



Digital radiography and historical contextualisation of the 19th century modified human skeletal remains from the Worcester Royal Infirmary, England



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ABSTRACT

Recent excavations at the Worcester Royal Infirmary revealed a large assemblage of modified skeletal remains dating to the late 19th century. The assemblage included a sample of 134 long bones, 76 of which were transected and 58 of which displayed evidence of gross pathology without transection. Transection may have been undertaken for the purposes of amputation, anatomical or morbid dissection, for surgical training or specimen preparation. In order to elucidate the motives for such modification, Direct Digital Radiography (DDR) was undertaken on the proximal and distal elements present to confirm the true prevalence of disease. The radiographic evidence revealed that some transected elements exhibited previously unobserved pathological changes. The ratios of proximal to distal elements varied between samples of pathological and non-pathological transected elements, suggesting different motives for modification. There was also a significant difference between the composition of the skeletal sample and that expected from historical records of amputation. Aggressive or acute/subacute as well as chronic stages of disease were observed, some lesions possibly relating to ascending infection following gangrenous limb ischaemia or haematogenous spread. Other rare conditions were detected using DDR, proving it to be a critical tool in the assessment of skeletal disease in the past.

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1. Introduction

Medicalisation of the human body during Industrial Period England led to unprecedented consequences for its treatment, manipulation and disposal. As is evident from the rise in skeletal evidence for autopsy during the post-medieval periods (Cherryson et al., 2011), the increasingly secular understanding of corporeal symptoms of illness allowed an exponentially growing body of specialists to oversee the management of disease and the diseased (Laqueur, 1989; Burney, 1994, 2000). This culminated in the foundation of a plethora of institutions promoted by socially progressive philanthropists during the late Georgian and Victorian era (1770–1901AD), most prominent amongst which was the infirmary. However, the treatment of patients was crude, with little available in the way of effective remedies from the contemporary

pre-antibiotic pharmacopeia (Hastings, 1841). General and thoracic procedures could not be carried out until after the introduction of anaesthesia from 1846 onwards and was still impeded until the development of antiseptic surgical techniques (Weiss, 2000; Kirkup, 2007). Prior to this, major surgical intervention that may leave traces in the skeleton was restricted to trepanation (removal of a portion of the cranial vault), excision (removal of foreign bodies i.e. tumours and diseased parts of bone i.e. joints) and amputation (complete severance via transection) of limbs.

Archaeological evidence for the treatment of the body and body parts from this period has come to light in recent years following the discovery of skeletal human remains associated with late Georgian and Victorian hospital buildings (Henderson et al., 1996; Chapman, 1997; Boulter et al., 1998; Fowler and Powers, 2012; Hull, 2003). One such rare assemblage was excavated in 2009 and 2010 from the site of the former Worcester Royal Infirmary (WRI), a provincial hospital in the West Midlands, England, founded in 1771 (Fig. 1). This large assemblage, consisting of 1848 disarticulated human bone elements, contains many examples of gross pathology as well as evidence for surgical intervention and anatomical dissection, in the form of transected elements in addition to superficial deflesh-

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Fig. 1. Location map of Worcester and the human skeletal deposits on site.

(after Worcestershire UK locator map 2010 by Nilfanion – Ordnance Survey OpenData. http://commons.wikimedia.org/wiki/File:Worcestershire.UK.locator_map.2010.svg#mediaviewer/File:Worcestershire.UK.locator_map.2010.svg).

ing marks. A full report of the osteological analysis of the remains was undertaken by [Western and Kausmally \(2011\)](#). The majority of the remains were found in discrete pits located in the vicinity of the hospital building, thought to date to the first half of the 19th century, with one deposit forming a fill of a large rubbish pit. No admissions registers survive for the hospital but there are some published reports, notably those authored by Henry Carden, who developed the ‘Carden Technique’ of amputation and Sir Charles Hastings, who founded the British Medical Association at the Infirmary while working as a physician there between 1818 and 1861 ([Western, 2012](#); [McMenemey, 1947](#)).

The lack of direct historical evidence meant that the precise nature of the remains at the time of the discovery was unclear. A number of the transected bone elements displayed osteological signatures indicative of non-therapeutic modification in the form of double transections (transection at each end of the diaphysis), multiple and rotated saw cuts ([Western and Kausmally, 2011](#)). However, differentiating between therapeutic and post-mortem transections in most individual elements, is difficult and signatures left on the bone by these modifications is not unequivocal ([Western, 2012](#); [Witkin, 1997](#)). This is particularly true given the secondary modification of elements for the purposes of the specimen preparation that may have originated from amputated limbs (see [Carden, 1864](#); [Liston, 1842](#)). At the time these bones were deposited,

aetiology of disease was a new and fast developing field within medicine, increasingly underpinning the discipline. The French anatomico-pathological approach was quickly adopted in England by morbid pathologists at the infirmaries ([Foucault, 2003](#)). The basic premise of this new paradigm was to correlate the symptoms observed in living patients on the wards with the lesions and morbid structures exposed during the post-mortem examination of the body in the dissection room. Bodies became subject to modifications not only for the practice of anatomical and morbid dissection but also for the practice of surgical techniques ([Lane, 2001](#)), with body parts often retained, shared and re-used, sometimes over lengthy periods of time ([Parsons, 1831](#); [Hurren, 2004](#)).

Hospitals also functioned as educational establishments and anatomical specimens became fundamental tools for the training of medical students. For example, by 1834, it was a condition of obtaining a license for medical teaching that a hospital housed a medical museum ([Reinartz, 2006](#); [Edwards and Edwards, 1959](#)). Such teaching collections comprised body parts obtained not only from patients at the hospital but also those that had been donated or purchased from private or teaching collections around the country ([Alberti, 2011](#); [Hurren, 2004](#); [Evans, 2012](#); [Chaplin, 2012](#)). Early collections were frequently replenished with fresh preparations due to contemporary preservation techniques still being experimental ([Alberti, 2011](#)). The collection of pathological specimens during

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