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Technical Note

Skeletal idiopathic osteosclerosis helps to perform personal identification of unknown decedents: A novel contribution from anatomical variants through CT scan

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ABSTRACT

Personal identification consists of the comparison of ante-mortem information from a missing person with post-mortem data obtained from an unidentified corpse. Such procedure is based on the assessment of individualizing features which may help in providing a conclusive identification between ante-mortem and post-mortem material. Anatomical variants may provide important clues to correctly identify human remains. Areas of idiopathic osteosclerosis (IO), or dense bone islands (DBIs) characterized by radiopaque areas of dense, trabeculated, non-inflamed vital bone represent one of these, potentially individualizing, anatomical features.

This study presents a case where the finding of DBI was crucial for a positive identification through CT-scan. A decomposed body was found in an apartment in June 2014 in advanced decomposition and no dental records were available to perform a comparison for positive identification. Genetic tests were not applicable because of the lack of relatives in a direct line. The analysis of the only ante-mortem documentation, a CT-scan to the deceased dating back to August 2009, showed the presence of three DBIs within the trabecular bone of the proximal portion of the right femur. The same bony district was removed from the corpse during the autopsy and analysed by CT-scan, which verified the presence of the same features.

Forensic practitioners should therefore be aware of the great importance of anatomical bone variants, such as dense bone islands for identification purposes, and the importance of advanced radiological technique for addressing the individualizing potential of such variants. We propose that anatomical variants of the human skeleton should be considered as being "primary identification characteristics" similar to dental status, fingerprints and DNA.

1. Introduction

Personal identification of unknown decedents is an important issue of forensic anthropology, not only for the criminal and civil legal proceedings, but also for the ethical consequences and the human right of being buried with his/her own name and mourned by relatives after death. The issue of unknown decedents is a social emergency affecting several countries [1–6]: for example, in Fulton County (Georgia, USA) the percentage of unidentified decedents amounts up to 4.4% each year [5]. In Milan (Italy) the proportion of unknown decedents is 3.1%, whereas in the whole of Italy the estimated number of bodies still needing identification is 1238 [7]. The urgent need for improving the chances of personal identification based on biological parameters is therefore clear.

Personal identification can be reached by a comparison between ante-mortem data from a missing person or victim, and post-mortem information obtained from the corpse during autopsy and anthropological examination. The Interpol DVI (Disaster Victim Identification) guidelines distinguish between primary and secondary methods of identification: the former are based on fingerprints, dental and DNA analysis, and the latter on personal descriptors and medical findings, clothing and other evidence [8]. The primary identifiers may provide a positive identification, because of their high individualizing potential. In cases where such information is not available, personal identification may be based on the morphological comparison of ante-mortem and post-mortem data derived from the skeleton, including signs of previous trauma or surgery, presence of orthopaedic devices, and pathological lesions. Although skeletal alterations caused by trauma or surgery may be shared by a number of persons, they may also express morphologically unique features, and therefore possess the same evidentiary value as primary identifiers. Some of the primary identification methods are not always applicable: for example DNA can be highly degraded in some skeletonised or burned remains [9], and also fingerprints may be

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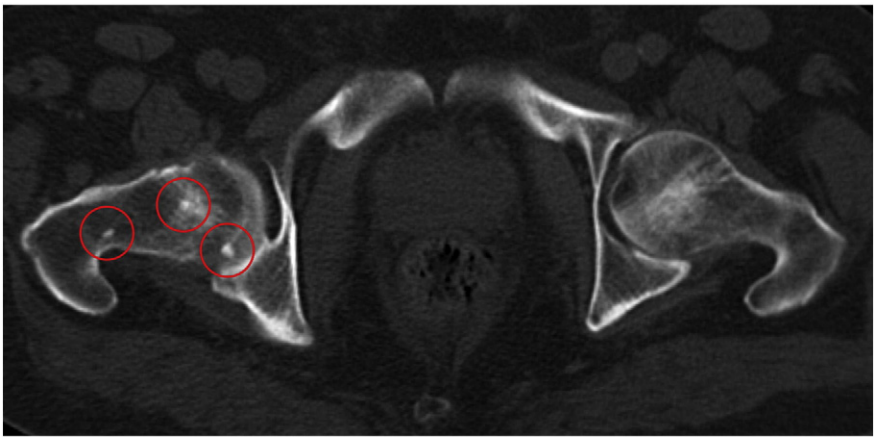

Fig. 1. Detail of the right femur acquired from an ante-mortem CT-scan dating back to August 2009: the three dense bone islands circled.

lost due to advanced decomposition [10]. From this point of view, the radiological skeletal assessment can provide useful and often conclusive indications concerning identification, either based on traumatic and surgical features, or on anatomical variants, which may also have a high individualizing potential [11]. In recent years, studies have evaluated the frequency of specific bone features such as fractures, signs of amputation, and the presence of orthopaedics' devices in population samples [12] in order to provide an indication concerning the rarity of these specific characteristics. Other studies have focused on the morphology of specific bone districts [13,14] with the idea to use these features for personal identification in the forensic context. Another avenue of research in the search for a reliable identification method has focused on radiological examinations of a number of bone districts and the identification of individualizing features, including the trabecular profile [15–19]. Areas of idiopathic osteosclerosis (IO), or dense bone islands (DBIs), which are defined as asymptomatic, radiopaque areas characterized on histological evaluation by dense, trabeculated, non-inflamed vital bone, represent skeletal features that may potentially be useful indicators for personal identification by radiological comparisons [20].

DBI mainly affects the jaws with a frequency ranging from 89.3% to 100% with presentation primarily in the premolar/molar region [20], but can occur in any region of the skeleton [21–23], especially in pelvis, and long bones [24]. However, very little is known about the prevalence of these features in the other parts of the skeleton.

This study aims at highlighting the potential use of anatomical variants, namely DBI, in a forensic context. A case is presented where DBI was crucial for reaching a positive identification. The importance of advanced radiological analyses such as CT-scan in order to provide a more detailed description of unique features in skeleton is highlighted as well.

2. Case report

In June 2014 a body in advanced decomposition was found in an apartment in Milan. It was thought to belong to the elderly resident who was seen alive for the last time six days before the finding. Since the face was no longer recognizable because of decomposition, personal identification based on biological features was requested. Unfortunately, dental comparisons could not be performed on account of a lack of ante-mortem dental records or even pictures of the deceased. Ante-mortem fingerprints were also not available. In addition, no relative could be found for a genetic comparison.

Consequently, all available ante-mortem data and clinical records were collected in order to find possible individualizing features useful to confirm the suspected identity of the deceased. A CT-scan of the abdomen and pelvis was found, dating back to August 2009. CT-scan showed the presence of three dense areas within the trabecular bone of the proximal portion of the right femur (Fig. 1). These areas were diagnosed as dense bone islands (DBIs). The nature and position of such formations highlighted by CT-scan allowed the operators to perform a comparison with a radiological examination of the right femur of the corpse. Following the autopsy examination, the proximal portion of the right femur was removed and a CT-scan was performed, acquiring slices with a 0.75 mm space interval (Siemens Somatom©). This image of the femur was oriented as similar as possible to the ante-mortem CT-scan by using the Multi-Planar Reconstruction (MPR) function of the freeware software Onis (DigitalCore, Tokyo).

The obtained CT-scan of the right femur from the unknown corpse showed the presence of three dense bone islands in the same position as those observed in the ante-mortem CT image (Fig. 2).

In order to check and highlight the concordance between the ante-mortem and the post-mortem CT-scans a comparison via juxtaposition and superimposition was performed. This procedure demonstrated that the number, position and shape of the three dense bone islands corresponded perfectly on the two images, thus confirming the identity of the individual (Fig. 3).

3. Discussion

Personal identification is a crucial task in forensic anthropology and it is closely linked to the anatomical concept of skeletal individuality: each skeleton shows specific features, physiological, pathological or artificial [25], which are not observed in other skeletons and therefore may be conclusive for reaching a positive identification.

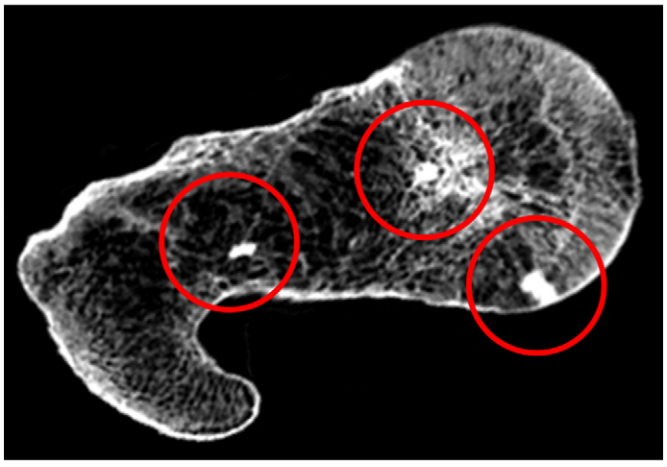

Fig. 2. Detail of the right femur of the cadaver acquired by CT-scan: the three dense bone islands circled.