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Technical note

Analysis of metallic medical devices after cremation: The importance in identification

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ABSTRACT

The recovery of a charred cadaver raises many issues concerning personal identification; the presence of prosthetic materials may provide very important and decisive information. Who is involved in the recovery of a charred body or of burnt human fragments, should therefore be able to recognize medical devices even if modified by fire effects. Metallic residues (585 kg) that came from 2785 cremations were studied. Medical devices were then divided by type and material in order to esteem the representativeness of each typology. The study illustrates the great presence of metal medical devices that could be of great help in identifying bodies and underlines that metallic medical devices types and morphology should be known by forensic practitioner involved in identification cases and that this kind of material can still be identified by physician and dentists, even if exposed to very high temperatures.

1. Introduction

The recovery of a charred cadaver raises many issues concerning the cause of death, the circumstances of death and the identification of the cadaver itself [1,2], which have to be faced together by the forensic pathologist, the forensic anthropologist and the forensic odontologist.

For identification purposes, a great contribution comes from the analysis of prosthetic materials, both odontological and non-odontological. Regarding the odontological identification, the comparison between ante-mortem and post-mortem data is a well-established reality in the forensic field [3–5], especially in the frame of the DVI system [6,7]. The literature also signals case reports of cadaver identification by dental means [8–10], sometimes reaching a probability value that is higher than the DNA analysis, in certain situations (putrefied cadaver [10]); the same techniques are obviously also used for the identification of mass disaster victims, like aircraft crashes (SK 686 [11], CJC 3407 [12]), in which all victims (or most of them) are usually charred. Simultaneously, multiple experimental studies are performed to gain useful information concerning the identification by dental techniques and the modification of dental materials after cremation [13–24].

On the other hand, also non-odontologic devices can be used to identify human remains [25] and multiple cases of identification are reported in literature [26–32]. For example, several positive identifications of burned human body are reported by tracking batch numbers engraved in implanted orthopaedic devices.

Comparison of antemortem traumas, skeletal morphology, and surgical artifacts with antemortem radiographs and surgical records can also help for identification.

Considering the cited literature, the presence of prosthetic materials in case of burnt corpses can represent a great aid for the identification process, because such materials may provide very important and decisive information. The need of a careful analysis of prosthetic materials in real cases is the starting point of the present study, which intends to focus the attention on all the medical devices that come out from a controlled situation like the cremation in crematorium.

Nowadays, thank to the innovative surgery techniques and materials, more and more metal prostheses are implanted. For example, almost 91.000 hip replacement operations (which are the most numerous) were performed in 2010 and this number is increasing of about 2.6% each year [33,34,35]. In Italy, about 157.000 prosthetic replacements were implanted only in 2010, with an increase of 4.8% each year [33,34,35].

Orthopaedic devices recovered in association with skeletal remains offer information that can assist in identification, because manufacturing companies insert summary information on the labels on products that allow them to be traced [36].

In 2011, 14.2% of the deceased Italian people was cremated (ISTAT), while in 2012, it is estimated to be 16.6%. This datum was below 1% until 1990; then the mentality of the people gradually changed towards cremation and the percentage grew up more quickly, increasing year by

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Table 1
Total number and weight of orthopaedic devices.

Metallic device tipology	Number	Weight (kg)
Endomedullary "gamma-shaped" nails	73	10.92
Synthetic plates	68	6.7
Prosthetic stems without articular head	90	14.4
Prosthetic stems with articular head	87	22.4
Free articular heads	80	5.425
Articular cups	161	12.3
Femoral condyles	57	14.858
Tibial plates	29	2.059

year till nowadays. In Italy, Northern regions are the most representative in the cremation choice. In Northern European Countries about 40 to 80% of people chose cremation, even if Switzerland is at the top with 88.88% [37].

The description of each prosthetic device found in this context will be performed, with particular attention to the most unusual ones: the information deriving from the observation will be then discussed in a practical point of view, highlighting the most relevant topics that can mark the difference and play a decisive role in the identification by prosthesis, when facing real forensic cases.

2. Materials and methods

The staff of the crematorium of Lambrate in Milan had collected all metal residues found in a total of about 2785 cremations.

The aim of this study was to analyse all these residues in order to classify them, giving back a report of their typology and frequency in relation to the general population from which they come, and evaluating their consequent importance in identification. Cremations in the analyzed crematorium take place in three ovens, two are electric ovens and one is a methane gas oven. They are heated to about 1200 °C; the coffin containing the body is placed inside, and the combustion occurs. The temperature increases to 900–1100 °C during combustion, which lasts about 90–120 min. All the remains are then raked down into a special tray to cool.

After the cooling process, metallic parts were separated from remaining human ashes via a special machine for magnetic metallic and by hands for non-magnetic metal devices. When metal is removed, the residual bones are crushed to the consistency of coarse sand. This residue weighs about 2 kg. It is demonstrated that after burning males are heavier than females and age has an effect in female skeletal weight [38].

The most common metal residues remaining were screws, nails, handles, metal prostheses (dental implants, hip and knee replacements). Other implanted items collected included intramedullary nails, vascular stents, cardiac valves and pace makers. Less frequently common objects were retrieved, like wear glasses, coins or frames: their presence is probably related to social customs.

All this metal materials were collected in a dedicated container and divided by medical pathologists, anthropologists and odontologists, performing the study selecting all metal prostheses or medical devices (as staples or venoclips) from the other metallic residues. Again, the first group was divided into different kinds of medical device as it follows: means of fracture fixation (Intramedullary nails and plaques), prosthetic hip/shoulder (stems with and without heads, free heads and articular cups), prosthetic knee (femoral condyles and tibial plateau), various medical devices (pipettes "Bard G", heart valves, vascular endoprosthesis, residual containers of pacemaker, pacemaker cables and dental devices.

After this distinction, the pieces of each group were classified and counted, in order to estimate the representativeness of each typology.

3. Results

The total amount of metal waste, coming out from 2785 cremations, was composed by 585 kg of metal residues, and it was manually and carefully screened and sifted, piece by piece by nine operators: four medical doctors, four anthropologists and one dentist. The careful, singular selection let to divide the entire amount of waste in two groups: the metal pieces referring to the coffins or personal belonging; the residues referring to medical prosthetic devices. Concerning the former, the fragments were constituted by the metal pieces of the coffins: nails, screws and plates. This group represented the majority of the residues, with a weight of about 490 kg (83.7% of the total weight).

Medical prosthetic devices had a total weight of about 95 kg (16.3% of the total weight). The analysis of this material appearance and its description was the aim of this study, and for this reason the prosthetic devices were further divided in subgroups. (Table 1).

Fig. 1. Four of the 73 endomedullary "gamma-shaped" nails. On the left (A) the dark and heavier metal nails, on the right (B) the bright and lighter ones.

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