
<td>--------</td>
</tr>
<tr>
<td></td>
<td>X</td>
<td>Y</td>
</tr>
<tr>
<td>Rt. EN</td>
<td>0.38</td>
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<td>Rt. EX</td>
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<td>N'</td>
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<td>0.03</td>
</tr>
<tr>
<td>Lt. EN</td>
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<tr>
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<td>Prn</td>
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<td>Rt. AL</td>
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<td>B’</td>
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<tr>
<td>Pog’</td>
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<td>0.31</td>
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<tr>
<td>Me’</td>
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<td>Rt. Pre</td>
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<tr>
<td><strong>Average of S.D.</strong></td>
<td><strong>0.49</strong></td>
<td><strong>0.48</strong></td>
</tr>
</tbody>
</table>

( unit : mm)
4. CT Scan

CT scans are a type of medical imaging that uses X-rays to create detailed images of the body. These images can be used to diagnose and treat a variety of medical conditions. CT scans are particularly useful for imaging the brain, abdomen, and chest, as well as other parts of the body.

CT scans work by using a computer to process the images taken by the X-ray machine. The computer can then create cross-sectional images of the body, which can be viewed in detail. CT scans are often used to detect tumors, assess organ function, and monitor the progression of certain diseases.

CT scans can be performed in a variety of ways, including conventional CT, dual-energy CT, and virtual colonoscopy. Conventional CT scans involve the use of a single X-ray source, while dual-energy CT uses two X-ray sources to create images with increased contrast. Virtual colonoscopy involves the use of a special CT scan to simulate a colonoscopy.

CT scans are generally safe and well tolerated by patients. However, there are some potential risks associated with CT scans, including the use of contrast agents and the potential for radiation exposure.

CT scans are often used as part of a comprehensive diagnostic workup for patients who are undergoing treatment for cancer. They can also be used to monitor the progression of certain diseases, such as epilepsy and multiple sclerosis.

In conclusion, CT scans are a valuable tool in the field of medical imaging. They can be used to diagnose and treat a variety of medical conditions, and they are generally safe and well tolerated by patients.
Gutta punch on.

MRI bony landmark.

1. CT

V works

3

V morpho proto

Pro

1.5

B Pog

* Ante- gonial notch

Go1

Go2, Go3

Gonion

1-3

x y z
Figure 9. Reference plane

A: Frankfort plane
B: Second plane passing through nasion and basion, tangent to the Frankfort plane

Third plane passing through bison, tangent the first and second plane.
5.

VWorks 3 CT 0.99 nmp. 1.04%.

4.

VWorks 3 CT 0.99 nmp. 1.04%.

5.

Supraorbitale, Lateral orbital margin, Infraorbitale, Nasion, ANS, A point, Zygomatic process, Upper incisor, Lower incisor, B point, Pogonion, Menton, PNS, Condylar inner margin, Condylar outer margin, Porion, Condylion, Gonion1, Gonion2, Gonion3, Sigmoid notch, Basion.

6.

Endocanthion, Exocanthion, Soft tissue, Nasion, Pronasale, Alare lateralis, Upper nostril point, Lower nostril point, Subnasale, Upper lip point, Cheilion, Stonion, Lower lip center, Soft tissue B, Pogonion, Menton, Preaurale.


ABSTRACT

A proposal of landmarks for craniofacial analysis using three- dimensional CT imaging

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Three- dimensional CT imaging is efficient in examining specific structures in the craniofacial area by reproducing actual measurements through minimization of error from patient movement and image magnification. Due to the rapid development of digital image technology and the expansion of treatment range a need for developing three- dimensional analysis has become urgent. Therefore the purpose of this study was to evaluate the percentage of error and magnification of three- dimensional CT’s using a dried skull and Vworks program (Cybermed Inc., Seoul, Korea) and also to obtain landmarks that are easy to designate and reproduce in three-dimensional images of normal and asymmetry patients the Vmorph- proto program (Cybermed Inc., Seoul, Korea) was used. The following conclusions were obtained;

1. In the comparison of actual measurements from the dried skull and the three- dimensional image obtained from the Vworks program the mean error was 0.99mm and the magnification was 1.04%.

2. Clinically useful hard tissue landmarks from three- dimensional images were Supraorbitale, Lateral orbital margin, Infraorbitale, Nasion, ANS, A point, Zygomaticomaxilla, Upper incisor, Lower incisor, B point, pogonion, Menton, PNS, Condylar inner margin, Condylar outer margin, Porion, Condy lion, Gonion1, Gonion2, Gonion3, Sigmoid notch, Basion.

3. Clinically useful soft tissue landmarks from three- dimensional images
were Endocanthion, Exocanthion, Soft tissue Nasion, Pronasale, Alare lateralis, Upper nostril point, Lower nostril point, Subnasale, Upper lip point, Cheilion, Stomion, Lower lip center, Soft tissue B, Pogonion, Menton, Preaurale.

The Vworks program can be considered a clinically efficient tool to produce and measure three-dimensional images. The soft and hard tissue landmarks proposed above are mostly anatomically important points which are also easily reproducible and designated. These landmarks can be beneficial in three-dimensional diagnosis and the prediction of images taken before and after surgery.

Key words: Three-dimensional CT imaging, Craniofacial analysis, landmarks