Virtual Reconstruction and Rapid Prototyping of the Skeleton

The Magdalenian perinate Wilcecy 11 is one of the best preserved infants yet discovered from this time period. It is dated to c. 13500 cal BP (Irish et al. 2009) and as such, is an important source of information on human developmental biology from this time period.

The remains were scanned over 2 days at the Institute of Ethnography and Archeology, Warsaw in the autumn of 2011 by the author. The remains were all scanned using a custom structured light scanner based upon the 3Di solutions system and was calibrated especially for scanning very small objects. Following data acquisition, the reconstruction was carried out at the Glocker laboratory for Digital Osteology on a dedicated workstation.

Reconstruction used a combination of Flexormax, Geomagic, 3DS Max and Avizo 7.0.

An example of the detail in the original scans can be seen below. These can be used for morhometric studies where the original material is too small, or too fragile, to be handled directly. Copies of scans will be available to other researchers, on request, after the conclusion of this project.

Fig. 1 (left). Rendering of surface scan of Pars Basilaris.

Fig. 2 (right). Rendering of current reconstruction. Scan QR code below to view a rotating model.

Biomechanical properties of the Long Bones

Introduction

The Wilcecy 11 skeleton preserves all the major longbones. Here, biomechanical properties for the humeri, femora and tibiae are presented for the intervals along which natural breaks occurred.

Methods

Cross sections where extracted from the scans at natural breaks using the contour tool in Geomagica. These polygons were then sealed and measured using tpsdist.

The comparative sample consists of individuals from the large collections of medieval and post medieval faetoal and neonatal material curated at the University of Sheffield. The sites used in this study were Newcastle Blaekgate, (Medieval), Bolsover Castle (Medieval), St Hilda’s Church, Newcastle (Post Medieval). Full numbers for each group are given in a separate table.

For the comparative sample, measurements were taken in tpsdist from scaled x-rays obtained using a Nomad Pro unit. Properties were calculated for all longbones using a formatted Excel sheet following the eccentric ellipse model from O’Neill and Ruff (2004) to ensure consistency of results. Unfortunately, little in the way of cross sectional geometric properties from juvenile fossils have so far been published at the museum under investigation (Cowgill6s 2010 data is for the 50% maesgn and residuals only are published). Please note that due to the small size of the comparative sample, I do not present any more advanced statistical analyses, in order to avoid giving a distorted view of the data.

<table>
<thead>
<tr>
<th>Bone</th>
<th>6-10MO</th>
<th>11-19MO</th>
<th>10-2MO</th>
<th>Neo</th>
<th>0-2MO</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tibia 65%</td>
<td>10</td>
<td>4</td>
<td>7</td>
<td>5</td>
<td>26</td>
<td></td>
</tr>
<tr>
<td>Fem 65%</td>
<td>8</td>
<td>6</td>
<td>14</td>
<td>9</td>
<td>38</td>
<td></td>
</tr>
<tr>
<td>Femor 35%</td>
<td>8</td>
<td>5</td>
<td>14</td>
<td>9</td>
<td>37</td>
<td></td>
</tr>
<tr>
<td>Humerus 50%</td>
<td>13</td>
<td>6</td>
<td>13</td>
<td>6</td>
<td>38</td>
<td></td>
</tr>
</tbody>
</table>

Table 1 (left). Comparative sample composition

Table 2 (right). Boxplots of cross sectional properties for Femur, Tibia and Humerus

Torsion of the Longbones

Results

Tibial torsion is 11.6°. This is broadly similar to values reported by Stashelli (2009), who reports normal values at birth of 7° up to 15° at full maturity. It also fits with the values reported for earlier hominins by Ponter et al. (2009) who give a mean value of 15.3°. The angle for humeral torsion is 52.5°, which is slightly above the lower value given by Cowgill (2010) for active groups. Cowgill however averaged his data for all individuals from 0-2 years of age, so no more detailed work on this age group is being undertaken.

Conclusions

I have identified here the effectiveness of using virtual reconstructions for osteological analysis and the benefits of rapid prototyping. I also demonstrate that Wilcecy 11 is biomechanically similar to other perinatal material. Humeral torsion is within the range expected for a young individual from an active group and tibial torsion is within the range expected, but more detailed work is required.

Acknowledgements

I would like to thank my PhD supervisor Andrew Chamberlin for support and discussion of results. Simon Stone and Steve Fletch er for technical support. Sue Roberts and Neil Freer for Fribig design for 3D printing. The Glocker bequest for equipment. Wilcecy 11 has been sponsored by the Institute of Archaeology and Ethnology, Polish Academy of Sciences, and financed by a State Committee of Scientific Research Grant (N. 1 101 01 01 27) awarded to Romuald Bzdul, PT.

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Fig. 3. Rendering of surface scan of right humerus

Fig. 4 (right). Boxplots of cross sectional properties for Femur, Tibia and Humerus

Fig. 5. Placement of Planes (Top) Closeness of angle measurement in tpsdist (Bottom)