Advances in the use of radiography in osteological analysis

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Radiography is commonly used as a diagnostic tool in the identification of pathological conditions, allowing the observation of changes that may not be apparent macroscopically (Fig 1). They may reveal subtle disease processes that only affect the internal structures of bones. In trauma analysis, osteologists can measure the extent of deformity and healing in fractured bones. The fracture type can often be identified, together with the injury mechanism (Roberts 2000: 349).

Although "Ideally every bone in every skeleton should be radiographed to detect such abnormalities" (Ortner 2003: 48), routine radiography is often prohibited in commercial archaeology by funding and time constraints. Invariably some conditions are missed or remain undiagnosed as a result (ibid). This may lead to discrepancies in the prevalence of certain diseases such as scurvy, rickets and Pagets disease (Roberts and Cox 2003: 400).

This poster discusses the use of computed radiography in the diagnosis of pathological conditions, comparing traditional plain film radiographs with digital images. It assesses the potential for the use of digital imagery in the routine examination of bone during analysis.

Plain film radiography

Conventional plain film radiography involves the exposure of an image onto an X-ray film. This film then undergoes a wet processing stage where it is treated with a developer chemical. Once the image is revealed, the film is fixed and dried. This is a time consuming and expensive process. The quality of the image or accuracy of an exposure is only apparent during the final stages of processing. If mistakes have been made or results are unclear the entire process must be repeated.

Many bone fractures may not be visible in a single plain and it is best practice to obtain two standard projections (Roberts 2000: 349). Some bones may require more than two views (Raby et al 2005: 4), resulting in multiple X-ray films and processing. Restrictions on time and space, together with the costs of film and chemicals, may limit that quantity and quality of work. Once developed, the images must be carefully stored to prevent damage or degradation of the film. Large collections may take up much space in an archive. This leads to the restriction of radiographic study to a limited number of bones of interest (Fig 2).

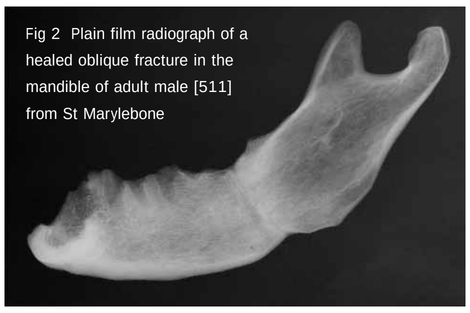
Fig 2 Plain film radiograph of a healed oblique fracture in the mandible of adult male [511] from St Marylebone

Computed radiography

Recent work by MoLAS in collaboration with the Department of Radiography at City University, London has investigated the use of computed radiography on large skeletal assemblages. The exposed image is stored on a photo-stimulable phosphor plate placed inside a radiographic cassette (Piraino and Grooff 2002: 36). Exposed cassettes can then be uploaded direct onto a computer and the latent image digitized. Once uploaded, the latent image can be cleared and the cassette reused for a new exposure (ibid 38).

The advantage of this technique is that numerous images can be obtained in a short period of time. With the lengthy processing removed, any mistakes with exposure or positioning are readily visible on the computer screen and can be quickly remedied.

Post processing techniques can be applied to a single exposure in order to manipulate brightness and adjust or invert contrast. Areas of interest can be highlighted and trabecular bone patterns enlarged to observe subtle changes. Measurements of bone: such as length, cortical thickness, fracture overlap, apposition and angulation can be directly recorded from the computer screen. These details can be saved separately and multiple images stored onto a compact disk allowing for easy storage and access. The images can be viewed from any computer and emailed directly to colleagues for interpretation. They can also be made readily available for publication (Fig 3).


Fig 3 Medio-lateral radiograph of the femora of individual [1059] from Sts Mary and Michael with an oblique healed fracture of the right femur. Ten degrees anterior displacement, 32mm overlap and 0% apposition

Case-study

The analysis by MoLAS of 705 individuals from the post medieval cemetery of the Catholic Mission of St Mary and St Michael, Whitechapel, London (1843–1854) revealed a wide range of pathological conditions. Using the computed radiography equipment at City University, 119 contexts were radiographed in just three days creating 144 images stored on four compact discs.

Fractures were recorded in 15.6% (110/ 705) of the total sample. This included 40.3% of the adult population (108/268) with just under half of the male sample (68/143: 47.6%) affected. Radiographs were taken of 43 contexts with fractures to the ribs and long bones with 98 separate images created in under two days. This enabled the confirmation of fractures recorded macroscopically and allowed the accurate measurement of deformity and healing, not possible from the gross specimen.

Sixty-two percent of the cemetery sample consisted of sub-adult individuals (437/705). Of these, 78 (/437: 17.8%) displayed macroscopic signs of rickets and 41 (/437: 9.4%) had signs of scurvy. Fifty-five individuals, including controls with no metabolic disease, were radiographed producing fifteen X-ray images (Fig 4).

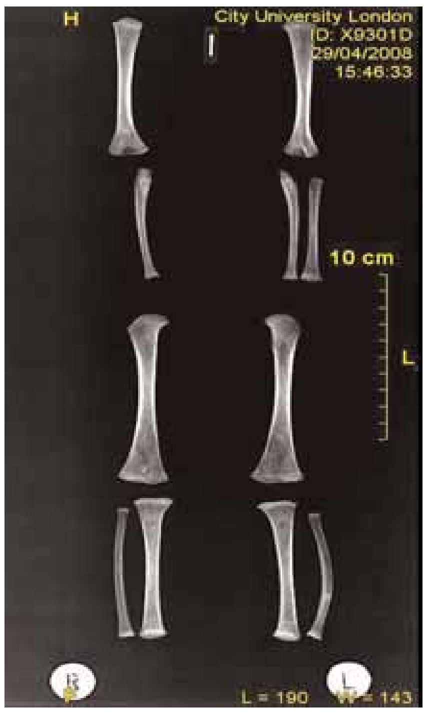

Fig 4 Antero-posterior radiograph of individual [1511] from Sts Mary and Michael showing active rickets and a greenstick fracture to the left fibula

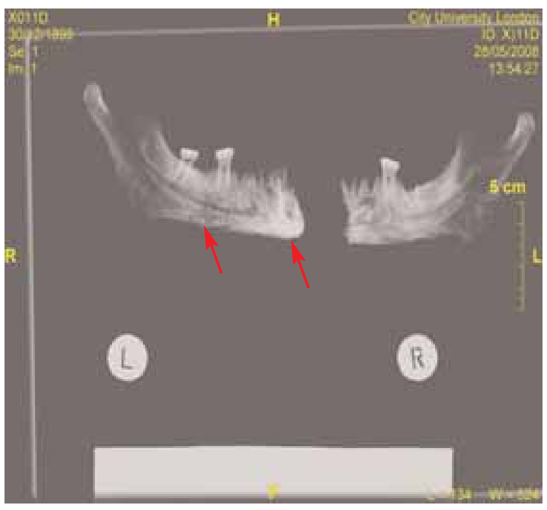
Fig 5 Radiograph of individual [660] from Sts Mary and Michael showing irregular radiolucent zones and strongly contrasting sclerotic area at the mentum, reflecting osteonecrosis of the mandible

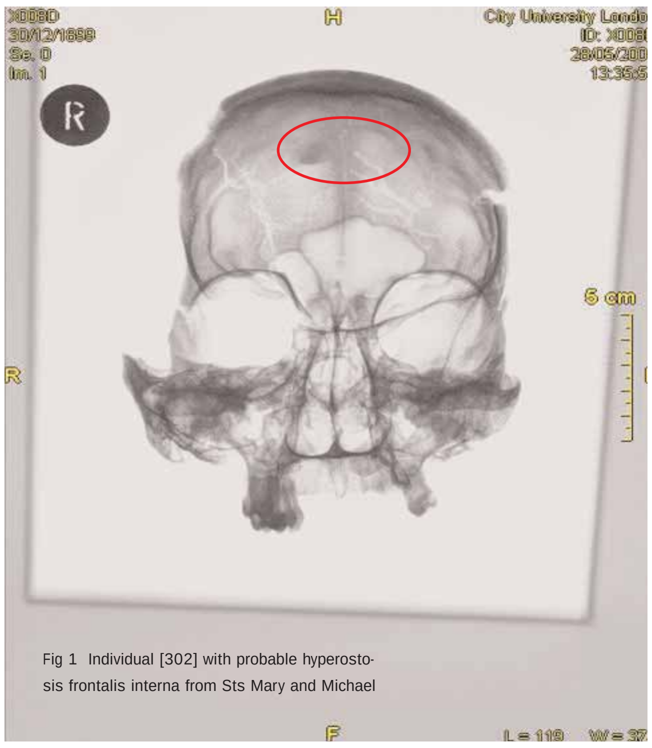
Fig 1 Individual [302] with probable hyperostosis frontalis interna from Sts Mary and Michael


Fig 6 Individual [660] from Sts Mary and Michael showing osteonecrosis of the mandible

Twenty-seven further individuals were radiographed (31 images) for the purpose of the diagnosis of a number of diseases, including TB, treponemal disease, osteochondroma, osteitis, gout, Osgood Schlatters disease, osteoporosis and an example of osteonecrosis of the mandible (Figs 5–6). A previous study by MoLAS of an assemblage of 301 individuals from the post medieval cemetery of St. Marylebone, Westminster, London used a Faxitron X-ray machine for conventional plain film radiography in order to analyse fractures. Only 25 images were produced in one day using 12 X-Ray films.

Conclusions

The large-scale radiographic study of human bone in commercial archaeology has often been compromised by tight budgets and limited time frames. The use of computed radiography and digital imaging allows a greater number of samples to be processed in a far shorter period of time than is possible with conventional film radiography.

The routine radiographic analysis of large samples of bone is now a realistic possibility within commercial archaeology. A greater volume of information can be obtained on pathological processes and prevalence in past populations, providing a valuable record to compliment macroscopic description and photography. This will increase the research potential of cemetery sites and more wide ranging questions and proposals could therefore be addressed.

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