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# Dismemberment and disarticulation: A forensic anthropological approach

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ABSTRACT

The dismemberment of a corpse is fairly rare in forensic medicine. It is usually performed with different types of sharp tools and used as a method of concealing the body and thus erasing proof of murder. In this context, the disarticulation of body parts is an even rarer event. The authors present the analysis of six dismemberment cases (well-preserved corpses or skeletonized remains with clear signs of dismemberment), arising from different contexts and in which different types of sharp tools were used. Two cases in particular showed peculiar features where separation of the forearms and limbs from the rest of the body was performed not by cutting through bones but through a meticulous disarticulation. The importance of a thorough anthropological investigation is thus highlighted, since it provides crucial information on the manner of dismemberment/disarticulation, the types of tools used and the general context in which the crime was perpetrated.



## 1. Introduction

The dismemberment of a corpse is an event which usually causes sensation and curiosity. In fact, it is frequently considered as a more brutal and inhuman act than the homicide itself. The term “dismemberment” refers to a voluntary criminal act, thus excluding accidental events. In these cases, the identification of the victim and the reconstruction of the cause and manner of death can be challenging.[1,2]

In literature, a general classification of various types of dismemberment has been developed and is nowadays widely accepted with a division in four categories based mainly on the aims and reasons of the crime[3–6,7]: the one with the highest number of cases is the so-called “defensive mutilation”, concerning all the cases in which the perpetrator (or the perpetrators) hacks the body in many pieces with the aim of more easily transporting and concealing. Instead, when the dismemberment is the result of impulsive and aggressive actions against the corpse of the victim (in order to remove parts of the body as a demonstrative act) the category is named “offensive mutilation”. “Aggressive mutilation” is represented by dismemberment as a way to kill, that is when the severing of body parts is the direct cause of death (frequently decapitation).[8,9] The last category is represented by “necromaniac mutilation”, i.e. when the perpetrator collects parts of a buried corpse for his own sexual pleasure.

Another classification was created by Salfati[10] who distinguished among “expressive” and “instrumental” mutilations; in the former, the victim represents a symbolic target, towards which the communication or satisfaction of the psychological needs of the perpetrator are directed; in the second case the main aim of the perpetrator is to achieve some advantage (for example, economic benefits).

For what concerns the relationship between dismemberment and psychiatric disease, very few studies are available at the moment. Rais et al., for example,[3] described a link between aggressive and defensive mutilations and alcohol/drug addiction, usually with previous psychiatric and criminal records, whereas in case of sexual crimes, previous criminal records are frequently present along with anxiety, schizophrenia or drug-addiction. To our

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knowledge, more precise indications useful for the identification of the offender have never been assessed.

In most cases dismemberment is performed with sharp objects (handsaws, chainsaws or different types of knives).[1,3,10,11] These tools can leave specific signs on the tissues and especially on bone. In fact, the analysis of cut and saw marks on the bone can enable the identification of the areas of severing as well as the tools used.[12–15]

However, still little literature exists on dismemberment and articles frequently refer to case reports (Table 1). The only systematic studies on this topic have been performed by Symes et al. whose observations are at present the main sources of information for forensic anthropology in the field of tool mark analysis on bone.[16–21] Moreover, a particular issue has never been analyzed: the disarticulation of some body parts as an alternative method of dismemberment, and a possible indication of criminal context.

The study presents six different cases of dismemberment which occurred in Milan, Italy, between 1999 and 2011.

## 2. Case reports

### 2.1. Case 1

In 2006 a dismembered body was found in four black plastic bags in the cellar of a building in the city centre of Milan; the victim was identified as a 77-year old female owner of the cellar. The son (a 50-year old male), who had difficult relationships with his mother and who had previously been imprisoned for other crimes, was charged with homicide.

At autopsy, the four plastic bags were opened: in the first the head was present, severed from the rest of the body at the fourth cervical vertebra which showed a complete transverse cut. The thorax, in the second bag, was separated from the abdomen by a transverse cut through the first lumbar vertebra. Abdominal organs and thighs (severed at the femoral condyles) were placed in the third bag. The fourth bag contained the upper limbs (the left one severed at the humeral diaphysis, the right one at the middle of the humeral head), and the remaining part of the lower limbs (Fig. 1). Several fractures were detected on the cranial vault and the cause of death was thus identified as skull and brain injuries due to multiple blunt force traumas. Investigating authorities searched for the type of tool used for dismemberment since a knife with a saw-type edge was missing from the collection of knives of the man's girlfriend (she too suspected). Soft tissues, in an advanced state of decomposition, provided no additional information. Afterwards, the man confessed the murder of his mother by hitting her on the head with an iron and then dismembering her body with an saw.

The areas of dismemberment of the neck and long bones (cervical vertebra, left humeral head, right humeral diaphysis (Fig. 1a), femoral distal diaphysis) showed fairly clean transverse cuts. However, one lesion on the left thigh was interesting: a cut mark in the major trochanter was detected (Fig. 1b) with the typical pattern of a false start: the perpetrator probably stopped when he hit the metallic prosthetic device in her femur after she had fractured it some years before. A silicone cast of the lesion was performed in order to reproduce the morphologic characteristics of the tool used; the cast showed characteristics which were inconsistent (mainly because of metric differences) with the knife found in the woman's apartment. The final cut to both legs was then performed on the distal diaphysis, just above the condyles (Fig. 1c). Hence, the use of a handsaw was demonstrated, and confirmed by the witnesses of the man: it created a clear severing of the head at the fourth cervical vertebra, without false starts. No false starts were found on the right humeral diaphysis, on the left humeral head and on the fourth lumbar vertebra. Clear saw marks with presence of false starts were indeed visible on the left femoral diaphysis (where the cut stopped on the prosthesis) and on the distal part of both femoral diaphysis (where the lower limbs were severed from the rest of the body). Murder and dismemberment were thus performed by a family member of the victim, using quickly available tools, probably lacking detailed anatomical knowledge.

### 2.2. Case 2

In 1999 a human torso and upper limbs enveloped in a shower curtain were found in an abandoned irrigation ditch: the head and the lower limbs were missing and every further attempt at recovering them was unsuccessful. At autopsy, a clear section (probably made by a sharp weapon with a linear or a serrated edge) through the hyoid bone and 3rd cervical vertebra was detected, but the most interesting features were on the lower part of the corpse: in fact, the lower limbs were totally disarticulated (Fig. 2) and the acetabula or surrounding parts of the pelvic girdle were totally lacking of any sign of cut marks, even after a stereomicroscopic survey. A clear cut mark was detected on the third cervical vertebra and on the hyoid bone, where the head was probably detached from the rest of the body, but no other cut marks were detected on the other dismembered parts. In this case several features suggested that the act could have been performed by one or more perpetrators, probably with the aim of better hiding the body. However, the technique of dismemberment was peculiar, since it was not performed in a “typical” manner (severing bones directly with sharp instruments) but by disarticulating the limbs, as proven by the total absence of cut marks on the cortical bone of the pelvic girdle and especially on the acetabula.

### 2.3. Case 3

In 2006, in a woodland near the city of Milan, the dismembered body of a male was discovered in four black plastic bags. The

**Table 1**
Available articles concerning case reports about dismemberment or mutilation.

| Authors | Year | Number of cases | Nation | Type of dismemberment/mutilation |
|---|---|---|---|---|
| Rajs J et al. | 1998 | 22 | Sweden | various |
| Reuhl J et al. | 1999 | 1 | Germany | mutilation with chain saw |
| Madea B et al. | 2000 | 1 | Germany | dismemberment with chain saw |
| Türk EE et al. | 2004 | 3 | Germany | decapitation with cutting tools |
| Konopka T et al. | 2006 | 1 | Poland | division of the body in many fragments (850) with various tools and charring |
| Di Nunno N et al. | 2006 | 3 | Italy | 2 cases of dismemberment and 1 case of decapitation with cutting tools |
| Konopka T et al. | 2007 | 23 | Poland | various |
| Dogan KH et al. | 2010 | 1 | Turkey | dismemberment and decapitation with cutting tools |
| Delabarde T et al. | 2010 | 1 | Ecuador | dismemberment with cutting tools |

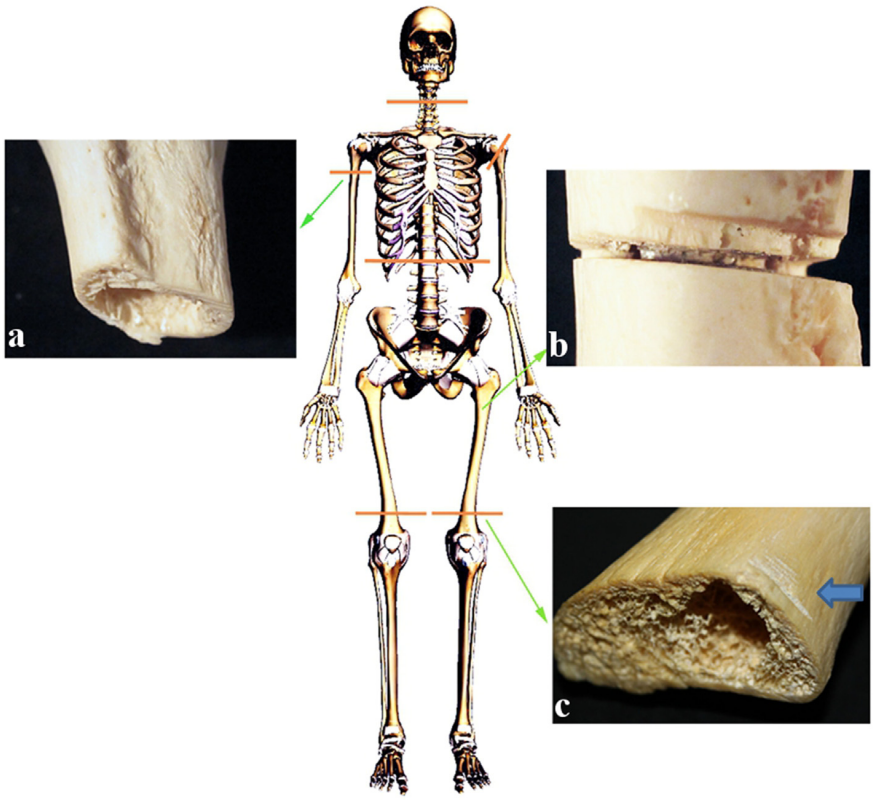


**Fig. 1.** case 1 – a) severed proximal epiphysis of the right humerus; b) cut in the left femur, stopped against the intramedullary prosthetic device; c) severed distal epiphysis of the left femur with signs of false starts (blue arrow). (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

corpse had unusual and particular features: the whole body was divided in different parts with clear signs of disarticulation. In fact, a perfect and clean disarticulation had been performed between the femoral heads and acetabula, hands and forearms were clearly disarticulated at the elbows, feet and legs were disarticulated at the knees and the head between the IVth and Vth cervical vertebra (Fig. 3). Many superficial cuts, small in length, shallow and with different directions, were found in every severed articulation: 23 small cut marks were found on the distal epiphysis of the left femur (Fig. 3a, a') and 17 on the distal epiphysis of the right femur (Fig. 3b, b'), with lengths ranging from 2 to 35 mm; 5 and 7 cut marks were found respectively on the left and right femoral heads, whereas on the left and right acetabula 3 and 4 marks were present (Fig. 3e, e', 3f). Those marks had lengths ranging between 3 and 19 mm. Furthermore, several small and shallow cut marks were clearly visible on the upper limbs: one on the left upper limb, 4 on the distal epiphysis of the humerus (Fig. 3g), one on the proximal epiphysis of the radius and 10 on the proximal epiphysis of the ulna (ranging from 3 to 17 mm) (Fig. 3h); concerning the right upper limb, one cut mark on the distal epiphysis of the humerus (Fig. 3i) and 5 cut marks on the proximal epiphysis of the ulna (Fig. 3j) were detected, with lengths ranging from 4 to 19 mm. Finally, 5 marks were found on the body and left transverse process of the fourth cervical vertebra (length 4–12 mm) (Fig. 3k). All these marks had the same morphological features: shallow with small kerf widths and small in length. All such peculiar marks on the bones indicated a very specific type of post-mortem activity: the cutting, in the articular area, of all the muscles, tendons and ligaments with the final purpose of disarticulating the victim in many parts.

### 2.4. Case 4

In 2010 the skeletonized remains of a skull, the first three cervical vertebrae and the hyoid bone were found inside a plastic bag on the bottom of a lake in Northern Italy. Remains belonged to a Negroid female aged 28–43 and the skull was still partly covered with adipocere. A specific cause of death was not assessable, but several cut marks were detected on the skull, mostly superficial and placed on the frontal bone, on the nasal and orbital bones, zygomatic arch, maxilla and mandibular body. Silicone casts were performed for each cut mark with the aim of recognizing the type of weapon, then cut marks and casts were analyzed macroscopically, with a stereomicroscope and with scanning electron microscopy. Two types of cutting injuries on the bones of the skull were thus recognized: one type showed straight walls at a 90-degree angle with the floor and average width of 1 mm, whereas the other type was thinner and with "U" or "V" shapes. Therefore, the corresponding cutting weapons were supposed to be one with a serrated edge (eg. a saw) and one with a linear edge (eg. a common kitchen knife), used with the aim of dismembering the body and making it unrecognizable with the removal of the facial soft tissues. An effort was made to detect metallic residues of the weapon on the edges and floor of the lesion with SEM-EDX but the analysis gave negative results since only several residues of iron were found (Fig. 4): although it is commonly found as a constituent of many types of blades, it was detected in high concentrations in the surrounding environment as well, so that a source of contamination could not be ruled out. In this case, despite the small amount of bones recovered, some hypotheses were however feasible: the cut marks found in some areas of the skull provided concrete

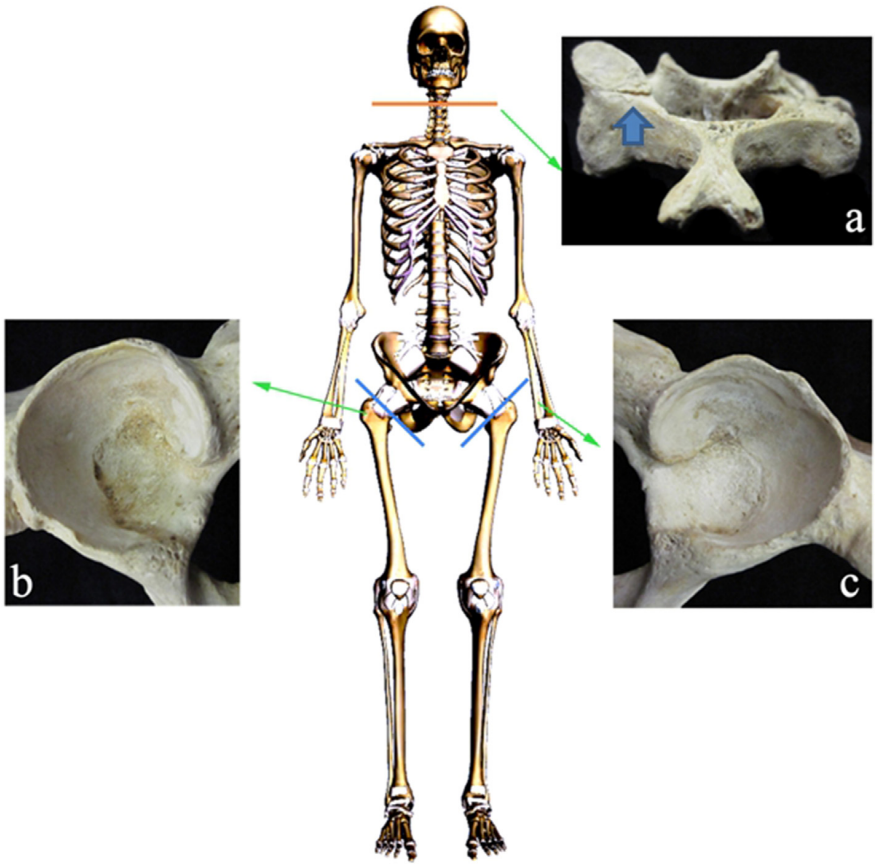


**Fig. 2.** cut mark on the cervical vertebra (a) and absence of signs of cutting on both acetabula (b and c).

evidence of the intention of concealing and making the body unidentifiable by removing the soft tissues of the face, as witnessed by the characteristics and position of the cut marks on the skull. The perpetrator was never identified.

### 2.5. Case 5

In 2011 some skeletal remains were found in a woodland in northern Italy. The remains belonged to a Negroid female aged 37–52 and were scattered in an area of some tens of meters; they consisted in a complete skull with mandible, 2nd – 4th – 5th cervical vertebrae, the distal part of the right humerus, the proximal part of the right ulna and the whole left tibia. Although an evident cause of death was lacking, some clear cut marks on bone clearly suggested signs of dismemberment. In particular, the right humerus was cleanly cut, with evident cut marks running parallel to each other and with the same characteristics of semilunar detachments of the surface of the cortical bone at regular intervals (Fig. 5). Such lesions underwent macroscopic surveys and were then observed by stereomicroscopy and SEM-EDX. Two crucial features were detected: the thorough measurement of the size of the lesions confirmed that the bone detachments had similar areas and were placed at the same distance. Moreover, residues of iron, chromium and nickel (typical components of cutting weapons) were detected around the margins of the lesions and not in the surrounding environment. Finally, with the aim of excluding the teeth of scavenging animals as a possible origin of the bone lesions, plasticine casts were made with models of cat, fox and boar dentitions. The morphology was inconsistent, whereas the plasticine mold of the edge of a serrated knife was superimposable with the features detected in bone. Thus, dismemberment was presumed to have been perpetrated with a serrated-edge blade (i.e. a manual saw). Unlike the previous case, no signs of attempts to hinder identification were detected. Neither the corpse nor the perpetrator have ever been identified, but the similarities with case 3 (corpses discovered in places near each other and similar victims: young, Negroid and both dismembered with similar instruments) provided support to the hypothesis of the same perpetrator for both cases.

### 2.6. Case 6

In 2010, thanks to the confession of the murderer, the dismembered body of a 76-year old male was found in several plastic bags discovered partly within a canal and partly in a farmstead in the outskirts of Milan, Italy. The body was in a good state of preservation (the homicide had been perpetrated just a few hours before) and severed in six pieces (thorax and abdomen, upper arms, lower arms and head). The cause of death was due to multiple head injuries perpetrated with a walking stick, followed by dismemberment and hiding of the different parts. In order to reconstruct the morphology of the cranial injuries and to identify the tools used, casts of every injury were taken and SEM-EDX investigations were performed: cranial blunt injuries were identified as the cause of death, and SEM-EDX detected many residues of tin left by the suspected tool (Fig. 6): the tin top of a wooden walking stick. Moreover, the

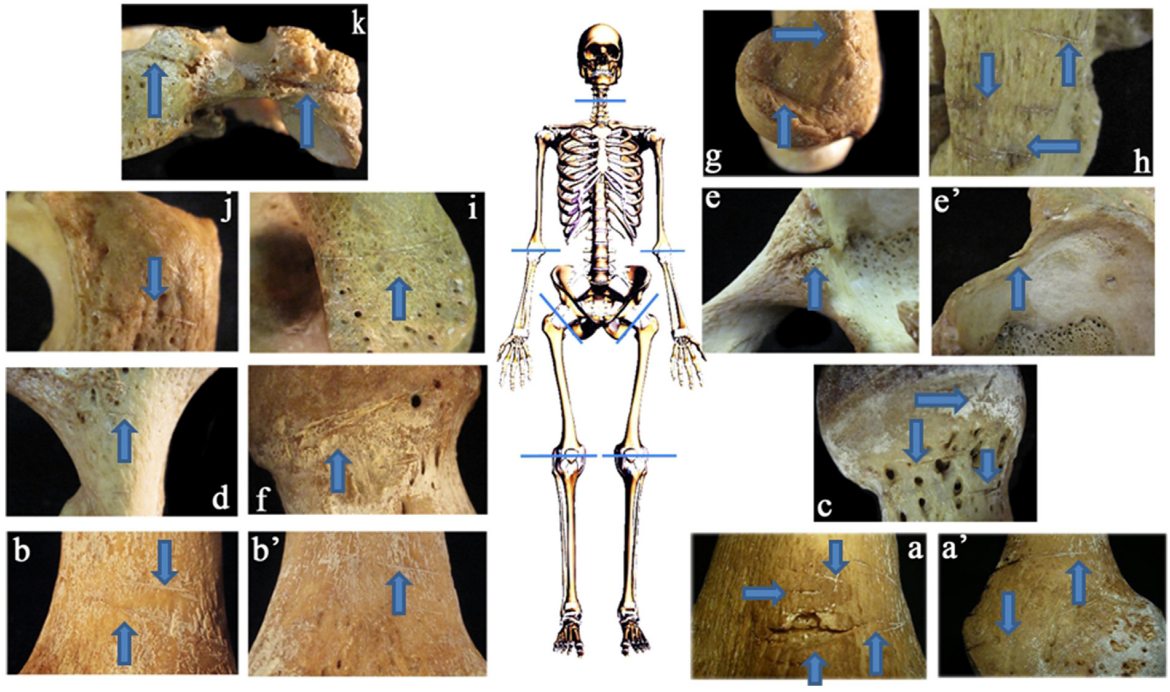


**Fig. 3.** case 3 – a, a') disarticulation at the knees: frontal and lateral view of distal epiphysisof left femur; b b') disarticulation at the knees: frontal and posterior view of distalepiphysis of right femur; c) disarticulation at the hips: left femoral head; d) disarticulation at the hips: right femoral head; e, e') disarticulation at the hips: left acetabulum; f) disarticulation at the hips: right acetabulum; g) disarticulation at the elbows: distal epiphysis of left humerus; h) disarticulation at the elbows: proximal epiphysis of left ulna; i) disarticulation at the elbows: distal epiphysis of right humerus; j) disarticulation at the elbows: proximal epiphysis of right ulna; k) disarticulation at the cervical column: fourth cervical vertebra. The arrows indicate the cut marks on the victim's bones.

edges of the dismembered parts were analyzed with SEM-EDX in order to find metallic residues left by the cutting weapons: two linear-edged ceramic knives (one with the tip of the blade broken and compatible with a splinter embedded in the 2nd cervical vertebra) and a serrated-edged bread knife. The cut marks found in the cervical vertebrae and in the right humerus indicated the use of a blade with a linear edge and this fact was confirmed also through the detection of residues of hafnium and zirconium, indicative of the use of one of the ceramic knives, as was further proven by the same analysis on the blade. The cutting injuries on the left humerus and both femora showed instead compatible features with a serrated-edged blade and SEM-EDX analyses detected residues of iron and chrome: this was compatible with the bread knife. The precise reconstruction of the manner of homicide and dismemberment through anthropological surveys and identification of specific instruments shed light on the whole scenario of the crime, in which the perpetrator had acted on impulse and without premeditation, using readily accessible tools.

## 3. Discussion

Postmortem dismemberment is mostly performed with the purpose of hiding a corpse and erasing any proof of the perpetrated crime, and several motivations behind this act have been described in the literature. At the moment, the issue of dismemberment has been mainly focused on from the perspective of psychology, in an effort to interpret the mind of the perpetrator[1–7]

Instead of starting from the reasons of the crime itself and thus from criminal-sociological aspects, this collection of peculiar cases provides interesting aspects from a forensic and anthropological point of view. The cases were in fact examined starting on the basis of the evidence gained from the investigation of the corpse itself (a relatively well preserved entire body or skeletal remains). Different methods of survey, which varied from the macroscopic morphological investigation to laboratory analyses (eg. SEM), enabled a more accurate reconstruction of the whole crime scenario. As a matter of fact, dismemberment cases are representative of the crucial role of forensic anthropology in the assessment of bone lesions.

Table 2 represents a summary of the main features of the six cases: the first case concerns what can be considered a "classic" dismemberment, or at least one of the most frequently found. As a matter of fact, the body was divided into several parts by direct cuts through the bones, performed by a person without specific knowledge on anatomy and with the aim of better transporting and hiding the body. Moreover, the cut in the left femur stopped when it ran into an intramedullary prosthetic device. Morphological analysis of the characteristics of the cuts, and reproductions with casts enabled us to recognize a saw, and also to rule out the use of a knife as previously suspected by investigators. The cause of death was identified in skull and brain lesions due to blunt force injuries: later, the perpetrator confessed he had used a flat iron.

Cases 2 and 3 are extremely peculiar: along with the typical cut marks detected in bones as signs of dismemberment, meticulous disarticulation of the joints was also found. This finding brings to mind some sort of anatomical expertise. Furthermore, which sharp weapons could have been used? Since the search for metallic residues with SEM-EDX was not yet routine at that time, macroscopic and stereomicroscopic surveys were considered sufficient. This time the study of cut marks was implemented with stereomicroscopic surveys and with the use of silicone casts: the first enabled a clear and detailed view of the lesion itself (especially for the interpretation of the edges), the second enabled a faithful reproduction of every cut mark allowing a thorough observation of its depth and of the walls/bottom of the kerf.

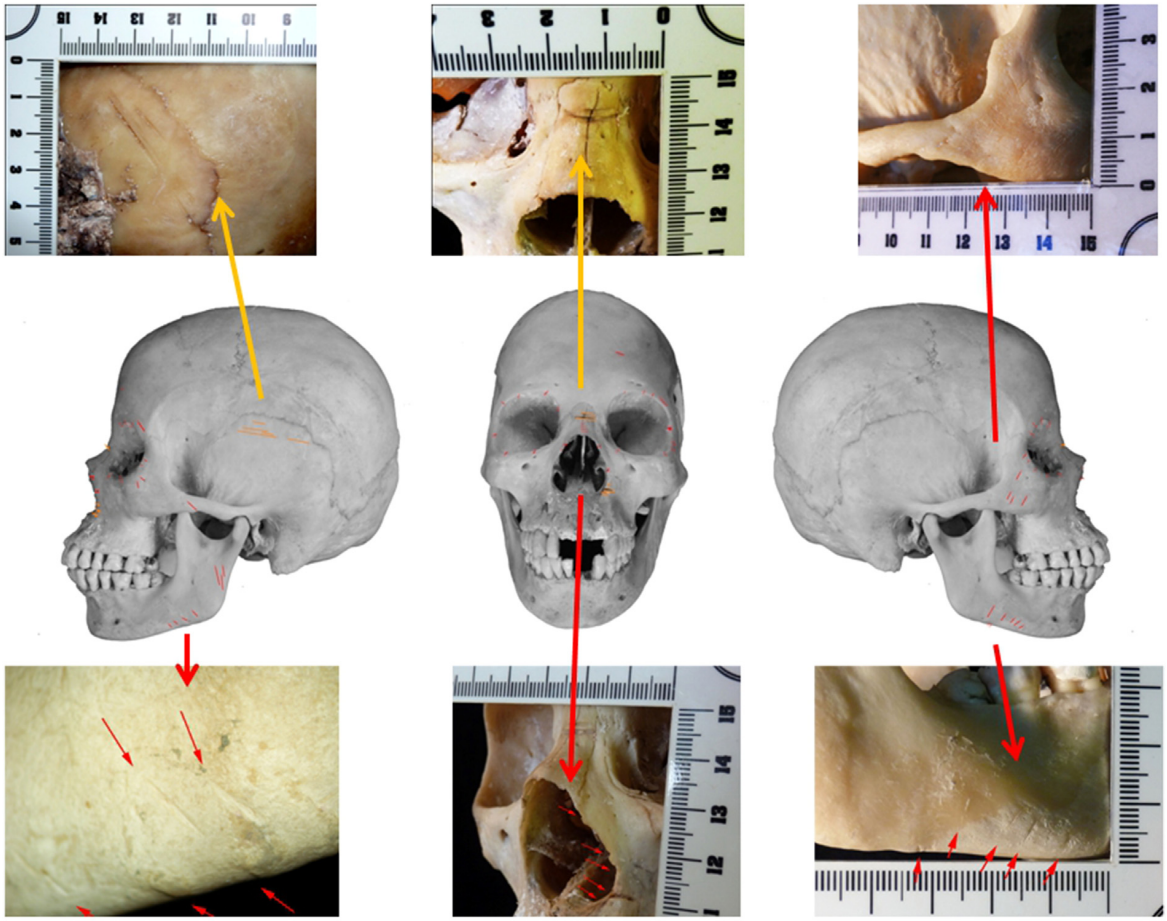

**Fig. 4.** CASE 4 – cutmarks on the skull. Red arrows: linear blade; orange arrows: serrated blade. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

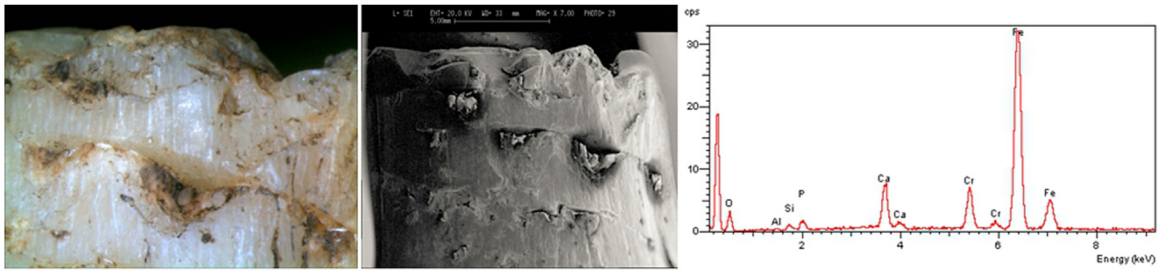


**Fig. 5.** CASE 5 – cutmarks on severed humerus with stereomicroscopy and SEM-EDX and relative spectrum with residues Iron and Chrome.

Cases 4, 5 and 6 represent the evolution of the analysis of cut marks on bone since the reliability and accuracy of the investigation increased by adopting a valuable technique: SEM-EDX. Its use is nowadays adopted in many fields of forensic pathology and anthropology, and the valuable help it can provide in the analysis of cut marks on bone has been previously stressed.[17] This instrument in fact, enables the performance of morphological evaluations with very high magnification thanks to a focused beam of primary electrons directly striking the sample. The combination with Energy Dispersive X-ray Analysis (EDX) allows for the assessment of the chemical composition of residues detected on the surveyed sample. Therefore, the analysis of tool marks on bones is completed by a thorough evaluations of the morphological features along with the nature of possible metallic residues. In case 5, the presence of a cut mark in the right humerus and composition of the used tool were determined, whereas in case 6 a match between cut marks and weapons was obtained, thus indicating which weapons were used and where on the body (since two different suspected knives were present). Case 4 is instead an expression of the main limitation of this technique: the high sensitivity increases the risk of false positive results due to contamination, as in this case, since residues of iron could be found in many cutting weapons but even in the soil where the remains were found. In case 5 microscopic images and precise measures led to the clear identification of a serrated blade as a cutting weapon. Otherwise, in cases 5 and 6 the elements detected were not present as contaminants in the surrounding environment. Contamination has therefore to be kept in mind when interpreting analyses with SEM-EDX. These cases however may represent a clear demonstration of the importance of this method

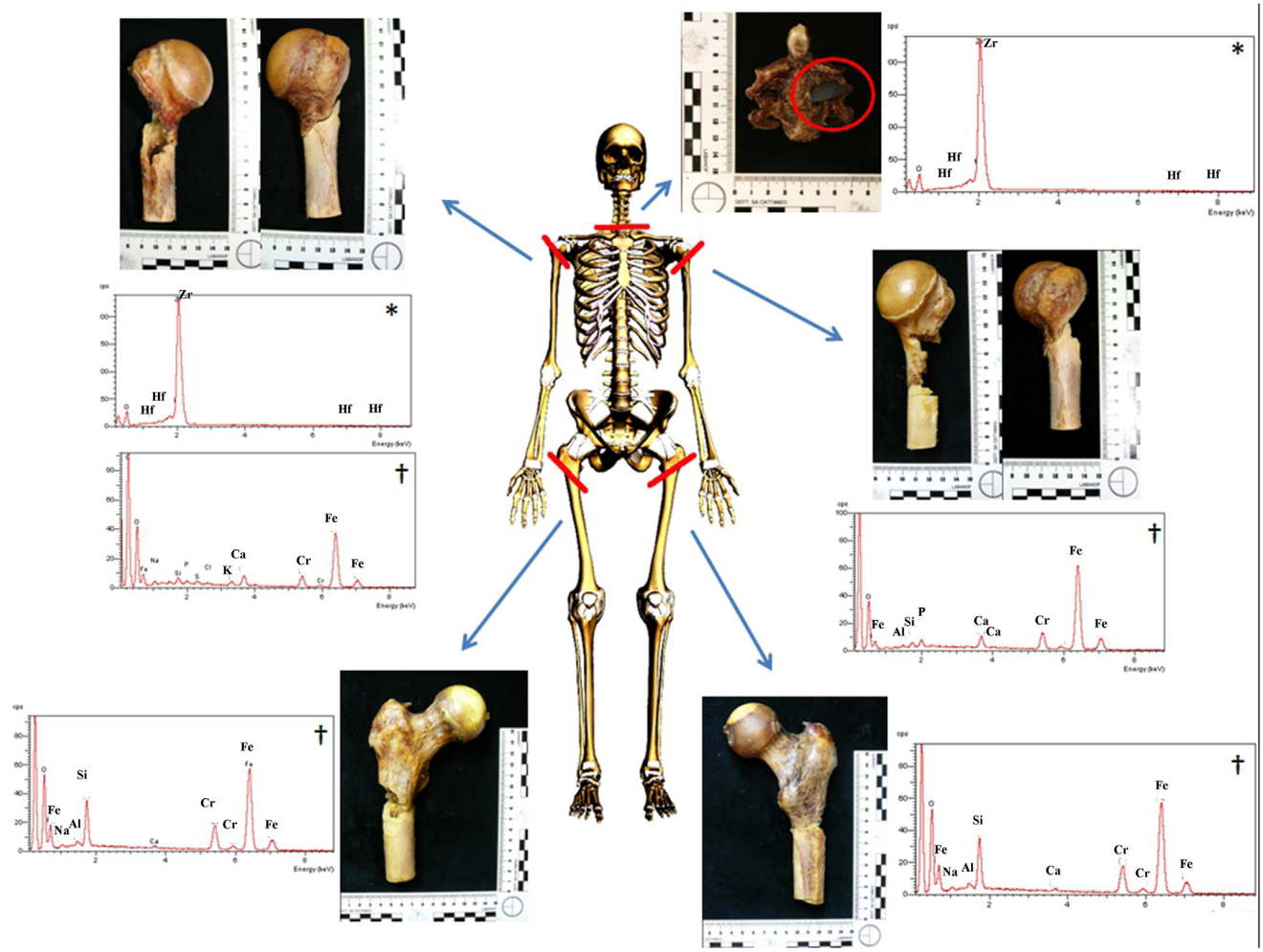


**Fig. 6.** CASE 6 – sites of dismemberment and relative spectrum with SEM-EDX. Red circle: ceramic knife's tip encased in cervical vertebra. * = spectrum of residues of Hafnium and Zirconium. † = spectrum of residues of Iron and Chrome. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

within the entire investigation, as t has become a pillar of the study of tool marks on bones.[22–25] In case 5 the study of bone injuries was further enriched with experimental tests on plasticine molds to exclude the activity of scavenging. A significant difference between the pattern of the cut marks and the outline of the teeth of different local fauna was detected, whereas a clear consistency with the outline of a serrated blade was clearly highlighted.

The evolution of the methods of survey in dismemberment cases is somehow following the evolution of techniques and new methods in the whole forensic field: starting from a pure macroscopic survey, the common forensic practice moved towards morpho-microscopic analyses, artificial reproduction of cut marks, the search for metallic residues. All these further investigations have strengthened the study of tool marks in bones.[16–21] However, the most crucial step of the investigation still remains the macroscopic/morphological survey: even with high magnification images, with precise measures or with the detection of residues, nothing should be done without a thorough osteological survey. Therefore, morphology could be considered the crucial element, even though it might not be enough.

Finally, this collection of cases demonstrates the fundamental support that comes from forensic anthropology in cases of dismemberment: it is crucial that the morphological analysis of lesions found in bones, as well as the search for residues using microscopic methods such as scanning electron microscopy, be performed in order to acquire important investigative information. Furthermore, the particular expertise of the author, such as in cases of disarticulation may be a fundamental clue. In fact, the analysis of these cases shows the difference between what may be considered a "classic" dismemberment technique and disarticulation. The first is performed with the use of instruments of a certain size, such as knives (both with smooth or serrated edges) or saws, axes and so on, leading to dismemberment by sawing bones directly through the diaphysis or epiphysis, regardless of the position of articular joints. On the other hand, disarticulation is performed with the use of smaller instruments (such as scalpels), following an anatomical criterion in dissecting at the level of the joints. The final effect, when anthropological assessments are performed, is that in the first case the marks left on the bones are particularly clear and can be studied both morphologically and from a chemical point of view. When disarticulation occurs, the main feature is the absence of marks on bones, except for small and shallow linear marks left by the cutting edge of the instruments, on which morphological investigations may be difficult to perform.

The detection of such a peculiar severing technique may be an important element in outlining a criminological profile of the perpetrator, since it might be a sign of expert "modus operandi" typical of specific criminal groups.

**Table 2**
Summary of the six cases.

| Case | Body parts available | Type of weapons | Type of surveys | Manner of dismemberment | Information provided by anthropological analysis |
|---|---|---|---|---|---|
| 1 | entire body dismembered in 7 parts | hand saw | • macroscopic analyses<br>• casts<br>• stereomicroscopy | "classic" dismemberment with severing of both humers, cervical and thoracic vertebrae, both femuri | • cause and manner of death<br>• manner of dismemberment<br>• exclusion of suspected tools<br>• identification of the tools used<br>• corroboration of suspected murder's confession |
| 2 | torso and upper limbs (lower limbs, head, I-II cervical vertebrae lacking) | unknown | • macroscopic analyses<br>• stereomicroscopy | severing of the head with cutting of the cervical vertebrae; bilateral disarticulation at the hips | • manner of dismemberment/ disarticulation |
| 3 | entire body dismembered (disarticulated) in 8 parts | unknown (scalpels?) | • macroscopic analyses<br>• stereomicroscopy | disarticulation of the head at the cervical column, bilateral disarticulation of the forearms at the elbows, of the lower thighs at the hips, of the legs at the knees | • manner of dismemberment/ disarticulation<br>• identification of the possible tools used<br>• hypothesis on the criminal context |
| 4 | skull, mandible, first three cervical vetrebrae and hyoid bone | • serrated blade (?)<br>• linear blade (?) | • macroscopic analyses<br>• steromicroscopy<br>• SEM-EDX<br>• casts | dismembermet alleged on the basis of the cutmarks found on the skull | • manner of dismemberment<br>• identification of the possible tools used<br>• hypothesis on the criminal context |
| 5 | skull, mandible, 2nd-4th-5th cervical vertebrae, distal part of right humerus, proximal part of right ulna, left tibia | serrated blade (saw?) | • macroscopic analyses<br>• steromicroscopy<br>• SEM-EDX<br>• tests on plasticine | dismembermet alleged on the basis of the curmarks found on the right humerus | • manner of dismemberment<br>• identification of the possible tools used<br>• hypothesis on the criminal context |
| 6 | entire body dismembered in 6 parts | • serrated blade (bread knife)<br>• 2 linear knifes (ceramic knives) | • macroscopic analyses<br>• steromicroscopy<br>• SEM-EDX<br>• casts | "classic" dismemberment with severing of both humeri, cervical vertebrae, both femurs at the hips | • cause and manner of death<br>• manner of dismemberment<br>• exclusion of suspected tools<br>• identification of the tools used<br>• corroboration of suspected murder's confession |

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None declared.

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