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Technical Note

Recording skeletal completeness: A standardised approach

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ABSTRACT

Recording the preservation of human skeletal remains is the foundation of osteological analyses for forensic and archaeological skeletal material. Methods for recording the skeletal completeness, one of the components of skeletal preservation documentation, are however currently non-standardised and subjective. To provide practitioners with a scientific means to accurately quantify skeletal completeness in an adult skeleton, percentage values for each skeletal element have been established. Using computed tomography (CT) volume rendering applications and post-mortem CT skeletal data for one adult individual, the percentage value for each bone relative to the complete skeleton was calculated based on volume. Percentage values for skeletal elements ranged from 0.01% (select hand and foot bones) to 8.43% (femur). Visual and written mediums detailing individual skeletal percentages have been provided as user-friendly reference sources. Calculating the percentage of skeletal remains available for analysis provides practitioners with a means to scientifically and objectively record skeletal completeness.

1. Introduction

Recording the preservation of human skeletal remains from forensic and archaeological contexts is a primary component of osteological analyses. Documenting the preservation is essential because the level of skeletal preservation dictates the extent to which conclusions can be drawn about the individual's ancestry, sex, age and stature (that is, a biological profile), trauma, pathology and/or unique osteological characteristics.

Recording methods for the preservation of human skeletal material are currently non-standardised. The level of detail recorded varies depending on the methodology employed and the purpose of the osteological investigation. Although there are no standard guidelines, the approach to recording typically includes some form of visual and/or written description of the:

- presence and absence of skeletal elements,
- completeness vs. fragmentation of the individual skeletal elements,
- condition of the skeletal elements (taphonomic processes), and a
- statement of the skeletal completeness.

Visual recording typically involves the use of schematic skeletal diagrams in which skeleton outlines are shaded to indicate the presence or absence of skeletal elements, and the completeness or fragmentation of those elements. Various schematic recording forms have been published within the last thirty years for both forensic and archaeological contexts [1–7], including the more recent advancements with digital recording methods using computer [8] and virtual application [9] software. Written descriptions of preservation are used as the additional, or alternative, medium to schematic diagrams. They involve documenting each skeletal element in an inventory checklist form [3,7,10] and detailing the various taphonomic processes affecting the skeleton.

One part is the recording of skeletal completeness. This comprises a statement summarising the presence/absence and completeness/fragmentation of the skeletal elements present to indicate how much of the total skeleton is available for osteological analysis [11]. Currently, the statement of completeness is typically reported using subjective and non-standardised descriptions such

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as 'poor' [12], 'good' [13], 'near complete' [14] and 'fairly complete' [15].

The aim of this research is to provide an objective and standardised method for documenting skeletal completeness. This standardised method provides a technique to quantify the percentage of the skeletal completeness preserved in an adult skeleton. Using computed tomography (CT) volume rendering applications, a tool increasingly used in osteological research [16–18] that has been found to be accurate and reliable [19], the proportion (percentage) of each skeletal element relative to the complete skeleton was calculated. Provision of a percentage value for each skeletal element, supplied as a reference list, provides practitioners with a means to accurately quantify skeletal completeness in any set of skeletal remains belonging to an adult individual.

2. Materials and methods

Calculating the proportion of each skeletal element relative to the complete skeleton was established through quantifying the volume of the complete skeleton and subsequently, the volume of each skeletal element using CT volume rendering applications. The CT skeletal data was obtained from one full body post-mortem CT scan of an adult male with no skeletal trauma or pathology. The CT scan was performed on a 128-row helical CT (Somatom Definition Flash, Siemens Healthcare) as part of the Victorian Institute of Forensic Medicine's routine autopsy process.

The CT scan of one young adult male with no obvious skeletal manifestations of disease or trauma was selected for review. Selection was based on the fact that the skeletal elements of a young adult are fully fused and therefore the complexities of accounting for bone development or deterioration were avoided. A male individual was used as the relatively larger skeletal mass of a male (compared to that of a female) was deemed easier to visualise and measure using the CT surface rendering tools. The individual had no evidence of skeletal trauma or pathology, ensuring that the proportions of the skeletal elements relative to each other would be expected to be in the normal range.

While differences in bone morphology enable forensic anthropologists to estimate an individual's sex, age and/or ancestry, such differences are not relevant when investigating the proportions of each bone relative to the complete skeleton. Consequently, based on the assumption that variables such as sexual dimorphism, ancestry and idiosyncratic variation are not relevant when assessing the presence or absence of skeletal elements, the calculation of skeletal proportions for one healthy adult was considered sufficient for this preliminary study.

Skeletal volume measurements were generated and recorded using the volume rendering application in the Philips Healthcare IntelliSpace Portal, V7, CT visualization software. This software

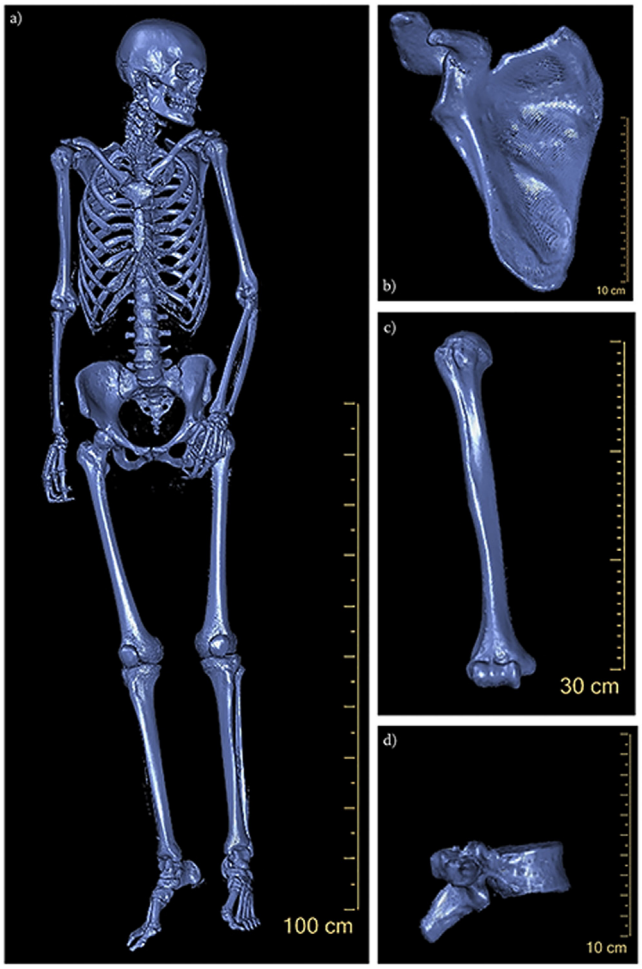

Fig. 1. Computed tomography volume rendering of the complete skeleton (a), and select skeletal elements of the right scapula (b), right humerus (c) and a thoracic vertebra (d).