

SHORT REPORT

The Utility of Minimal CT Scanning in the Study of Two Egyptian Mummy Heads

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ABSTRACT The remains of two Egyptian mummies from the New Kingdom site of Qurnah were investigated using computer tomography. Two scout views and two CT slices were studied for each specimen. General descriptions of the specimens were drawn from these images. Standard anthropometric measurements were taken from the CT scans and compared with a sample data set describing skeletal material from the same site. One specimen was found to be typical of males from this population, and the other was tentatively described as female. We conclude that minimal CT scanning may be useful for the study of mummies, and may provide craniometric data not otherwise available. Copyright © 1999 John Wiley & Sons, Ltd.

Key words: Egypt; mummy; anthropometry; computer tomography

In the century since Petrie (1898) first demonstrated the use of radiologic technology in the study of Egyptian mummies, diagnostic radiology has made an invaluable contribution to anthropology. The great advantage of plain radiography and computed tomography (CT) over autopsy and dissection lies in the potential for non-destructive analysis of human remains. Recent advances in CT technology have encouraged new analyses, such as 3D imaging and tissue density measurement (Zurnedden *et al.*, 1994). Many published accounts of the application of CT technology within anthropology focus on highly detailed and comprehensive analyses of valuable individual specimens (Pickering *et al.*, 1990; Chege *et al.*, 1996; Strouhal *et al.*, 1996; Melcher *et al.*, 1997). These represent investments of funds and time which may not be available to many projects. Our interest lies in assessing how useful minimal cross-sectional

CT scanning may be for anthropometry and the description of previously unpublished individual mummies.

Two 'guillotined' mummies held in the Duckworth Collection (University of Cambridge) were selected for this study. Research in the archives of the Duckworth Collection revealed that these two specimens were collected from a 'New Empire' (New Kingdom) site at Qurnah (El Qurna) by Budge in the mid 1880s. Mummy A is the unbandaged head and neck of an adult man (Figure 1), while Mummy B is a bandaged head and neck (Figure 2).

Using a CT HiSpeed Advantage Scanner (G.E. Medical, USA) *in situ* at Addenbrooke's Teaching Hospital, Cambridge, UK, CT images were generated of each mummy in the transverse, sagittal and parasagittal planes. At the time of going to press, the cost of this treatment was approximately UK£30.00 per specimen. Preliminary scout views (digitized radiographs) in the sagittal and coronal planes were taken (Figures 3 and 4) to ensure correct alignment of

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the final, computed tomography horizontal and sagittal views (Figures 5 and 6). Both external and internal anatomical landmarks were used to position the mummy in the scanner headrest. Internal features such as the internal occipital protuberance and positions of bregma and the lambdoid suture were essential for positioning the axial views for Mummy B.

A scan thickness of 5.0 mm resulted in a high level of resolution of all tissue types. As can be seen from Figures 5 and 6, this resolution allowed fine details, such as those of the individual layers of bandaging material around Mummy B, to be examined. After adjusting the brightness and contrast of the images, they were transferred from computer to film and reproduced at a scale of 1:2 on plates 350 mm × 430 mm. A 5.0 cm scale was reproduced next to each image so that the consistency of the size reduction could be measured.

The Budge Collection of New Empire specimens from Qurnah, held within the Duckworth Collection, includes of a large number of complete skulls as well as mummified heads, of



Figure 2. Mummy B.

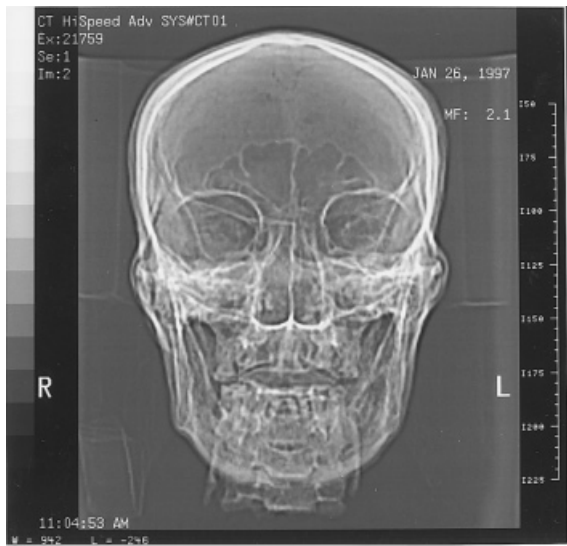


Figure 1. Mummy A.

which the majority are documented as being male. We were concerned to analyse the information gleaned from CT scans of the two mummies in comparison with corresponding data from these skeletal finds, and so several cranial measurements familiar to anthropometric studies were taken from the CT scans (Table 1). The scans were transferred from computer to film and reproduced at a scale of 1:2 on plates 350 mm × 430 mm. All subsequent CT measures were multiplied by a factor of 2.0, in order to compensate for this half-size reproduction. A computer-generated 5.0 cm scale was reproduced next to each image so that the consistency of the size reduction could be measured; an examination of each scale bar showed them to be exactly half life size ($p < 0.001$) (i.e. 1 mm on the film represented 2.0 mm at life size). To generate a comparative data set, a sample of 100 crania documented as male was taken from the New Kingdom Qurnah collection (Duckworth catalogue section EGY-QE 2028, 2029, 2030, 2032), and the same measurements were recorded (Table 1). All these measurements



(a)



(b)

Figure 3. Preliminary scout view of Mummy A (a) in the sagittal plane, and (b) in the coronal plane.

were taken using spreading calipers and Mitutoyo 500-133U digimatic calipers (Mitutoyo Ltd, UK). Error was assessed by repeating the measurements and a paired sample *t*-test of these sets revealed no significant difference in data from the two sources ($t = 45.16$, $p < 0.0001$).

The metrical data from the two mummies were compared with the arithmetic means and S.D.s of the comparative skull sample. All but

one of the measurements for Mummy A fell within $\pm 1 s$; for example the value of *Maximum length* is 178.89 mm for Mummy A, which lies within $+0.2 s$, suggesting that this specimen is drawn from the population ($p = 0.1$). In contrast, however, the maxilloalveolare length of Mummy A (65.69 mm) falls well above the comparative mean, although within the range of the comparative sample (46.91–69.89 mm). The measurements for Mummy B all fell within $\pm 4 s$; for example, the value of *Nasal height* is 40.88 mm for Mummy B, which lies within $-2.5 s$ and suggests that Mummy B is a small outlier and, therefore, perhaps not drawn from the population ($p = 0.05$). In terms of cranial morphology as measured here, therefore, Mummy A appears to be typical of the male Qurnah skull population, and Mummy B appears to be significantly smaller, which may imply that the latter specimen is female.

Measurements of cranial thickness were also taken from the CT scans. The inaccessibility of the endocranium in complete skulls has meant that these variables are rarely included in multivariate analysis of morphometrics, and no 'standards' as thorough as those presented by Howells (1973) exist for them. Nevertheless, these measurements are included in Table 1, in the hope that future studies based on CT technology may encourage more comparative analysis of these traits.

In addition to metrical analysis, this study has provided useful general descriptive information about the specimens. Both mummies are missing the brain, and fractures of the ethmoid and sphenoid bones indicate transnasal removal. The orbits and mouth of both are empty (the tongue can be clearly seen in Mummy A). The CT scans of Mummy B show some retraction of the skin, leaving only a thin layer across the face. Sediment in the occipital and basicranium of this specimen is revealed as a solidified mass with some internal structure, but with a density much less than that of bone. This could have resulted from incomplete cleaning of the endocranium during mummification, and may be a mixture of tissue and natron. Mummy A exhibits a large frontal sinus and considerable cranial robusticity in terms of muscle attachments and large mastoid processes. Mummy B does not

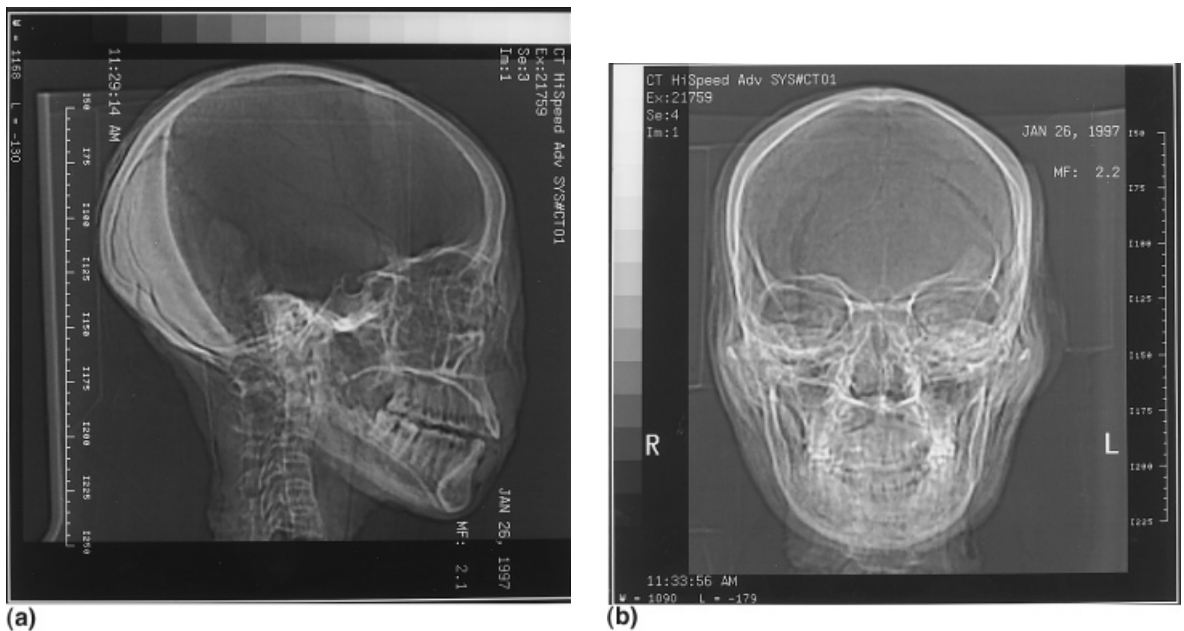


Figure 4. Preliminary scout view of Mummy B (a) in the sagittal plane, and (b) in the coronal plane.

exhibit a large frontal sinus and appears gracile in terms of muscle attachments, size of mastoid processes and gonial angles; this may indicate female sex. Both specimens exhibit adult dentition. Mummy A appears to be missing premolars and canines, but it is not clear whether this refers to ante- or post-mortem

loss. Both specimens demonstrate considerable attrition (slightly more advanced in Mummy A), and while the coarse nature of diets in these populations is well-known to cause dramatic dental wear, this evidence does suggest that the individuals were mature adults at death.

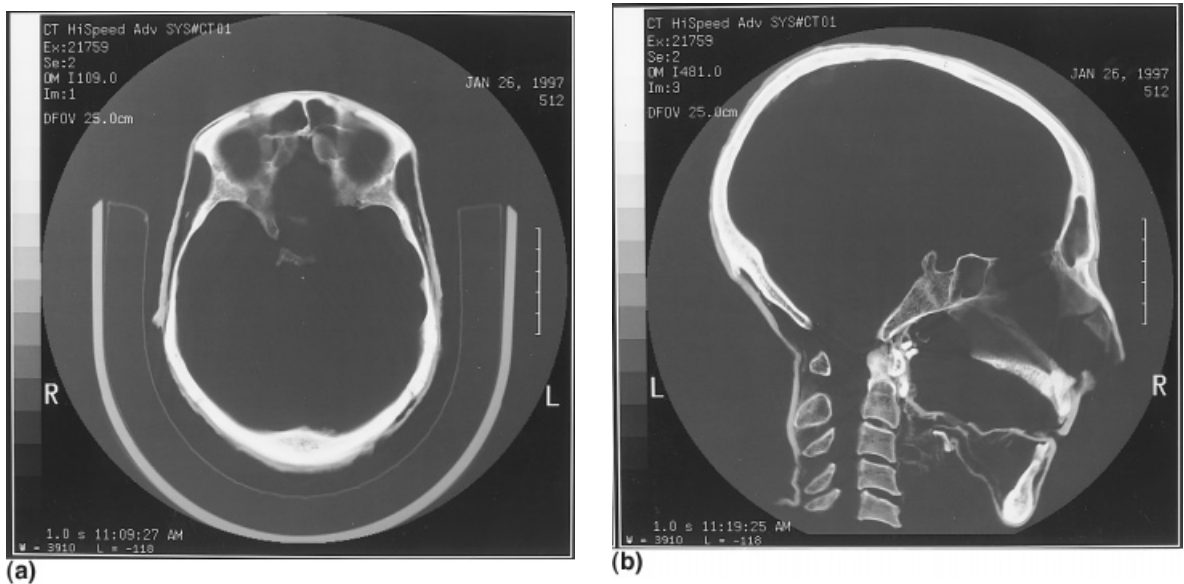


Figure 5. (a) CT horizontal view of Mummy A. (b) CT sagittal view of Mummy A.

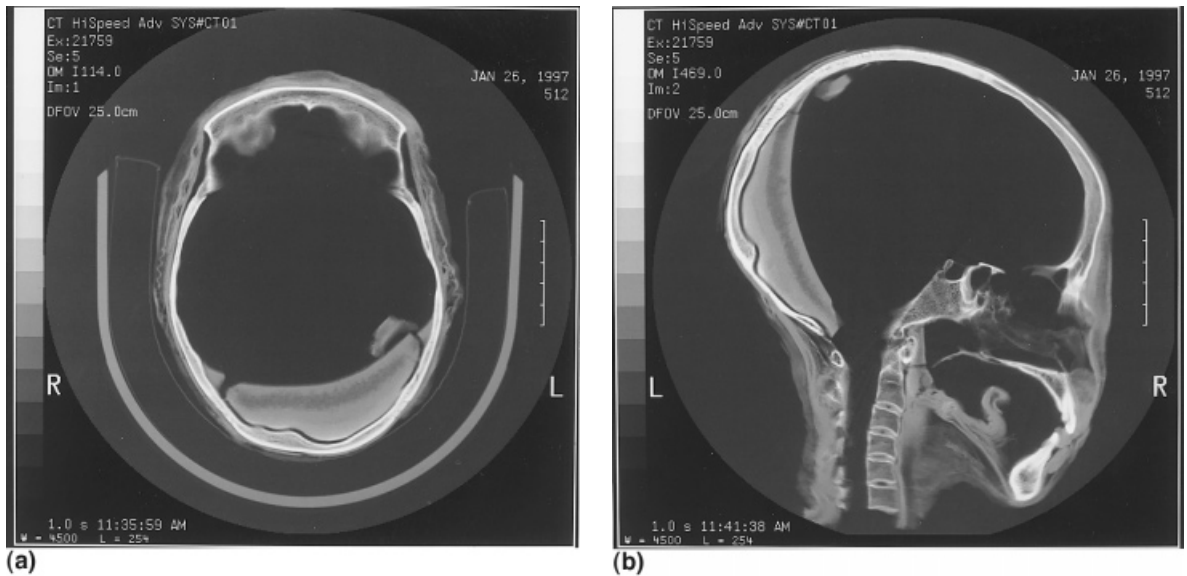


Figure 6. (a) CT horizontal view of Mummy B. (b) CT sagittal view of Mummy B.

Table 1. Cranial measurements from the CT scans

| Measurement (mm) | Mummy A | Mummy B | Comparative mean | Comparative S.D. |
|--|---------|---------|------------------|------------------|
| Max length (glabella to opisthocranium) | 178.89 | 179.66 | 180.22 | 6.63 |
| Max breadth (euryon to euryon) | 130.1 | 129.13 | 134.04 | 4.83 |
| Basion-bregma height | 135.62 | 133.44 | 137.39 | 5.18 |
| Upper face (nasion to alveolare) | 68.34 | 57.66 | 64.52 | 4.33 |
| Nasal height (nasion-nasospinale) | 50.1 | 40.88 | 49.09 | 3.17 |
| Maxilloalveolar length (prosthion to alveolon) | 65.69 | 57.66 | 57.12 | 3.89 |
| Mandibular symphysis height (gnathion to infradentale) | 32.27 | 28.47 | 28.75 | 2.57 |
| Thickness at bregma | 6.5 | 5.54 | x | x |
| Thickness at opisthocranium | 7.07 | 6.69 | x | x |
| Thickness at inion | 11.62 | 7.97 | x | x |
| Thickness at centre frontal | 8.04 | 8.95 | x | x |
| Thickness at temporal | 4.99 | 4.5 | x | x |

CT scanning is an important method of gathering information from archaeological human remains, but the emphasis on comprehensive analyses, and the costs of equipment and expertise, have prevented it from becoming a standard method of anthropometric analysis. The present study has shown that with the lowering costs of CT technology and the increased speed with which computers can now handle and process images and information, CT scanning has direct application to the quantitative, statistical study of skeletal material. The integration of quantitative information from minimal CT scans with existing data sets is a valuable way to increase our understanding of existing data, and

of generating new information precluded from other types of study.

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