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Corpse dismemberment: a case series. Solving the puzzle through an integrated multidisciplinary approach.

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Corpse dismemberment: a case series. Solving the puzzle through an integrated multidisciplinary approach.

Abstract

The finding of corpse parts poses several challenges for the forensic pathologist presenting implications for identification, diagnosis of death and determination of wounds vitality. Further interpretative difficulties in cases of cadaveric dismemberment derive from the scarcity of tanatochronological parameters useful to estimate the post-mortem interval (PMI) and the absence of uniform investigative protocols in the different centres of forensic pathology. The present study proposes an investigation protocol for the cadaveric dismemberment through the discussion of a case series. The study group consisted of cases in which the dismemberment was performed after the murder. For all cases, a study protocol based on crime scene investigation, post-mortem computed tomography (PMCT), autopsy, toxicological, histological, immunohistochemical and genetic investigations was implemented. In particular, the standardised use of radiographic study before the autopsy allows all to have information that can guide the forensic pathologist during the autopsy. The use of immunohistochemistry allows an assessment of the vitality of the lesions possibly involved in the determinism of death, as well as of the surfaces of dismemberment, representing a tool of considerable utility for forensic purposes. The genetic investigations allow the identification of the victims, while the toxicological ones highlight the possible abuse of substances. The implemented protocol presents a demonstrated usefulness in improving diagnostic accuracy in corpse dismemberment cases.

Keywords: Corpse dismemberment, post-mortem computed tomography, immunohistochemistry, wounds vitality, forensic pathology, post-mortem techniques

The term “dismemberment” is used to indicate the detachment of the limbs and/or the head from the trunk at the level of the respective joints, or the subdivision of the thorax, the abdomen or the limbs into the respective segments [1]. From this definition, which implies the criminal intent of the offender, the cases in which the formation of corpse parts is due to other causes, such as traffic accidents, are excluded.

Despite the evidence of a relative rarity attested in several scientific contributions [2-5], the cadaveric dismemberment and the finding of anatomical parts inevitably produce sensationalistic effects related to the cruelty of the crime and to the circumstances in which it occurred. Furthermore, the dismemberment of the corpse produces a growing emotional burden and greater judicial implications than the homicide as related to the violation of respect for human remains [6].

According to Püschel and Koops, the dismemberment can be perpetrated for aggressive or, more frequently, defensive purposes [7,8]. In the first case, the mutilations are inflicted for homicidal intent and present a causal role in the determinism of death. In the second case, the detachment of anatomical parts is performed on the corpse in order to facilitate its removal and concealment, to mystify the evidence of the crime or to hinder the identification of the victim [9]. Moreover, the dismemberment can be classified as offensive in cases where the perpetrator impulsively removes parts of corpse – mostly breasts, genital organs and viscera – with demonstrative intent. Finally, the mutilations inflicted on buried cadavers with the aim of obtaining a fetish are described as “necromaniac” [10].

In consideration of the possible eventualities, the finding of corpse parts poses several challenges for the forensic pathologist presenting implications for identification, diagnosis of death and determination of wounds vitality [11,12]. Further interpretative difficulties in cases of cadaveric dismemberment derive from the scarcity of tanatochronological parameters useful to estimate the post-mortem interval (PMI) [13-16], as well as from the frequent finding of accessory lesions attributable to trial cuts and the multiplicity of usable cutting tools [17]. Hence, in addition to the indisputable problems related to the identification of the victim and the determination of the causes of death, there is considerable interest in the possibility of determining whether the dismemberment took place ante-mortem or post-mortem.

To date, investigative protocols for the forensic approach to cases of cadaveric dismemberment have not yet been defined, mainly due to the difficulty in finding sufficiently numerous case series. The majority of the studies available on the subject are focused on examining the crime scene, analysing the circumstances and methods of dismemberment and discussing the psychological elements underlying the motive [18-21]. Additionally, in light of recent innovations [22], multidisciplinary approaches based on the use of different methods aimed at implementing diagnostic accuracy are rarely documented.

Based on these assumptions, the present study proposes an investigation protocol for the cadaveric dismemberment through the discussion of a case series.

Case series

The study group consisted of dismemberment cases observed at the Departments of Forensic Pathology of Sapienza University of Rome, Foggia and University of Macerata between 2016 and 2018.

For all cases, a study protocol based on crime scene investigation, post-mortem computed tomography (PMCT), autopsy, toxicological, histological, immunohistochemical and genetic investigations has been implemented (Figure 1).

Post-mortem computed tomography

All the corpses were PMCT-scanned prior to autopsy. CT scans were acquired through a 64-slice system according to standardised scanning protocol: tube voltage 120 kV; tube current 250 mAs; section thickness 0.6 mm; reconstruction interval 0.5 mm; gantry rotation time 0.5-second; pitch 0.9.

The corpses were contained in artefact-free body bags; all CT-scans were acquired without contrast agents administration.

PMCT-data were transferred to a workstation for post-processing reconstruction, carried out with a slice thickness of 1.25 mm in increments of 0.7 mm, using soft tissue deconvolution algorithm (B20 kernel) and bone-weighted deconvolution filter (B46 kernel). Scans were subsequently analysed through a viewing software (OsiriX® v.5.8.2 32-bit; Pixmeo, Geneva, Switzerland), elaborating two-dimensional (2D) sagittal and coronal reformations and volume rendering (VR) reconstructions.

Autopsy investigation

In accordance with the existing standardised protocol, an autopsy investigation including a comprehensive external and internal examination was performed. The postmortem interval was ≤48 h in each case.

During the external examination, the morphology, dimensions and anatomical features of cadaver parts were documented. Subsequently, an examination of the cut surfaces was carried out through a description of the different anatomical layers (cutaneous, subcutaneous, muscle, bone) and any macroscopic sign indicative of vitality.

Finally, the characteristics of the injury patterns were determined and documented for subsequent investigations on mechanisms of injury, harmful means and causes of death.

Internal examination was performed according dissection by layers, as well as the study of the viscera when *in situ*. At the cut surfaces with evident macroscopic sign indicative of vitality, skin and muscle samples were taken for histological and immunohistochemical investigations. Moreover, in all cases, skin and muscle samples without signs of vitality were taken as negative control, in equal numbers of positive samples (10 samples for each case). Furthers organ and tissue samples as well as biological fluids, were taken for toxicological and genetic investigations.

Toxicological investigation

Samples of tissues, organs and biological fluids were cryopreserved at -20°C. Consequently, the biological matrices were subjected to a comprehensive drug screening through gas chromatography combined with mass spectrometry (GC-MS).

Histology and immunohistochemistry

A routine microscopic histopathological study through haematoxylin-eosin (H&E) staining was performed on formalin-fixed and paraffin-embedded (FFPE) tissues.

Immunohistochemical investigation of all samples was carried out using an antibodies panel composed of anti-CD15 (DAKO, Copenhagen, Denmark), anti-interleukin (IL)-15 (R&D Systems, Minneapolis, MN, USA) and anti-tryptase (Novus Biologicals, Littleton, CO, USA). The dilution ratio of primary antibodies was 1:50 for

CD15, 1:100 for IL-15 and 1:1,000 for tryptase. Four-micrometre-thick paraffin sections were loaded on slides covered with 3-aminopropyl-triethoxysilan (Fluka, Buchs, Switzerland). A pre-treatment to facilitate antigen retrieval and increase membrane permeability to antibodies was performed. The incubation process took place at 20°C for 120 minutes. The detection system utilised was the LSAB + kit (Dako, Copenhagen, Denmark), an avidin-biotin technique in which a biotinylated secondary antibody reacts with peroxidase-conjugated streptavidin molecules. The positive reaction, according to standard methods, was visualised by 3.3-diaminobenzidine (DAB) peroxidation.

A semi-quantitative evaluation of the immunohistochemical findings was performed by two different investigators without prior knowledge. Measurements were taken at the same magnification of image (10x) and the immunohistochemical reaction was graded as follows: - (not expressed), + (isolated and disseminated expression), ++ (expression in groups or widespread foci), +++ (widespread expression). A third blind microscopic investigator was involved to weigh the evidence. In all cases the histological and immunohistochemical studies exhibited no reaction in control samples.

Genetic investigation

Samples of muscle and bone tissue were taken from the individual cadaveric parts for genetic testing. Further samples were obtained from buccal swabs performed on the families of the alleged victims. Nuclear DNA was then extracted, isolated, amplified and genotyped. The data obtained were finally analysed and crossed for the identification of the victims.

Results

The proposed investigation protocol allowed the establishment of the victim's identity and the cause of death and confirmed that the dismemberment took place post-mortem in all the examined cases. PMCT scans performed prior to autopsy allowed the characterization of the dismemberment method, investigation of the cut surfaces, determination of the regularity of the soft tissues and the skeletal segments, as well as detection of fracture foci and haematomas (Table 1). Autopsy investigation has documented the absence of macroscopic signs of wound vitality at the dismemberment surfaces. Further, a strangulation compression mark and an abdominal sharp force injury were found (Table 1). Histological and immunohistochemical examination, in addition to confirming the macroscopic data on the vitality of lesions causing the death, highlighted the absence of a vital reaction at the dismemberment surfaces (Table 2). Toxicological investigations made it possible to detect positivity for opioids in two cases (Table 3). Genetic investigation confirmed the identity of the victims and allowed researchers to assign all the body parts to the same subject.

Case 1

In 2016, a plastic bag containing a right lower limb was found along the edge of a rural road. During the subsequent investigations, a red backpack containing a right lower limb and other plastic bags containing anatomical parts of the head and trunk, upper limbs and abdominal viscera were found at the crime scene (Figure 2). The victim was identified as a 49-year-old female subject residing in the same city.

CT scans on the anatomical parts showed the regularity of the cut surfaces in correspondence to the soft tissues and the skeletal segments (Figure 3). By contrast, at the upper limbs, on the contrary an irregular profile of the

surfaces of the humeral metaphyses was evident in relation to the presence of bone spicules (Figure 3).
At the external examination, it was possible to ascertain that the block composed of the head and the trunk was divided by the other anatomical parts at the level of the humeral metaphyses and of the L5 vertebra; the lower limbs were separated from each other at the level of the pelvis through a section passing across the pubic symphysis and sacrum (Figure 4). At the neck level, the presence of a reddish cutaneous compression mark was highlighted (Figure 4). The upper limbs were characterised by the presence of several ecchymotic areas. All the cutting surfaces were clear and characterised by the presence of superficial cut lesions on the cutaneous edges.
At the autopsy, the scalp and galea capitis presented an ecchymotic area (4.9 x 3.6 cm) at the left parietal region; in the right temporo-occipital region, a haemorrhagic area (4 x 3.5) at the scalp and galea capitis level was also detected (Figure 4). In the right laterocervical region, at the level of the compression mark previously described, the presence of haemorrhagic areas at the dermis, sternocleidomastoid muscle and thyroid muscle was documented. The liver presented a linear and regular cut lesion (3 x 2 cm) at the lower margin of the right lobe.
Histological and immunohistochemical investigations confirmed the absence of vital reactions in all samples taken at the cut surfaces and at the hepatic lesion. In the samples taken at the cervical haemorrhagic areas, a positivity of the reaction for CD-15, IL-15 and tryptase was documented. Immunohistochemistry showed a patchy dermal strong positivity of CD15 (++++), tryptase (++++), and IL-15 (++++) reaction in the marginal zones above and below the compression mark. The microscopic observation of the samples showed the following structural differences: IL-15 was located around the dermal vessels and diffusely sparse in sub-dermal connective; CD15 and tryptase reactions were intense in dermal connective tissue (Figure 5).
Toxicological investigations documented a positivity for ethanol (0.26 g/L), morphine (0.30 mcg/mL), methadone (0.39 mcg/mL) and EDDP (0.12 mcg/mL) on peripheral blood samples.
At the end of the investigations, the cause of death was attributed to strangulation with subsequent dismemberment of the corpse for defensive purposes. In consideration of the characteristics of the cut surfaces it was established that the dismemberment was probably carried out through a smooth blade cutting weapon with a penetration and sliding mechanism. PMCT and autopsy investigation also allowed researchers to highlight that the cut surfaces at the upper limb level presented the typical pattern of the combined cutting and twisting mechanisms. The toxicological positivity for ethanol, morphine, methadone and EDDP was considered not relevant in the determination of death.

Case 2

In 2017, a black plastic bag containing a left lower limb and a right lower limb joined together through adhesive tape were found inside a dustbin. Inside a second dustbin was found a further black plastic bag sealed with adhesive tape containing cadaveric remains consisting of a block comprising the head, trunk and upper limbs. At the end of the investigations, the victim was identified as a 59-year-old female subject who had disappeared in the previous days.
The PMCT demonstrated multiple fracture foci of nasal bones, thyroid cartilage and the vertebral body of C5. The lower limbs were dismembered in correspondence to the upper third of the thigh with an irregular cut surface due to the presence of discontinuity in the cutaneous, muscle and bone layers. In particular, the bone surfaces had numerous serrations and multiple bone spicules.
The inspection of the cadaveric remains highlighted the presence of several blue painted areas. The cut surfaces,

as previously demonstrated using the PMCT, were irregular and jagged, free from haemorrhagic infiltration (Figure 6). At the cutaneous margins of the dismemberment areas, multiple superficial and parallel cut lesions have been observed. The external examination also allowed researchers to document the presence of multiple ecchymotic areas of various shapes and sizes at the level of the face, neck, abdomen, back and upper and lower limbs. On the anterior surface of the left leg, a cutaneous lesion with regular margins that was free from haemorrhagic infiltration was also found.

At autopsy, the scalp and galea capitis presented a haemorrhagic area in the right frontal region. The facial dissection showed the fracture of the nasal bones with haemorrhage of the surrounding soft tissues (Figure 6). The study of the neck documented the presence of haemorrhage of the subcutaneous tissue, the platysma muscle and the sternocleidomastoid and sternohyoid muscles, with a greater representation at the right hemisome further haemorrhagic areas were detected in the right thyrohyoid and omohyoid muscles. The skeletonisation of the thyroid cartilage revealed a longitudinal fracture of the shield and a rupture of the left upper horn with coexistent haemorrhage of the surrounding soft tissues. A somatic C5 fracture associated with abundant haemorrhagic infiltration of the perivertebral soft tissues was evidenced after the removal of the cervical organs (Figure 6). The dissection according to anatomical layers in correspondence of the ecchymotic areas found at the external examination allowed researchers to document the haemorrhagic infiltration of the subcutaneous fat and the superficial muscular layer. In the muscle tissue of the right lower limb, near the femoral diaphysis, a 4-cm metal fragment due to the serrated blade of a saw was found.

Histological examination of the haematoxylin-eosin stained samples demonstrated the presence of erythrocyte extravasations in the skin of the neck, the right sternocleidomastoid muscle and the skin taken at the ecchymotic areas (Figure 7). By contrast, the examination of the samples taken in correspondence to the dismemberment surfaces documented the absence of signs of vital reaction. The immunohistochemical study confirmed the histopathological evidence with negativity of the tested antibodies at the dismemberment surface level and the positivity of the reaction at the neck level (Figure 7).

The toxicological investigations of samples of peripheral blood, bile and gastric content provided a negative result.

Conclusively, the cause of death was attributed to strangulation with subsequent dismemberment of the corpse for defensive purposes. As for the homicidal dynamic, the strangulation occurred after an aggression with the production of blunt force injuries. The characteristics of the cut surfaces and the discovery of a fragment of the blade have made it possible to establish that the dismemberment was carried out through a serrated saw with a penetration and sliding mechanism.

Case 3

In 2018, two red trolleys containing parts of corpses arranged in twelve plastic bags were found at the edges of a country road. The investigations allowed the identification of the victim as an 18-year-old female subject.

The PMCT performed before the autopsy allowed researchers to detect an area likely to be haemorrhagic in the scalp of the left frontal region. At the same time, it was possible to identify the dismemberment areas at the C5-C6 and T12-L1 vertebrae, as well as the scapular girdles, elbows, pelvic girdles and knees.

The external examination of the cadaveric remains allowed the identification of 11 different blocks, including the head and part of the neck, skin of the anterior surface of the trunk, breasts, skin of the back, segments of the thoracic skeleton and soft tissues, arms and forearms, thoracic and abdominal viscera, skin of the pubic and perianal regions, lumbosacral spine and pelvis disjointed at the level of the pubic symphysis, soft tissues of the thighs, femoral bones and legs disjointed at the level of the tibial plates (Figure 8).

At the head dissection, a haematoma of the scalp (1.8 x 1.8 cm) was observed in the right frontoparietal region. By contrast, the neck had a regular section surface at the level of the C5 vertebra as well as an integrity of the airways and digestive structures, hyoid bone, cartilaginous structures and glottis. On the anterolateral right side of the thorax, at the level of the 9th and 10th intercostal spaces, two cutting lesions of the respective length of 1.5 cm and 10 cm were highlighted. Regarding the upper limbs, the dismemberment surfaces at the level of the humeral heads and elbows were regular; on the anterior surface of the left wrist, there was a sign of acupuncture with haematoma of the surrounding tissues. On the skin of the back, several superficial and parallel cut lesions were also found, characterised by the absence of macroscopic signs of vital reaction. Finally, at the costal surface of the right lobe of the liver, four cutting lesions were found with regular margins and respective length of 2.5 cm, 2.7 cm, 2 cm and 1 cm.

Histological investigations carried out on samples taken at the dismemberment surfaces and stained with haematoxylin-eosin have shown no signs of vital reaction. In the same way, the samples taken at the cut lesions on the skin of the back were histologically negative. However, the microscopic analysis showed the presence of quantitatively heterogeneous erythrocyte extravasations in the samples taken at the level of the right frontoparietal region, of the 9th and 10th intercostal space muscles, of the acupuncture mark on the left wrist and of the cut lesions on the hepatic parenchyma. The immunohistochemical study using CD-15, IL-15 and tryptase antibodies confirmed the vitality of lesions affecting the frontoparietal region, the intercostal muscles and the wrist (Figure 9). No immunohistochemical investigation was carried out on samples taken at the level of hepatic lesions due to the blurred signs of vitality shown by histochemical analysis.

Toxicological investigations documented a positivity for morphine on peripheral blood (< 200 ng/mL), vitreous humour (12 ng/mL), bile (3834 ng/mL), hair (0.11 ng/mg), brain (297 ng/g), liver (376 ng/g) and kidney (1998 ng/g) samples. Positivity for codeine was found in bile (132 ng/mL), brain (20 ng/g), liver (26 ng/g) and kidney (112 ng/g) samples.

Ultimately, despite the coexistence of blunt force injuries, the cause of death was attributed to a wound penetrating the abdomen. Furthermore, it was found that the dismemberment was carried out post-mortem, probably through a smooth blade cutting weapon. With regard to the toxicological aspect, it was possible to establish that the victim was under the effect of heroin and that the substance was detectable in unsuitable concentrations to produce toxic effects or cause death.

Discussion

Post-mortem investigation is universally recognised as a valuable diagnostic step in cases of corpse dismemberment due to the possibility to determine, in addition to the causes of death, the manner in which the injuries were inflicted [23]. However, it is necessary to emphasise that the absence of uniform investigative protocols to be applied in the different centres has significantly hindered progress in the forensic approach to dismemberment cases.

Despite the substantial similarities between the cases documented in the different studies, there is currently no methodological agreement due to the lack of evidence, and autopsy is often the only investigation carried out, as recourse to complementary methods is extremely variable and heterogeneous [24,25]. A similar lack of consensus among the published protocols generates considerable difficulties for the forensic pathologist, sometimes resulting in hesitation due to the impossibility of providing reliable evidence in the trial.

Several scientific contributions produced over the years on the subject have mainly focused on autopsy findings and criminological aspects of dismemberment cases. In accordance with the results of these studies, the dismemberment followed the murder in all the cases examined, confirming the higher frequency of the defensive mode [26]. Specifically, in the cases presented, the dismemberment was carried out with the aim of dispersing and concealing the corpse remains more easily.

Given the different approach adopted in the previous studies and the lack of evidence, the present paper currently represents the first proposal for a multidisciplinary investigative protocol. Here, an operating procedure has been proposed for a complete and specific diagnostic investigation of corpse dismemberment cases that allows an accurate assessment of the aspects concerning the wound vitality and the causes of death.

The proposal to integrate classical methods with the described diagnostic steps was conceived with the aim of simplifying the pathological study of dismemberment cases. Indeed, the examination of the dismembered corpse constitutes a highly specialised assessment that can be made easier and more accurate through the proposed methodological implementation. The application of such a method makes it possible to obtain reliable diagnostic information on the harmful dynamics of relief in cases of corpse dismemberment.

Consistently with the results obtained, each of the methods contemplated in the investigative protocol presents a demonstrated usefulness in improving diagnostic accuracy and allowing the forensic pathologist to provide reliable evidence.

The added value of the proposed diagnostic algorithm lies mainly in the introduction of PMCT and immunohistochemical analysis as mandatory investigations in cases of cadaveric dismemberment. PMCT highlights complex findings at the autopsy table or those that may be misunderstood during an autopsy [27,28], such as bone fragments or parts of the blade used for dismemberment. Nonetheless, a radiographic study before the autopsy allows not only the preservation of the information for subsequent evaluations, but above all provides information that can guide the forensic pathologist during the autopsy [29,30]. Furthermore, as demonstrated in other studies on wound vitality [31,32], immunohistochemical analysis using anti-CD15, anti-IL-15 and anti-tryptase antibodies allows greater diagnostic accuracy than just macroscopic evidence [33,34]. Specifically, the immunohistochemical panel used allows a precise assessment of the lesion possibly involved in the determinism of death, as well as of the dismemberment surfaces, representing a tool of considerable utility for forensic purposes. Further studies in the fields of proteomics, metabolomics and epigenetics could provide useful elements for post-mortem investigation of a complex forensic investigation such as dismemberment. The diagnostic accuracy of miRNAs could expand the range of diagnostic tools available in the assessment of the vitality of a lesion [35]. These biomarkers could become useful for the chronological diagnosis of the lesions, integrating the data relative to the expression of the miRNA with those shown by the results of histological and immunohistochemical investigations [36].

Indicating the gap in knowledge and possible limitations, the present study is based on a limited series of cases that also need to be extended through the application of the diagnostic algorithm in different centres. In fact, the extensive application of the protocol under discussion will make it possible to standardise investigations into corpse dismemberment cases, but above all to obtain homogeneous data useful for method validation. Secondly, further details are needed to address the difficulties in the characterisation of the post-mortem interval and to codify an approach that allows researchers to overcome the interpretative obstacles deriving from the scarcity and heterogeneity of tanatochronological parameters in dismembered corpses [37-39].

Conclusively, the results obtained demonstrate that the implemented protocol represents a valid tool for the forensic pathologist in the approach to a complex problem, such as dismemberment. In fact, the proposed methodology has allowed the establishment of the identity of the victim and the cause of death as well as confirming that the dismemberment took place post-mortem in all the examined cases.

Conflict of interest

The authors have no conflicts of interest to disclose.

Authors' roles

All authors contributed equally to manuscript drafting and critical discussion and approved the final version.

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Figures legend

Figure 1. Diagnostic algorithm for cases of corpse dismemberment.

Figure 2. Crime scene investigation: A) white plastic bag and red backpack containing anatomical parts; B) yellow plastic bag containing an upper limb; C) anatomical parts of head and trunk; D) abdominal viscera.

Figure 3. Post-mortem computed tomography: A) coronal scan demonstrating the method of dismemberment of the lower limbs; B) axial scan of the hip dismemberment surface; C), D) and E) 3D volume rendering of corpse parts with a focus on bone (C, E) and soft tissues (D).

Figure 4. Autopsy investigation on the corpse parts: A) anatomical parts composed of head, neck, trunk, upper and lower limbs; B) cutaneous compression mark on the neck of the victim; C) scalp haematoma at the right temporo-occipital region; D) dismemberment surface of the left upper limb.

Figure 5. Histological and immunohistochemical findings: A) vital reaction (arrows) in skin samples taken at the cutaneous compression mark on the neck of the victim; B) tryptase immunoreaction (+++) on skin samples taken at the cutaneous compression mark on the neck of the victim (arrows); C) and D) absence of microscopic signs of wound vitality in skin samples taken at the dismemberment surfaces.

Figure 6. Autopsy investigation on the corpse parts: A) anatomical part composed of head, neck, trunk and upper limbs; B) fracture of the nasal bones with haemorrhage of the surrounding soft tissues; C) dismemberment surface of the right lower limb; D) somatic C5 fracture associated with haemorrhagic infiltration of the perivertebral soft tissues (arrows).

Figure 7. Histological and immunohistochemical findings: A) erythrocyte extravasations in the skin of the neck; B) CD15 immunopositivity (+++) in skin samples taken at the neck (inside the circle); C) absence of microscopic signs of wound vitality in skin samples taken at the dismemberment surface of the right lower limb; D) immunohistochemical negativity for IL-15 in tissue samples taken at the dismemberment surface of the right lower limb.

Figure 8. Autopsy investigation on the corpse parts: A) anatomical part of the head and neck; B) anatomical parts of the arms and forearms; C) abdominal viscera.

Figure 9. Histological and immunohistochemical findings: A) erythrocyte extravasations in tissue samples taken at the ninth intercostal space; B) CD15 immunopositivity (+++) in tissue samples taken at the ninth intercostal space (brown reactions); C) absence of microscopic signs of wound vitality in skin samples taken at the dismemberment surface of the left upper limb; D) immunohistochemical negativity for IL-15 in tissue samples taken at the dismemberment surface of the left upper limb.

Table 1. Summary of post-mortem computed tomography and autopsy findings.

	Case no. 1	Case no. 2	Case no. 3
Post-mortem computed tomography	▪ Bone spicules at the level of humeral metaphyses ▪ Regularity of the other dismemberment surfaces	▪ Multiple fracture foci of nasal bones, thyroid cartilage and the vertebral body of C5 ▪ Irregularity of dismemberment surfaces	▪ Probable hematoma of the scalp in the right frontoparietal region ▪ Regularity of dismemberment surfaces
Autopsy investigation	▪ Dismemberment at the level of humeral metaphyses, L5 vertebra, pubic symphysis and sacrum ▪ Multiple ecchymotic areas at the upper limbs ▪ Reddish cutaneous compression mark at the neck ▪ Hematoma of the scalp at the left parietal region and right temporo-occipital region ▪ Hemorrhage of the neck muscles	▪ Dissection at the upper third of the thighs ▪ Multiple ecchymotic areas on the body surface ▪ Hematoma of the scalp and galea capitis at the right frontal region ▪ Fracture of the nasal bones with hemorrhage of the surrounding soft tissues ▪ Hemorrhage of the neck muscles and fracture of the thyroid cartilage ▪ Somatic fracture of C5	▪ Skin dissection ▪ Disarticulation of shoulders, elbows, hips and knnes ▪ Spine dissection at C5-C6 and T12-L1 ▪ Hematoma of the scalp in the right frontoparietal region ▪ Cutting lesions at the ninth and tenth right intercostal spaces ▪ Sign of acupunture at the left wrist ▪ Cutting lesions on the right lobe of the liver

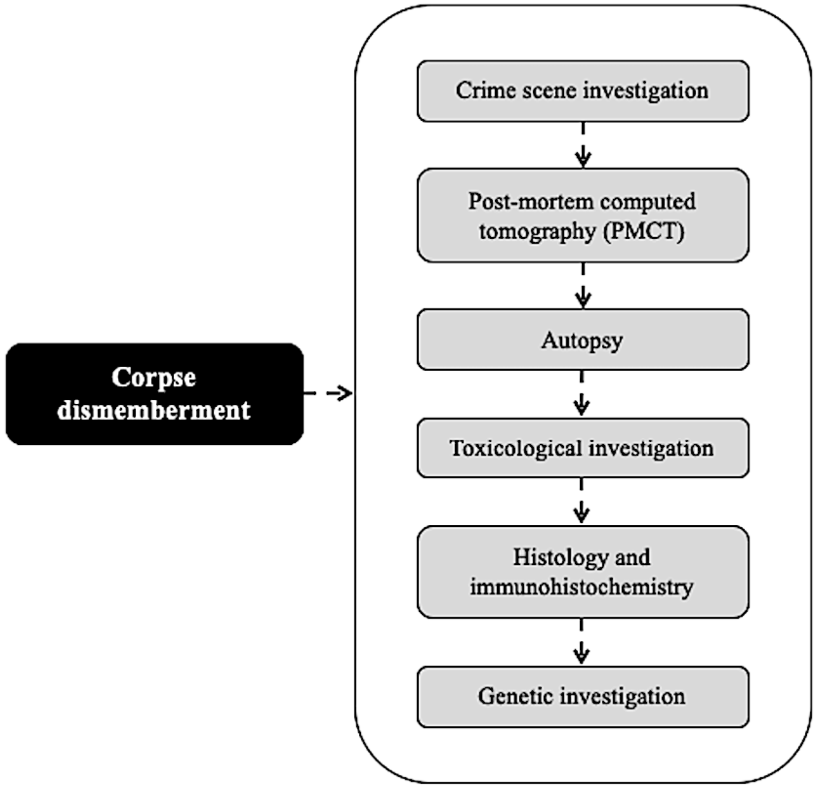
Table 2. Semi-quantitative evaluation of the immunohistochemical findings.

	Case no. 1		**Case no. 2**		**Case no. 3**	
	Other injuries	**Cutting surfaces**	**Other injuries**	**Cutting surfaces**	**Other injuries**	**Cutting surfaces**
CD15	+++	-	+++	-	++/+++	-
IL-15	+++	-	+++	-	++/+++	-
Tryptase	+++	-	+++	-	++/+++	-

Assessment of the immunohistochemical reactions for anti-CD15, anti-IL-15 and anti-tryptase antibodies. Intensity of immunopositivity was graded as follows: - (not expressed), + (isolated and disseminated expression), ++ (expression in groups or widespread foci), +++ (widespread expression).

Table 3. Summary of toxicological findings.

	Case no. 1	Case no. 2	Case no. 3
Peripheral blood	Ethanol (0.26 g/L) Morphine (0.30 mcg/mL) Methadone (0.39 mcg/mL) EDDP (0.12 mcg/mL)	Negative	Morphine (< 200 ng/mL)
Vitreous humor	Not available	Not available	Morphine (12 ng/mL)
Bile	Not available	Negative	Morphine (3834 ng/mL) Codeine (132 ng/mL)
Gastric content	Not available	Negative	Not available
Hair	Not analyzed	Not analyzed	Morphine (0.11 ng/mg)
Brain	Not analyzed	Not analyzed	Morphine (297 ng/g) Codeine (20 ng/g)
Liver	Not analyzed	Not analyzed	Morphine (376 ng/g) Codeine (26 ng/g)
Kidney	Not analyzed	Not analyzed	Morphine (1998 ng/g) Codeine (112 ng/g)


Corpse dismemberment
Crime scene investigation
Post-mortem computed tomography (PMCT)
Autopsy
Toxicological investigation
Histology and immunohistochemistry
Genetic investigation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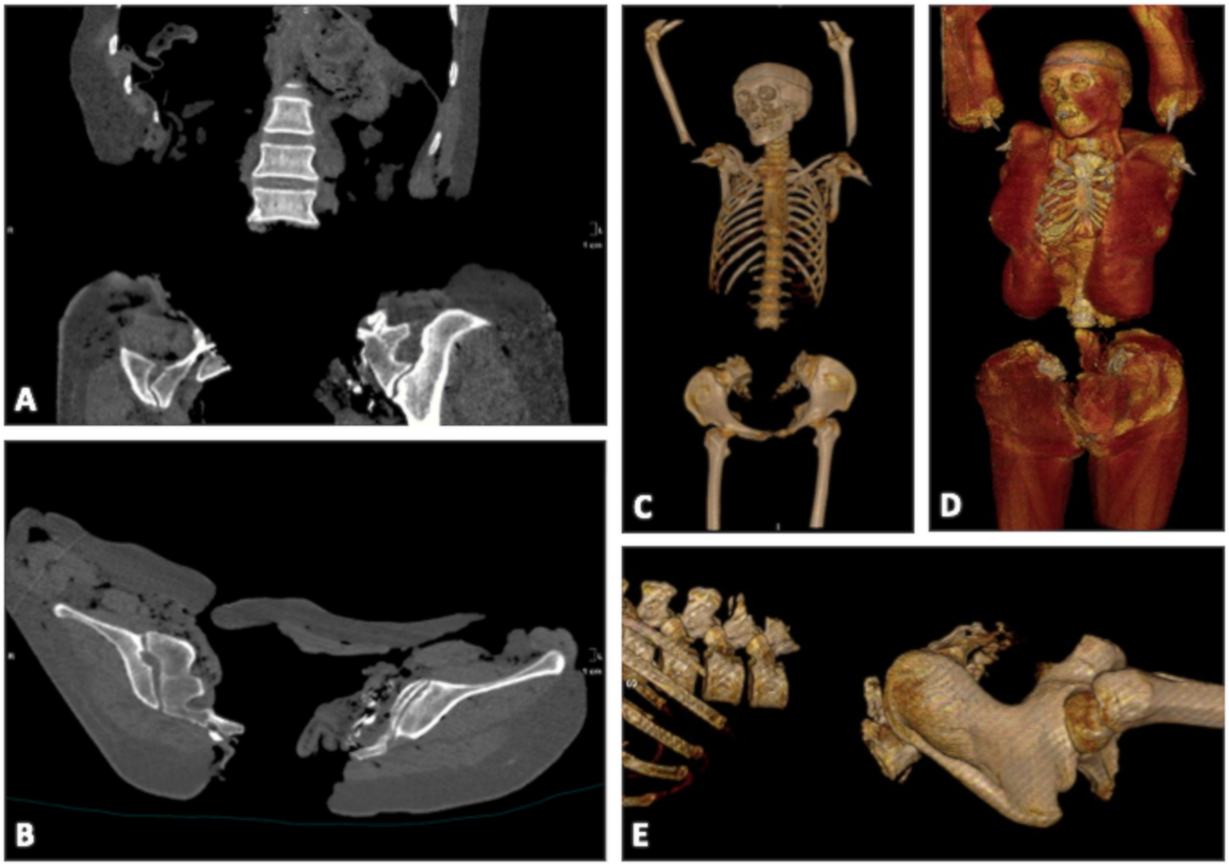
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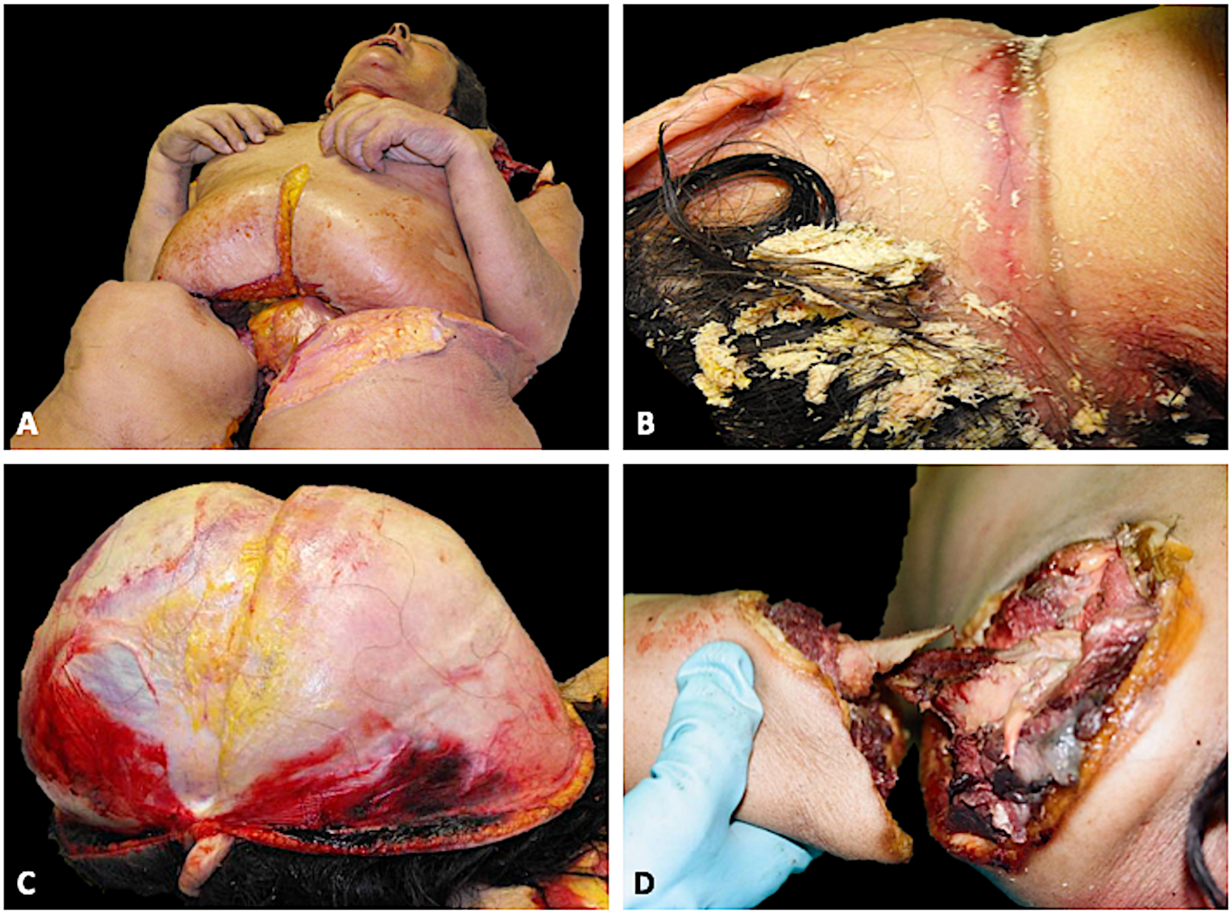
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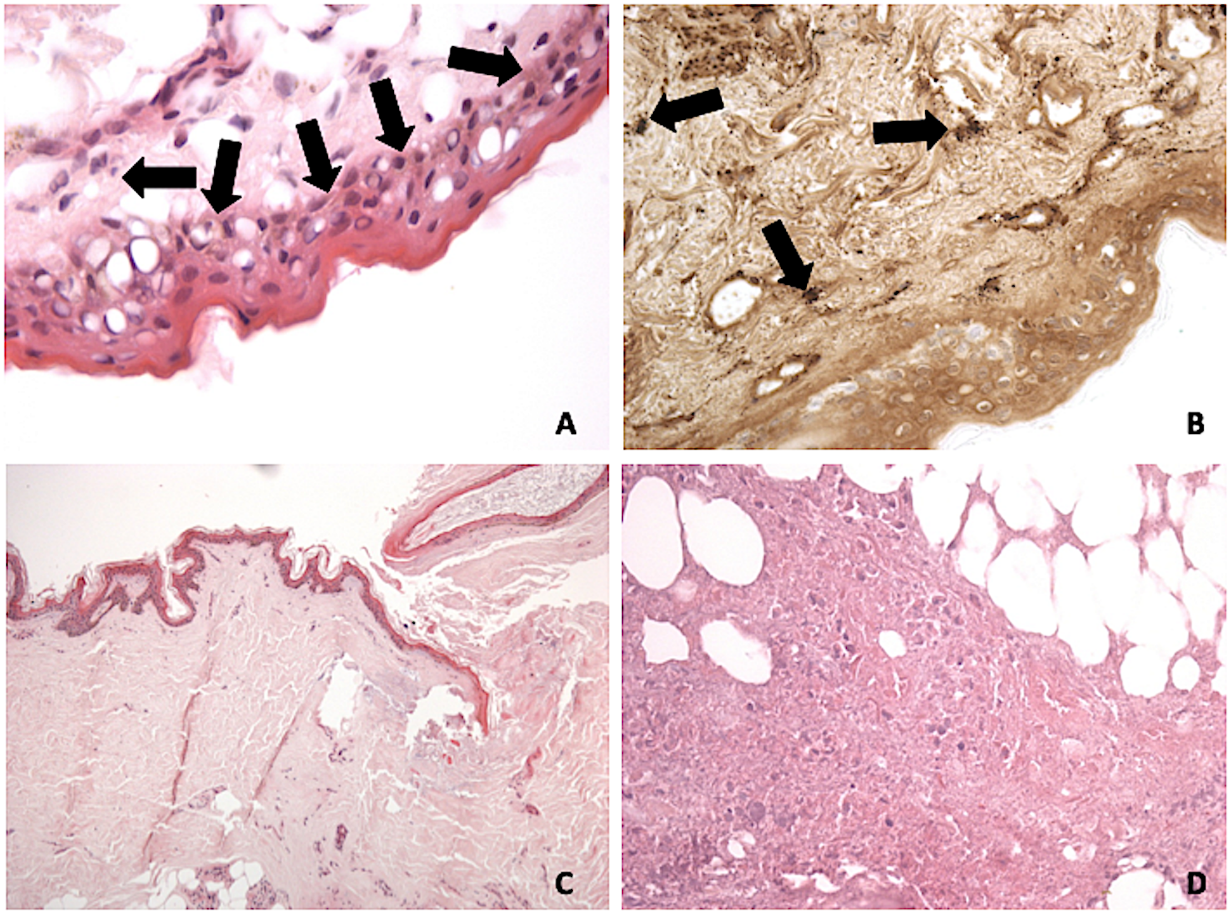
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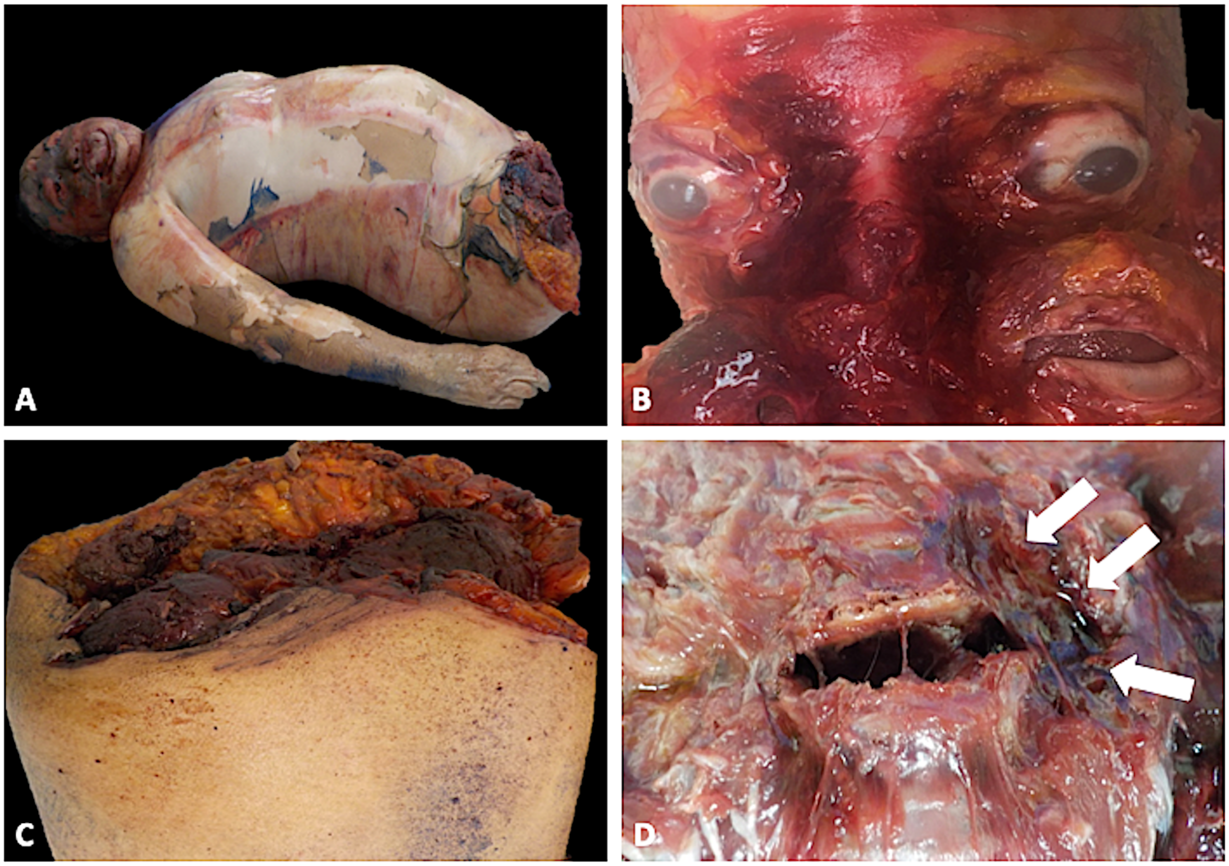
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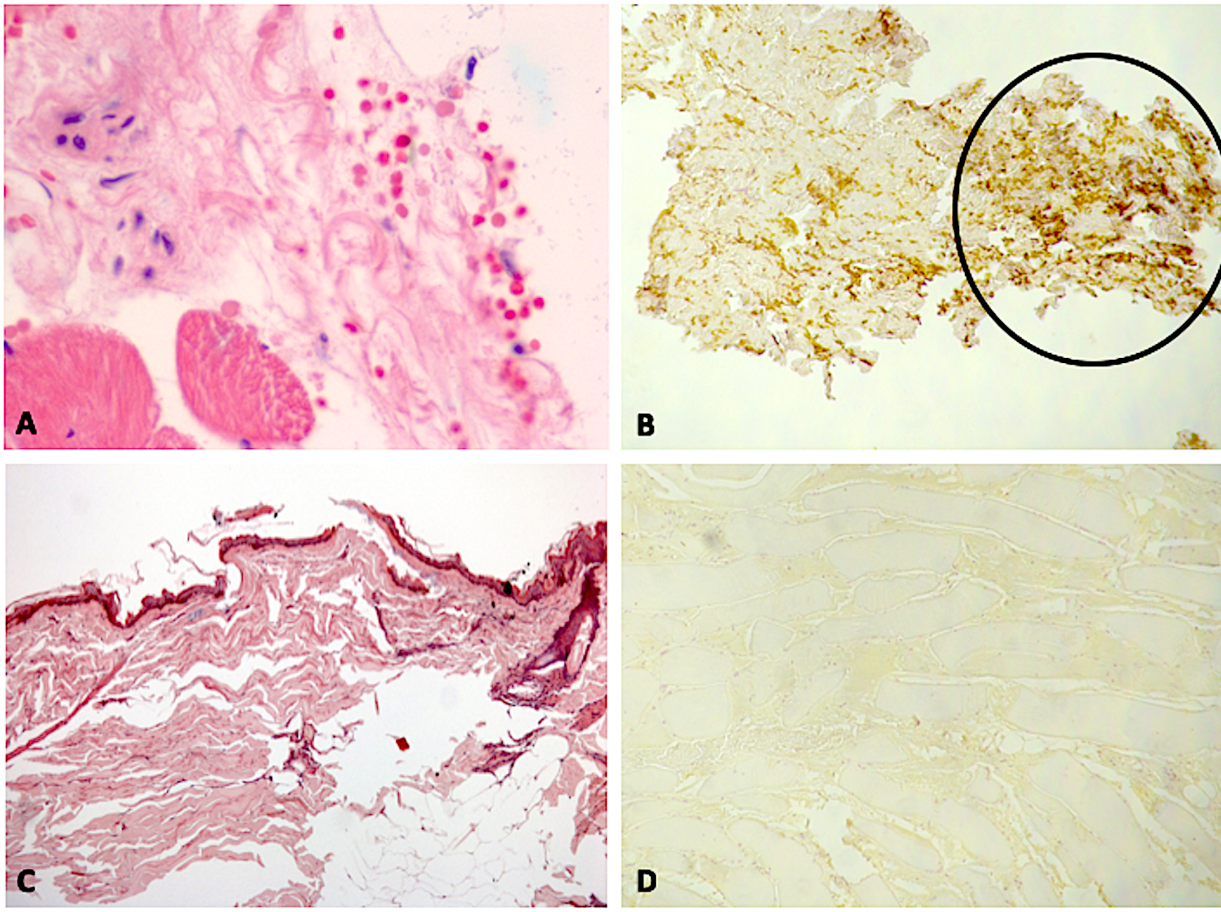
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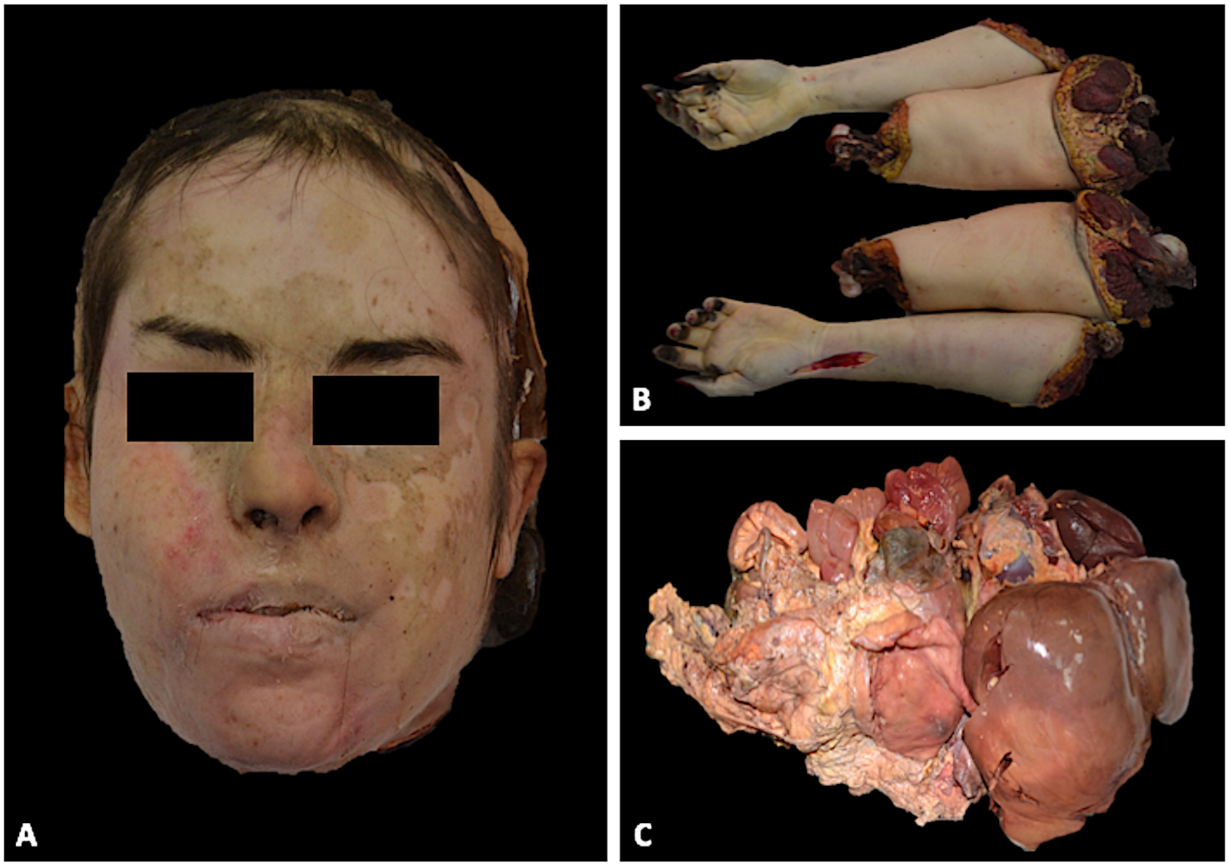
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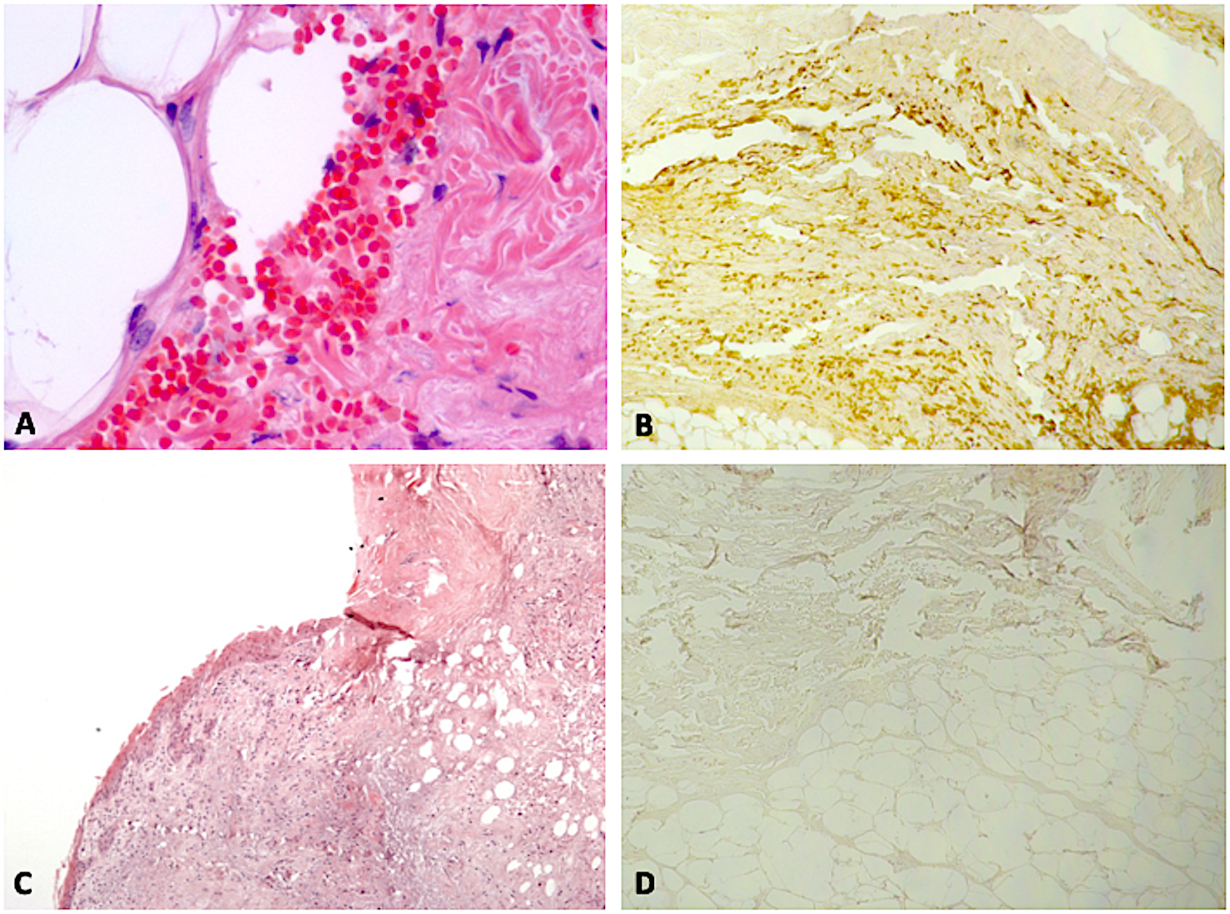
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HIGHLIGHTS

- Finding of corpse parts poses several challenges for the forensic pathologist.
- Multidisciplinary approaches implementing diagnostic accuracy are rarely documented.
- Investigative protocols for the investigation of dismemberment cases are needed.
- Identification, diagnosis of death and determination of wounds vitality are mandatory.
- Scarcity of tanatochronological parameters make it difficult to estimate the PMI.

Conflict of Interest statement

Authors have no competing interests to declare.