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A Novel Protocol for the Forensic Investigation of Body Dismemberment: A Case Series and Report

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ABSTRACT

The phenomenon of "criminal dismemberment" remains underexplored in the scientific literature, despite its significant relevance as a post-homicidal behavior. This study seeks to address this gap by proposing an innovative, multifactorial methodology for the analysis of dismemberment cases. The methodology is structured into several key phases essential to ensure the technical and scientific validity of the results, and it is aimed at facilitating the reconstruction process of injuries on dismembered cadaver sections to delineate criminodynamics, establish the post-mortem interval, and assess injury vitality.

Following an extensive review of existing literature, the study initially focused on Italian national cases relevant to the period 1923-2022, before expanding to include US case studies. The analysis reveals persistent gaps in both forensic pathology and legal practice, emphasizing the need for improved methodologies in criminal dismemberment investigations. This study provides essential guidelines for forensic practitioners and legal professionals, offering valuable insights into the characteristics of criminal dismemberment and the psychology of its perpetrators. By consolidating and applying these procedures, the study aims to enhance forensic and legal investigations, ultimately contributing to a more comprehensive understanding of this rare but critical criminal behavior. The proposed protocol offers a scalable framework for complex homicide investigations, especially in cases lacking judicial access.

Introduction

The phenomenon of "criminal dismemberment" - we will adopt the terminological notation proposed by Holmes in 2017 to specifically refer to cases of dismemberment associated with the crime of homicide - is scarcely represented in the scientific literature, as it constitutes an unusual post-homicidal behavior[1]. To enrich the existing body of research on this subject, the present study aims to propose an innovative methodology based on a multifactorial evaluation strategy, structured into several key phases: 1. crime scene analysis; 2. forensic photography; 3. forensic pathological analysis; 4. application of advanced post-mortem imaging techniques; 5. in-depth exploration of genetic and immunohistochemical evidence; 6. integration of psychological autopsy (PASIC, Psychological Autopsy Structured on Individual Cases); 7. identification of the victim through genetic sampling. This framework aims to facilitate the reconstruction process of injuries on dismembered cadaver sections to delineate criminodynamics, provide a contribution to establish the post-mortem interval (PMI), and assess injury vitality. Following a meticulous review of the existing scientific literature on the subject, we focused our attention on the analysis of local case studies, particularly concerning Italian national cases relevant to the period 1923-2022. The study was subsequently expanded to include US case studies, drawing on an extensive review of the existing literature.

Data were gathered from open-access news archives, academic papers, and law enforcement reports where available. Identifying the characteristics that define "criminal dismemberment" and understanding the psychology of its perpetrators hold central importance for criminological analysis[2]. Beyond this objective, we anticipate that this study will provide significant added value to forensic investigations by establishing guidelines applicable to legal and medical practitioners. In particular, we have identified significant gaps in the literature that persist to date in both forensic pathology and legal domains. Prompted by this finding, we conducted a detailed analysis of local case records, preceded by a comprehensive review of the international scientific literature using platforms such as Pubmed and Google Scholar. For the purpose of developing this procedure, we began by revisiting the well-established classifications described in the literature, which distinguish three types of dismemberment[3]: 1. *defensive dismemberment* refers to cases in which the primary objective is to dispose of the victim's body or conceal their identity; 2. *aggressive dismemberment* occurs when the perpetrator is driven by intense rage or acute psychosis, typically manifesting during the homicide and persisting throughout the dismemberment phase; 3. finally, *offensive dismemberment* is characterized by sexually motivated behaviors indicative of sadistic tendencies[4]. These definitions proved useful for categorizing cases into clusters based on offender behavior patterns. The attempt to conceal the dismembered body undoubtedly represents one of the variables that deserves significant attention[5]. For instance, a poorly organized concealment may indicate the possibility of a single perpetrator behind multiple homicides[6]. As for the motive, identifying it in relation to each individual case remains highly complex. In other words, while some information on motives regarding solved cases were available on news outlets, we have no certainty regarding whether some of the cases we studied involve multiple perpetrators or if they constitute serial homicides. Given the complexity in reliably determining motives based solely on available investigative data, there emerges a clear necessity for supplementary methods capable of exploring offender psychology in greater depth. One of the most notable aspects is certainly the absence, in the scientific literature, of any indication that a psychological autopsy protocol has ever been applied as part of these kinds of methodologies. It is for this reason that we intend to integrate a new protocol defined as PASIC, also in light of the results already achieved through its implementation in particularly old cold cases[7]. Given these premises, we believe it would be of particular interest to organize an internationally structured database that collects existing case studies, in order to provide more elements for epidemiological and

forensic-pathological studies, as well as for legal evaluations. Furthermore, it should be taken into consideration that criminal dismemberment in forensic contexts often serves as a significant indicator of underlying motives and psychological states of perpetrators, complicating investigative processes[3]. In certain cases, it is particularly challenging to distinguish between anatomical lesions resulting from specific autopsy procedures and those resulting from criminal dismemberment[8]. The distinction between autopsy practices and dismemberment, particularly in relation to skeletal evidence, necessitates meticulous analysis; this is underscored by studies demonstrating the challenges in differentiating post-mortem incisions from ritualistic or medical interventions. The proposed protocol outlines a comprehensive set of techniques, including post-mortem CT (computerized tomography), innovative genetic analyses, psychological autopsy, crime scene evaluation through crime mapping, and forensic pathological methods to systematically document and analyze wounds on the victim's remains. The inclusion of toxicological analyses is also of particular interest, whenever possible[9]. Moreover, an additional benefit arises from the standardization of forensic photography procedures, which are useful for cataloging, archiving, and making available images ranging from crime scenes to autopsy tables, including detailed depictions of injuries, and potentially the blunt instrument or weapon used[10]. Creating such an archive will facilitate the sharing of multidisciplinary activities, even across geographically distant case studies. This protocol can also enhance the accuracy of victim identification and backing evidence against suspects. This can serve as an added value to already existing protocols. Furthermore, robust forensic investigation extends to typing DNA from long-stored unidentified remains, demonstrating substantial success in maintaining the integrity of evidence over time[11]. By formalizing a structured approach through methodologies such as the PASIC, the case study becomes more meticulous, addressing both the individual victim's psyche and the broader criminodynamics involved in the case[12]. Ultimately, the significance of this innovative methodology lies in its ability to generate reliable insights that facilitate justice and closure for victims' families.

Methods

Cases were selected from databases, journalistic sources, academics references and national and international archival documents related to body dismemberment (such as PubMed, ScienceDirect, JSTOR, National Criminal Justice Reference Service, FBI Vicap, Doe Network).

The research was conducted between January 2025 and June 2025 and is intended to be updated through subsequent studies. The study was conducted at the NeuroIntelligence Research Institute, which is located precisely in the geographical area, Varese, where the most emblematic dismemberment cases occurred, cases that provided the basis for scientific investigation and further analysis.

The analyzed cases encompass criminal behaviors not only attributable to serial killers but also to occasional offenders, incorporating dismemberment modalities classified as *offensive* – centered on deriving sadistic pleasure from the act – *defensive* – characterized by efforts to conceal or prevent victim identification – and *aggressive* – marked by the predominance of extreme and uncontrolled post-mortem violence[13].

For the purpose of this study, we opted to consider not only cases that were solved, but also those that, as of June 2025, remain unsolved, to provide a more comprehensive analysis of the phenomenon under investigation. By considering both types of cases, we aim to avoid selection bias and to present a more balanced and critical perspective.

The examined cases pertain to the period 1923-2025, selected based on birth sex – only cases involving female victims were selected – and age, when available.

Cases in which, for example, only a single anatomical part of the body was recovered were excluded from the study, as such cases do not allow for a reliable determination of whether a criminal dismemberment has occurred[14].

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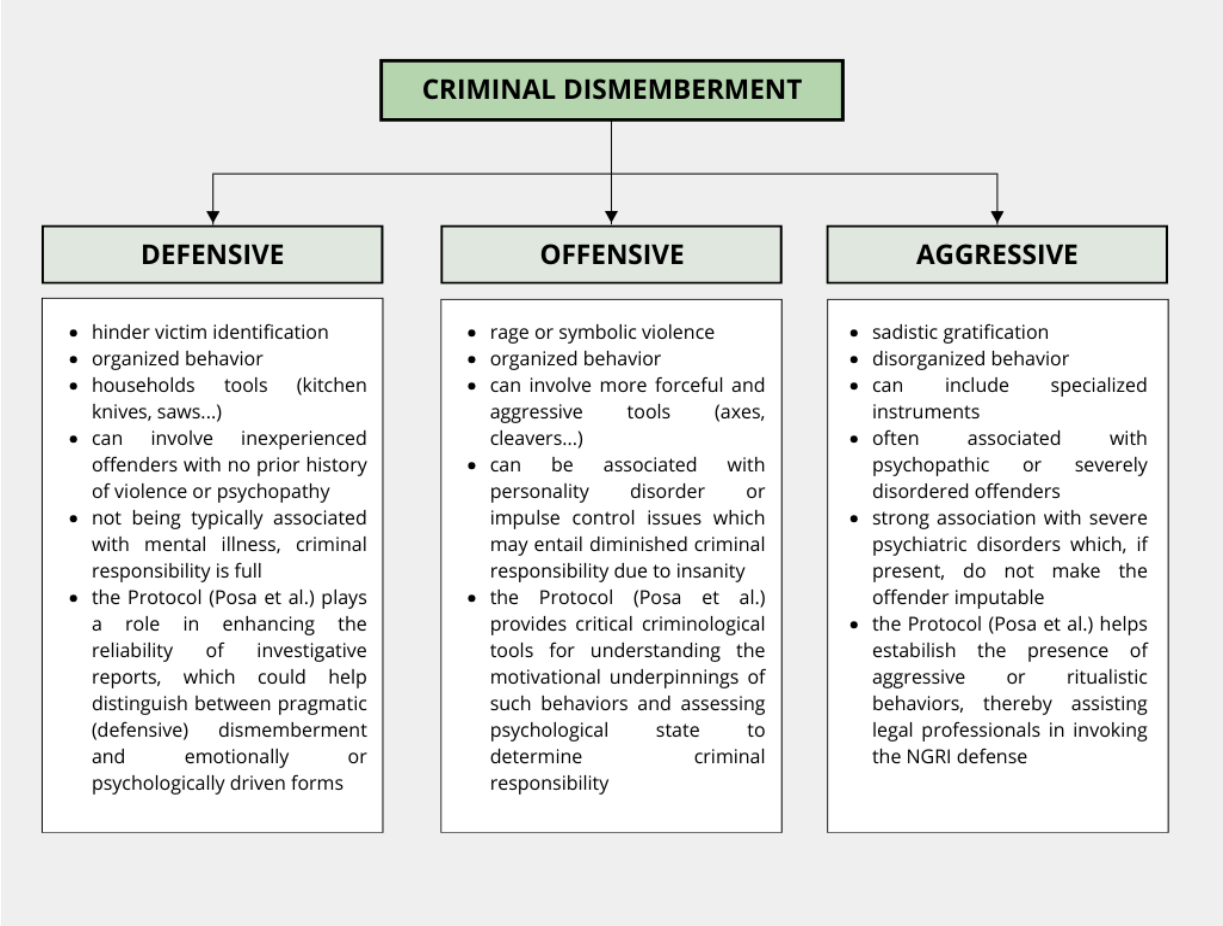

Fig. 1. Criminal dismemberment: a classification

Once the dataset was established, publicly available information was utilized to collect data for each relevant case. Additionally, wherever possible, data were gathered from a diverse range of sources to enhance the reliability and validity of the study, including media reports, encyclopedic entries and court records. In cases where data were retrieved from unofficial sources (journalistic), their reliability was verified through cross-referencing with official sources, encyclopedic references and judicial documentation.

Where possible, the study involved a comparative analysis of the different dismemberment modalities (defensive, offensive and aggressive) within homogeneous groups selected based on specific parameters, including biological sex at birth, relationship offender/victim, ethnicity/race, the motive for murder and dismemberment, methods and location of body disposal, instruments used and legal classifications.

Inclusion criteria	Exclusion criteria
• Cases of dismemberment attributed not only to serial killers but also to occasional offenders	• Cases in which only a single anatomical part of the body was recovered, as these do not allow for a reliable determination of criminal dismemberment
• Cases involving offensive, defensive, and aggressive dismemberment	
• Both resolved and unresolved cases were considered	

Fig. 2. Inclusion and exclusion criteria

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In the second place, pioneering a comprehensive and interdisciplinary approach to the forensic investigation of body dismemberment, the present study employed a systematic approach designed to enhance the understanding of criminodynamics and the motivational underpinnings of each case. The methodology was applied starting from the analysis of a series of twenty-two Italian cases pertaining to the period 1923–2022.

Each case was subjected to a detailed forensic analysis combining traditional and innovative techniques, using the information available from open sources. The authors followed the steps outlined in the introduction section for each case.

This standardized procedure also incorporated psychological autopsy based on the PASIC framework[12], which facilitated the reconstruction of individual psychological and psychosocial profiles. This approach aimed to identify potential mental health risk factors and life circumstances that may have predisposed victims to violent outcomes. Taphonomic principles[15] and insights drawn from historical forensic practices[11] were integrated to further substantiate the interpretative depth of the analysis, particularly regarding medico-legal evidence.

The case series was independently evaluated by our multidisciplinary team with expertise in medicine, forensic pathology, psychology and law.

Interdisciplinary discussion ensured consensus on interpretative variables such as motive attribution and behavioral typologies of the perpetrator. Following data acquisition, variables were compiled into a structured dataset and subjected to both descriptive and inferential statistical analyses. This multifaceted methodological framework not only advances the forensic investigation of complex dismemberment cases but also underscores the critical role of integrating clinical, psychological, cultural, and legal perspectives in understanding the broader phenomenon of criminal dismemberment.

Victim's Name	Date of Incident	Age	Modus Operandi	U.S. State
EK	1964	21	The victim was strangled, dismembered and her remains put into several suitcases.	California
ABF	April 18, 2023	80	Remains stuffed into suitcases and bags, thrown into a river.	Florida
SR	April 1, 2024	19	The victim's remains were scattered across an open field.	Wisconsin
TF	October 15, 2024	-	Victim shot, stabbed and remains scattered inside and outside the victim's residence	Kentucky
FX	January 3, 2025	33	The body was discovered hidden within a storage unit.	Minnesota
MS	January 3, 2025	34	Razor blade used for dismemberment. The body was discovered hidden within a storage unit.	Minnesota
EP	March 25, 2025	14	Remains found in garbage bags near a remote forest	Arizona
MC	May 22, 2025	16	Victim was kidnapped and murdered, her remains were found in a dumpster	Florida

Fig. 3. International cases

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Victim's Name	Date of Incident	Age	Modus Operandi	Location
MC	1923	73	The victim was killed with an agricultural tool and her body severed into two parts	Savona, Italy
RB	1926	-	The victim was killed and her body dismembered in a hotel room	Torino, Italy
PBT	1928	-	The victim was dismembered and thrown into a well	La Spezia, Italy
PG	1932	-	The victim was dismembered and her remains put into suitcases	Naples, Italy
GS	1949	-	The victim was killed, dismembered and her remains hidden in a river canal	Verona, Italy
SM	1963	20-30	The victim was beheaded and dismembered	Pistoia, Italy
Unidentified	1972	-	The victim was tortured, killed with a blunt object and her body dismembered. Her remains, put in plastic bags, were thrown into a river	Gignod, Aosta, Italy
MC	1978	38	The victim was mutilated, beheaded, dismembered and her remains dispersed in a forest	Loano, Savona, Italy
Unidentified	1980	-	The victim was dismembered with an electric saw, burnt and her remains were put into bags. Remains dispersed in a river	Roma, Italy
Unidentified	1986	94	The victim was dismembered with a knife and her remains put into garbage bags	Pavia, Italy
MTM	1989	28	The victim's body was dismembered with a knife and her remains were put into bags	Milano, Italy
AS	1995	21	The victim was strangled and dismembered	Grottazzolina, Ascoli Piceno, Italy
RS	2001	64	The victim was dismembered and her remains thrown into garbage bins	Rome, Italy
Unidentified	2004	30-50	The victim's hands and feet were tied, bones fractured, jaw missing, dismembered	Asso Valbrona, Como, Italy
Unidentified	2006	-	-	Florence, Italy
AM	2010	49	The victim was strangled, dismembered with a knife	Teramo, Italy
Unidentified	2010	28-52	Dismembered and beheaded	Malgrate, Lecco, Italy
Unidentified	2011	20-25	Dismembered	Olzino, Como, Italy
PM	2018	18	The victim was raped, killed and dismembered. Her remains were found in a suitcase	Macerata, Italy
EP	2021	31	Dismembered. Remains found in a dumpster	Bologna, Italy
CM	2022	26	The victim was killed with a hammer, slaughtered and thrown into a cliff	Rescaldina, Milano, Italy
LC	2022	84	The victim was killed and dismembered in a bathtub	Melzo, Milan, Italy

Fig. 4. National cases

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Results

CASE CLASSIFICATION BY DISMEMBERMENT TYPE

Among the 22 Italian cases analyzed in this study, 18 were categorized as clear instances of defensive dismemberment, characterized by body fragmentation primarily aimed at concealment or obstruction of identification. These cases involved the use of bags, suitcases, rivers, or remote locations to dispose of remains, behavioral elements consistent with previously established typologies in the literature[16]. In one case, the dismemberment displayed features suggestive of offensive dismemberment, marked by potential sexual or sadistic motivations. However, the available evidence is insufficient to make a definitive conclusion regarding psychological intent or paraphilic elements. The remaining three cases could not be conclusively classified due to limited or inconclusive data. In these instances, the scarcity of details, such as absence of crime scene photographs, incomplete anatomical recovery, or lack of autopsy information, precluded a reliable assessment of the offender's motivations. It is important to emphasize that all data regarding these Italian homicides were obtained exclusively from open sources and published academic literature. Although a formal request for judicial documentation was submitted to the competent courts of law, such materials were not yet available at the time of writing. This represents a critical limitation of the present analysis. Nonetheless, the authors chose to publish these preliminary findings to contribute to the limited scientific literature on dismemberment in Italy, with the intention of producing a future, updated publication dedicated exclusively to these cases once full judicial records become accessible.

The eight U.S. homicide cases included in this study, spanning the period from 1964 to 2025, were selected based on the availability of detailed open-source information and academic references. Similar to the Italian dataset, all information was obtained through publicly accessible sources, such as journalistic reports and academic literature. Judicial documentation was not available at the time of analysis. This limitation necessarily constrains the depth of psychological and legal interpretation and underscores the preliminary nature of the findings presented here. Based on the criminodynamic features reported, five out of eight cases were classified as defensive dismemberment, marked by concealment-focused behaviors such as hiding remains in bags, dumpsters, or remote locations. These cases lacked evidence suggestive of excessive mutilation, symbolic staging, or paraphilic behavior. One case (involving a teenage victim found dismembered in a garbage bag in a remote forest) presented indicators that may align with offensive dismemberment, given the apparent brutality and potential sexual undertones inferred from the crime's context. However, in the absence of forensic or psychological autopsy data, this classification remains tentative. In the remaining two cases, classification could not be conclusively determined due to insufficient details in the public record. In both instances, the recovery of only partial remains and limited investigative disclosures made it impossible to reliably interpret the offender's motivation or the specific dynamics of the dismemberment. As with the Italian case series, these findings are preliminary and subject to revision pending access to court records or official investigative files.

VICTIM DEMOGRAPHICS

Of the 22 Italian victims included in this study, all were biologically female. The age was explicitly reported or could be estimated in 15 out of 22 cases (68,18%).

Among those:

- The youngest identified victim was 18 years old
- The oldest was 94 years old
- The average age among those with known or estimated ages was approximately 43 years
- Six victims were aged 18–30 (27,27%)
- Four victims were aged over 50 (18,18%)

In three cases, the victims remain unidentified, with no age estimation publicly available. In several additional

cases, only partial information was available (e.g., estimated age range or skeletal remains only), limiting detailed analysis.

As for the U.S. victims, a total of eight cases were included, all involving biologically female individuals. The age was available in seven out of eight cases:

- The youngest victim was 14 years old
- The oldest was 80 years old
- The average age among those with reported ages was approximately 31 years
- Three victims (37,5%) were aged under 20
- Two victims (25%) were aged 31–40
- One victim was 80 years old

In one U.S. case, the victim's age was not publicly disclosed. All age information was derived from open-source or published academic materials.

ANATOMICAL OBSERVATIONS AND INJURY PATTERN

Among the 30 cases analyzed (22 Italian and 8 U.S.), only two presented insufficient anatomical information beyond the confirmation that dismemberment had occurred. In both instances, the absence of any public details regarding the distribution of injuries or recovered anatomical parts made further categorization impossible. In the remaining 28 cases, lesions and dismemberment marks were documented as involving multiple body regions, suggesting extensive post-mortem manipulation. While the degree of detail varied depending on the source, the available descriptions indicate that limb removal was the most frequent pattern, often accompanied by additional trauma. Decapitation was explicitly reported in three cases, all of which involved additional forms of dismemberment. These homicides were all part of the Italian case series. It must be noted that the lack of access to full medico-legal documentation, including autopsy reports, injury diagrams and histological assessments, poses a significant limitation. Without these materials, it is not possible to precisely evaluate lesion morphology, establish perimortem vs. postmortem trauma, or assess the vitality of specific injuries. Consequently, while anatomical patterns can be described at a broad level, the forensic interpretation remains preliminary.

GEOSPATIAL AND TEMPORAL PATTERNS

Of the 22 Italian cases included in this study, the majority occurred in northern Italy, with confirmed cases documented in the following regions: Lombardy (31,8%), Veneto, Marche, Piedmont, Liguria, Emilia-Romagna, Aosta Valley, Campania Tuscany and Lazio. Central and southern Italy showed a minor prevalence of dismemberment homicides, with the latter having only one included in our case series. Thus, the authors decided to focus primarily on the northern part of the country. The remains were recovered from a variety of locations, including forests, rivers, suitcases, garbage bags, dumpsters, residential structures, and wells. In several instances, the disposal sites were located in remote or natural areas, while others were situated in urban settings. Interestingly, it can be noted that the remains of dismemberment homicides in Como and Lecco Provinces, Lombardy, were dispersed almost exclusively in remote, mountainous areas near lakes. This is likely due to the peculiar characteristics of those locations. The temporal distribution of the Italian cases spans from 1923 to 2022, with almost every decade represented in the dataset, except the 1950s.

The eight U.S. cases occurred in California, Florida, Minnesota, Wisconsin, Kentucky, and Arizona. Disposal sites were particularly varied, with no apparent and recurrent pattern, and included suitcases, garbage bags, storage units, dumpsters, fields, and rivers. The cases range in date from 1964 to 2025, with a majority of incidents concentrated in the 2020s.

Discussion

The findings from this study underscore the diagnostic and analytical utility of an integrated forensic protocol in dismemberment investigations.

The need for a novel forensic protocol that encompasses a multi-step framework was evident after a thorough review of the existing literature was conducted.

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This protocol integrates multifaceted methods that enhance the depth and accuracy of forensic assessments, aiming to elucidate the criminodynamics associated with dismemberment cases.

Leveraging this structured methodology, investigators can achieve a more comprehensive understanding of victim identification and the circumstances surrounding the crime scene[17]. Furthermore, the application of genetic and immunohistochemical analyses significantly bolsters the quality of evidence collected, addressing critical aspects outlined in previous works that advocate for improved methodological rigor in forensic anthropology[18].

Turning our attention to the criminal phenomenon under consideration, where the application of the protocol in question has demonstrated particular utility, certain foundational points deserve to be established.

Criminal dismemberment, marked by evidently peculiar features, was investigated due to the substantial number of victims discovered within a geographically limited area, as well as the consistent presence of nearly identical anatomical resection patterns across all examined cases – with the exception of one case involving decapitation.

In this context, it is essential to briefly outline the inclusion and exclusion criteria that support the consideration of criminal dismemberment cases.

In this regard, it is important to briefly highlight the inclusion and exclusion criteria that allow for the classification of a case as one of "criminal dismemberment".

Dorland's Illustrated Medical Dictionary describes "mutilation" as the removal of a limb, organ, or other significant body part, or the infliction of profound disfigurement[19]. The motivations for such acts can differ, with the most common including the disposal of the body or the obstruction of identification processes[20]. In other instances, mutilation may be intended to degrade the victim, fulfill deviant sexual impulses, or manifest intense aggression or psychopathological conditions.

"Dismemberment" refers to the deliberate fragmentation of a corpse using machetes, hatchets, and, in some instances, power saws[21]. Of particular forensic interest are the characteristic notches found on bones, resulting from repeated blunt-force trauma and, occasionally, from serrated blade incisions[22].

In such cases, the action of dismemberment is carried out through a dual mechanism: both via the sharp cutting edge of a blade and through the blunt-force impact generated by the mass of the instrument when applied with considerable force.

Even in dismemberment cases, it is possible to assess the vitality of the lesions, thus enabling the forensic pathologist to determine whether the dismemberment occurred while the subject was still alive, in the agonal phase (in limine vitae), or post-mortem[23].

Traditionally, the reasons for concealing a corpse and destroying crime evidence, especially through dismemberment, have been analyzed from a psychological standpoint, aiming to understand the perpetrator's mind[24]. This collection, however, diverges from criminal-sociological explanations. It instead highlights forensic and anthropological aspects, with each case examined based on evidence obtained directly from the body[25].

In the following sections, we will explore in greater depth the use of various tools – such as the psychological autopsy (Psychological Autopsy Structured on Individual Cases, PASIC), toxicological, genetic analyses and computed tomography techniques – which are of crucial importance in the study of criminal dismemberment cases. Firstly, the use of psychological autopsy, particularly the PASIC protocol, marked a significant advancement in the psychological dimension of forensic analysis[12]. Its structured framework allows for a nuanced reconstruction of victim vulnerabilities and potential perpetrator psychopathology, enriching the overall understanding of criminodynamics. This addresses a notable lacuna in the existing literature, where psychological autopsy methods have rarely been systematically applied to dismemberment cases. Moreover, the typological classification of

dismemberment provided critical insights into offender behavior. Patterns consistent with offensive dismemberment were often accompanied by sexually sadistic elements and paraphilic indicators, whereas defensive dismemberment correlated with attempts to delay identification. These associations support the theoretical framework proposed in earlier taxonomies[26], while empirical application through our case series lends these models new operational validity.

The integration of toxicological and genetic analyses are indispensable in establishing cause of death and verifying victim identity, particularly in degraded remains[27] [28]. In line with prior forensic protocols, these techniques can substantially increase evidentiary reliability, thereby reinforcing the protocol's applicability in both forensic and judicial settings.

Each of these tools will be discussed more thoroughly in the following sections.

FROM LOCAL PATTERNS TO GLOBAL INSIGHTS: THE ITALIAN CASE SERIES IN THE FORENSIC INVESTIGATION OF CCRIMINAL DISMEMBERMENT

The Italian case series, spanning from 1923 to 2022, which included 22 homicides, served as a crucial preliminary foundation for understanding the complex dynamics of criminal dismemberment. This extensive dataset provided a rich empirical basis for the subsequent comparative analysis with cases relevant to other geographical contexts, particularly the US, thereby contributing to a broader, globally informed perspective on forensic methodologies and the prevalence of this kind of crime. Our work represents an integrative effort aimed at re-evaluating and expanding upon the Italian cases already documented in existing literature, acknowledging, however, the inherent limitations of historical data collection and the retrospective nature of such an undertaking. The intersection of unique geographic, temporal, and socio-economic factors profoundly influences the forensic analysis of body dismemberment cases within Italy. The period between 1923 and 2022 encompasses significant societal transformations, including periods of war, economic shifts, and evolving legal frameworks, all of which undeniably impact criminal behavior and investigative practices. Factors such as regional variations in population density, ranging from densely populated urban centers to sparsely inhabited rural areas, directly affect the likelihood of discovery, the preservation of evidence, and the operational scope of forensic teams. The systematic analysis of the Italian case series reveals discernible patterns related to victim selection and disposal methods, which align with broader criminological trends observed internationally[29]. A recurring finding is the propensity of offenders to relocate dismembered remains away from the primary crime scenes. This behaviour is typical of dismemberments that fall into the "defensive" category, which account for the majority of cases internationally[30]. Concealment strategies often involve exploiting environmental features, such as dense forests, hazardous terrain or bodies of water, posing significant challenges for recovery efforts and subsequent forensic examinations. The geographic landscape of Italy, characterized by its diverse and complex morphology, coupled with unique demographic and population density features, present unique challenges. The state of preservation of remains, heavily influenced by environmental factors, directly impacts the range of forensic analyses that can be conducted, from DNA profiling to entomological and botanical examinations[31]. These unique challenges underline the necessity to propose an innovative, multidisciplinary approach to studying these complex homicides, even after they are classified as cold cases.

EVALUATION OF THE CRIME SCENE AND ITS SIGNIFICANCE

The meticulous examination of the crime scene serves as a cornerstone in forensic investigations, particularly in cases involving body dismemberment, where the context and environment significantly influence the understanding of the crime[32]. By evaluating the spatial and physical elements of the scene, investigators can glean critical insights into the criminodynamics and potential motives behind

the acts[33]. For instance, studies have shown that motivations can vary according to offender identity, with demographic factors influencing both the choice of victim and the method of body disposal, such as whether remains are left at the scene or moved to a secondary location[34]. Beyond demographic characteristics, several physical and environmental factors also profoundly impact criminal dynamics and investigative procedures[35]. The urban or rural context of a location, for instance, greatly influences the availability of concealment options and determines the likelihood of witnesses observing suspicious activities. Similarly, the terrain type – ranging from densely wooded areas to urban settings with extensive infrastructure – affects both the perpetrator's decision-making processes and the investigator's strategies for scene analysis and body recovery[35]. Population density also plays a crucial role, as densely populated areas may provide anonymity and numerous disposal options, whereas sparsely populated areas often necessitate more deliberate concealment efforts[36]. Additionally, factors such as proximity to transportation networks, bodies of water, or remote wilderness areas can dictate the offender's methods and increase or decrease investigative challenges. Investigators can leverage advanced analytical tools to meticulously examine the terrain and environmental features of a crime scene; notably, satellite imagery and GIS (Geographic Information System) software offer critical insights into specific locations. It is common that homicides encompass more than one crime scene, rather than a single location[36]. This is especially true for cases of dismemberment homicides. Evaluating all the different crime scenes, including the site of the homicide, the location of dismemberment and disposal site, is fundamental, as each setting provides unique insights into the offender's decision-making process and motivations. Particularly, in cases of body dismemberment, these scenes may reveal critical behavioural patterns, the offender's familiarity with specific geographic areas, and their efforts to conceal the crime. A comprehensive analysis of all related crime scenes can thus significantly enhance investigative strategies, improve linkage accuracy, and contribute to the construction of a more accurate offender description[37].

Furthermore, advancements in forensic methodologies, including the psychological autopsy structured on individual cases (PASIC), enhance the depth of analysis surrounding the mental state of perpetrators, thereby contributing to a more comprehensive view of the crime scene's significance[12].

REVISITING THE CRIME SCENE: USING FORENSIC PHOTOGRAPHY TO RE-EVALUATE A SCENE

Photography is defined as the process or art of producing images of objects on sensitized surfaces by the chemical action of light or of other forms of radiant energy. This complex process has been possible since the 1820s, and the first photograph to be used as evidence in a courtroom was taken in 1851[10].

Forensic photography constitutes a fundamental component of protocols aimed at investigating cases of criminal dismemberment, facilitating the systematic archiving of evidentiary materials and the provision of visual documentation for medico-legal deliberations[38]. The effective integration of photographic practices within forensic workflows necessitates the judicious selection and utilization of imaging and computational technologies, supported by adequate practitioner training and adherence to standardized procedural methodologies. In forensic settings, photography serves multiple purposes. A crime scene is, by definition, perishable[10]. Thus, photography is particularly useful to secure over time the accurate state of evidence and traces on the scene at the time of discovery. In some cases, pictures taken by forensic photographers may even serve as evidence in court[10]. In addition, in specific conditions, such as when the original piece of evidence is no longer in existence, photographs themselves become evidence.

The forensic photographer assumes a pivotal role, wherein proficiency in both technical and artistic aspects of photography, combined with continual updating of relevant techniques and technologies,

is essential for the accurate documentation and preservation of evidentiary data[39].

The acquisition of reliable forensic photographs requires adherence to established procedural guidelines. Initial steps include securing the crime scene to preserve its original state, thereby preventing the introduction of misleading visual evidence[39]. Environmental variables – such as ambient lighting and weather conditions – must be assessed to optimize camera settings. A systematic photographic approach is employed, beginning with wide-angle images to document the overall context, followed by close-up views to establish spatial relationships between evidence and surroundings. Victim documentation should emphasize anatomical location, nature of injuries, and general condition[40]. Evidence must be photographed perpendicularly to reduce perspective distortion, both with and without measurement scales, to ensure accurate representation of size and context[10]. Comprehensive coverage also entails capturing the scene before and after placement of evidence markers, ensuring scene integrity. Additionally, specialized imaging techniques, including the use of alternate light sources and optical filters, may be employed to enhance the visibility of latent evidence such as fingerprints, bite marks, and trace impressions[38].

INTEGRATION OF IMAGING TECHNOLOGIES

Although not always possible, the implementation of advanced imaging technologies represents a significant advancement in forensic investigations, particularly in complex cases such as body dismemberment[41]. The integration of post-mortem computed tomography (CT) plays a pivotal role in this novel protocol, providing detailed anatomical insights that are crucial for the evaluation of wound patterns and internal injuries without the need for invasive procedures. As demonstrated in recent studies, post-mortem CT aids in the identification of vital structures and can significantly aid in assessing the post-mortem interval, thereby enhancing the overall understanding of the circumstances surrounding the death[42]. Additionally, this imaging technique complements genetic and immunohistochemical evaluations by providing a clear visual framework that informs the analysis of trauma and decomposition processes[43]. The incorporation of these technologies, alongside methodologies such as the PASIC protocol, supports a comprehensive approach to forensic investigation[12].

GENETIC EVALUATIONS

Genetic analysis allows for identity confirmation whenever possible. For establishing the genetic identity of a sample, the specimen is initially collected by qualified personnel; the collection can include tissues (such as muscle, liver, blood), teeth, or bone fragments. According to current protocols, samples are maintained under controlled conditions to optimize their preservation, such as freezing at -20°C or -80°C, or, less commonly, storing in DNA-specific solutions[44]. Properly stored samples then undergo DNA extraction, employing various instruments depending on the type of sample. For example, homogenizers are used to break down hard tissues (bones, teeth), while bead-beaters are applied to soft tissues. Currently, DNA extraction kits employing chemical methods followed by purification via silica-based or magnetic columns represent the most commonly used approach. During extraction, refrigerated centrifuges are employed to separate phases and preserve the sample integrity. Lastly, specific protocols are available for degraded DNA or samples considered challenging, such as ancient or damaged DNA. Once extracted, the DNA undergoes quantification through spectrophotometers and fluorometers utilizing specific reagents to measure both the concentration and quality of the extracted DNA.

The subsequent step involves DNA amplification, a process conducted using PCR (Polymerase Chain Reaction) thermocyclers – devices performing cycles of denaturation, annealing, and extension to amplify specific DNA loci. Commercial PCR kits for Short Tandem Repeats (STRs), such as AmpFlSTR or PowerPlex kits, are available and widely employed; these kits simultaneously amplify multiple standardized STR loci relevant for forensic identification.

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Following amplification, the STR fragments are separated and analyzed using capillary electrophoresis (CE). This process involves a genetic analyzer in which PCR-amplified fragments, previously labeled with fluorochromes, are separated according to their length. The system outputs a genetic profile (electropherogram), displaying peaks corresponding to the various STR alleles. Genetic software tools subsequently interpret these results, generating genetic profiles which can then be compared against reference samples, either direct or familial, when available. All operations are performed according to validated protocols aligned with international standards (ISO 17025, SWGDAM). The following figure shows an electropherogram of a female, generated by multiplex PCR and subsequent automated electrophoretic sequencing.

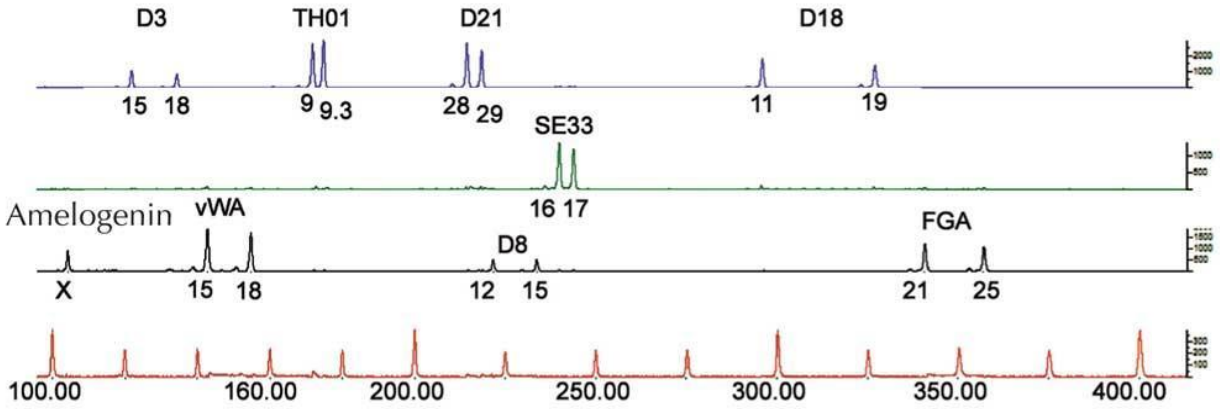

Fig. 5 DNA profile electropherogram

Genetic profiling is applicable in paternity testing, sexual assault investigations, matching biological traces to suspects or victims, identifying missing persons and enhancing DNA databases. In the realm of forensic investigations, after the traumatic event of dismemberment, the integration of genetic and immunohistochemical evaluations plays a crucial role in victim identification. These methods provide a robust framework to analyze biological materials that may remain after significant tissue loss. Specifically, techniques such as DNA profiling can yield definitive identification, while immunohistochemistry allows for the visualization of specific proteins associated with the victim's tissues, further assisting in delineating individual features and biological characteristics. Thanks to genetic genealogy, it is now possible to identify victims and perpetrators of violent crimes, even when neither is present in law enforcement databases.

Importantly, pursuing these methodologies is complemented by the PASIC protocol, which emphasizes understanding individual life histories that may shed light on motive and context[12]. Such integrative approaches are essential in a comprehensive forensic framework, particularly within the context outlined in the case series of the Italian victims, where accurate identification is paramount amidst deteriorated conditions.

IMMUNOHISTOCHEMICAL EVALUATIONS

Immunochemical analysis is one of several techniques employed to identify substances, tissue markers, and biological fluids. Once discovered and documented at the scene, the corpse is transported in suitable containers designed to prevent contamination to a forensic laboratory or morgue. Upon arrival, various examinations are conducted since, following death, the body undergoes abiotic processes such as circulatory arrest, hypostasis, and rigor mortis, as well as putrefactive processes (autolysis, skeletal reduction, and atypical putrefaction), all of which alter the body's integrity and complicate subsequent analyses.

Immunochemical analyses assist in determining the presence of chemical substances in the body of the deceased, providing important clues regarding the

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cause of death. These analyses are typically performed on samples of urine, blood, and gastric contents, and are utilized to detect the presence of medications, alcohol, narcotics, or other chemical substances within the body. This method relies on the selective binding between an antibody and an antigen, coupled with a detection system (colorimetric, fluorescent, or electrochemical) that allows for the measurable identification of the target molecule. Various techniques are employed for immunochemical analyses; among the primary ones is the Enzyme-Linked Immunosorbent Assay (ELISA), an enzymatic colorimetric method used both qualitatively and quantitatively. In ELISA, an antibody is conjugated to an enzyme; subsequently, the antigen binds, a substrate is added, and a colorimetric reaction occurs. Typically, this method is employed to detect substances such as drugs of abuse, hormones (e.g., HCG), and pathogens.

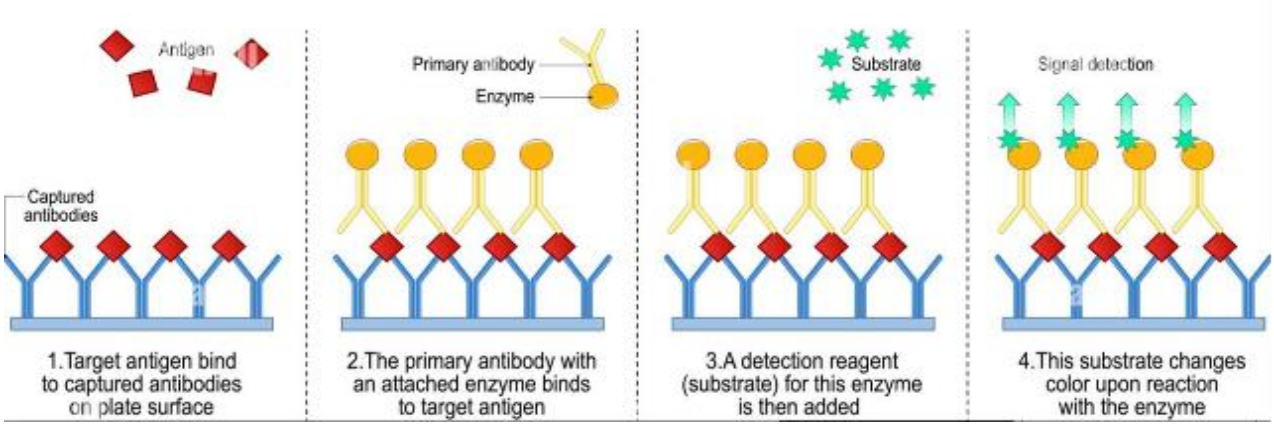

Fig. 6 Illustration of the ELISA (Enzyme-Linked Immunosorbent Assay) process

Another example of an immunochemical test is the Western Blot. This test can be performed on samples obtained from deceased individuals, but it does have limitations. The samples must be collected as soon as possible after death to prevent protein degradation and must be appropriately preserved for the same reason. The Western Blot involves separating proteins through electrophoresis; these proteins are then transferred onto a membrane, incubated with specific antibodies, and subsequently detected through enzymatic reactions or fluorescent substances. Due to its high specificity, this technique is often utilized as a confirmatory diagnostic test.

Immunochromatographic methods, also known as rapid tests, can be applied to deceased individuals but come with specific temporal limitations and require careful interpretation of results. Often, these are utilized as initial screening tests pending confirmation through more precise methodologies. For instance, rapid toxicological tests may be conducted on urine and blood immediately following death to detect substance use. In these tests, the antigen migrates along a strip; if an interaction with the antibody occurs, a visible band appears. Rapid tests are widely employed as pregnancy tests and for COVID-19 detection. They are primarily qualitative in nature. Another method applicable in forensic or post-mortem contexts, albeit with limitations, is chemiluminescence. This technique is useful in identifying infections, hormone levels, drug presence, poisoning, or indirect causes of death. However, this analysis should ideally be performed within 24 hours of death to ensure sample integrity and accuracy of results. In this method, antibodies are labeled with fluorochromes or luminescent agents, rendering it a highly sensitive technique. Another commonly utilized analysis in autopsy settings is immunohistochemistry (IHC), where immunochemical methods are applied to histological sections. This technique allows for the identification of specific tumor markers, detection of infections, and investigation of neurodegenerative diseases. However, there are important considerations: tissue fixation times are critical, with formalin-fixed tissues frequently used due to their optimal post-mortem

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preservation qualities. Furthermore, immunohistochemistry can be employed to identify specific tissue types by utilizing monoclonal antibodies directed against brain, muscle, liver tissues, among others. This technique is especially relevant for the cases discussed in this article, where isolated organs or tissues may not be easily recognizable.

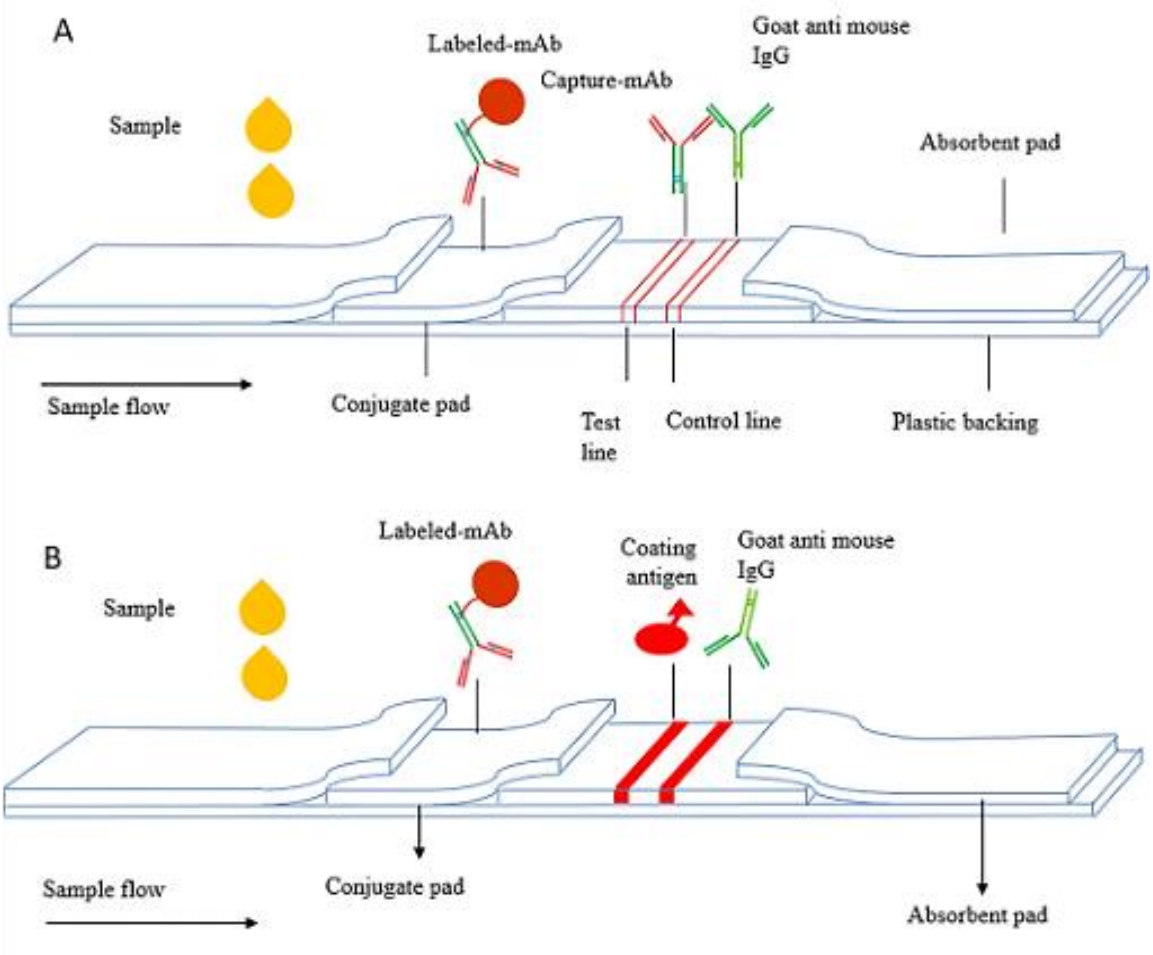

Fig. 7 Western Blot Method

PSYCHOLOGICAL AUTOPSY AND ITS IMPLICATIONS FOR CRIMINODYNAMICS

examining the multifaceted nature of body dismemberment cases, the integration of the Psychological Autopsy Structured on Individual Cases (PASIC) offers critical insights that enhance our understanding of criminodynamics[45,7]. This structured method not only addresses methodological shortcomings of traditional psychological autopsy practices, such as the MAP (Modelo de Autopsia Psicologica) and MAPI (Modelo de Autopsia Psicologica Integrado) protocols, but also emphasizes a comprehensive evaluation of psychological characteristics and risk factors associated with victims and perpetrators alike[12]. By employing PASIC, investigators can derive nuanced insights into the motivations and psychological states leading to such violent acts, ultimately contributing to a deeper understanding of the circumstances surrounding each dismemberment case in our study. Specifically, the protocol's emphasis on a detailed retrospective analysis of individual lives allows for a contextualized interpretation of behaviors that may have precipitated the crime, making it essential for evaluating post-mortem intervals and the vitality of lesions in forensic investigations[12]. Thus, the implications of PASIC extend beyond mere data collection and foster a more holistic approach to understanding complex criminal behaviors. This innovative psychological autopsy protocol diverges significantly from traditional methodologies. While MAP and MAPI models depend on closed-ended, standardized questions, PASIC effectively leverages an open framework for individualized case evaluation.

THE ROLE OF THE PROTOCOL IN JUDICIAL POLICE ACTIVITIES

The legal aspects relevant to the present scientific study should be addressed starting from the utility that the Protocol may have in the context of criminal proceedings.

This is particularly significant when considering that its application could contribute to enriching the scientific literature, which remains limited in terms of the phenomenological understanding of *post-mortem* dismemberment. The scarcity of studies in this field is primarily attributable to the effect of underreporting, to which this crime is subject, as well as the complexity of the dynamics that characterize it[17].

In this regard, numerous scholars concur in considering dismemberment a transversal phenomenon, thereby underscoring the necessity of an inherently multidisciplinary approach[1].

In both civil law and common law systems, judicial police activities play a central role following the acquisition of the *notitia criminis*. From the earliest stages after such acquisition, the Protocol proves useful in ensuring the rapid execution of autonomous police investigations, contributing not only to their expeditious completion for the purposes of preliminary investigations but also to a more reliable reconstruction of the essential elements of the offense and other relevant aspects to be reported to the prosecutor.

Furthermore, in cases where judicial police authorities must make a strategic decision between promptly informing the prosecutor about the direction of the investigation or allowing for a reasonable period to compile a comprehensive report on the criminal offense and the supporting evidence, the Protocol serves to minimize the qualitative gap between these two alternatives.

It should be noted that, in proceedings concerning offenses deemed particularly serious by the legal system, such as the case under examination, the necessity of immediately entrusting the direction of the investigation to the prosecutor, for obvious reasons related to the expeditious nature of investigative activities, complicates the collection of evidence. In such circumstances, the Protocol would be particularly valuable: by supporting the investigation into the offender's motives and behavioral patterns and providing investigators with key elements to understand the criminodynamics and underlying motivations, it enables the submission of a sufficiently detailed, rather than merely summary, report to the prosecutor on the defining characteristics of the criminal act.

PSYCHOLOGICAL AUTOPSY STRUCTURED ON INDIVIDUAL CASES AS AN AID IN THE ADJUDICATING MAGISTRATE'S WORK

In the cases of dismemberment analyzed, the legal framework appears particularly complex, as multiple criminal offenses may be attributable to the same perpetrator.

From a descriptive perspective, the study of cases concerning the victims discovered in Italy between 1923 and 2022 necessitates a focus on the offenses of torture, homicide and corpse desecration. Within the category of intentional violent crimes characterized by exceptional cruelty and brutality, the psychological state of the perpetrator assumes central importance and presents considerable complexity. Through the methodological approach offered by innovative protocols such as PASIC, an attempt is made to address this complexity by providing judicial authorities with scientifically grounded tools to assess the offender's criminal responsibility, their level of social dangerousness, the circumstances surrounding the crime, the severity of the acts under prosecution, as well as the perpetrator's antecedent, concurrent and subsequent conduct.

First and foremost, the act of dismemberment should not be superficially correlated with mental disorders in the perpetrator, particularly when no evidence of paraphilic behaviors – such as sexual sadism, necrophilia or necrosadism – is present.

Jurisprudence has long emphasized that the extreme cruelty and brutality of the acts committed

do not, in themselves, exclude the capacity to understand and will, which is fundamental in determining criminal responsibility.

Moreover, it is essential to acknowledge the increasing prominence of the debate surrounding the insanity defense (Not Guilty by Reason of Insanity, NGRI) in legal and criminological discussions over recent decades. In this regard, it must be clarified that the success of such a defense strategy is contingent upon demonstrating that the claimed mental disorder was present at the time of the crime and that it significantly impaired or entirely nullified the defendant's capacity to understand and will their actions.

Recent studies on the phenomenon of *post-mortem* dismemberment, analyzing the demographic and behavioral characteristics of offenders who engaged in corpse mutilation, have revealed that the majority of perpetrators did not have a primary psychiatric diagnosis[46]. While mental illness may contribute to such behaviors in some cases, dismemberment may also serve pragmatic and organized purposes[3].

Subsequent research has explored the motivations underlying such criminal behaviors without, however, delving into the potential role of mental illness as a primary motivating factor[13]. A more targeted analysis of this aspect would undoubtedly provide a valuable contribution to the assessment of such crimes in the context of the insanity defense.

Another crucial consideration concerns the need to strengthen the exercise of judicial discretion, essential for sentencing determinations, by incorporating technical assessments derived from the application of the Protocol. This pertains particularly to the investigation of meta-legal factors such as the offender's propensity for criminal behavior, their social dangerousness, and, consequently, their likelihood of recidivism.

RECOMMENDATIONS FOR FURTHER RESEARCH IN FORENSIC DISMEMBERMENT CASES

Considering the complexity of forensic dismemberment cases, evidence suggests that future research must delve deeper into the integration of interdisciplinary approaches to enhance investigative outcomes. Expanding upon the proposed protocol, greater emphasis on advanced imaging technologies, such as 3D reconstructions and enhanced CT scans, could yield more comprehensive insights into the dismemberment process and the circumstances surrounding each crime. Additionally, exploring the psychological characteristics of perpetrators through extensive psychological autopsies could illuminate potential behavioral patterns linked to dismemberment offenses. It is also critical to establish standardized procedures for collecting and analyzing biological evidence that may be recovered from dismembered remains, as this could aid in providing more definitive connections to unknown victims or suspects. Finally, the application of machine learning techniques to analyze data from past cases may assist in identifying emerging trends in dismemberment incidents, ultimately contributing to more effective prevention strategies in forensic medicine.

Conclusions

The primary aim of this study was to identify a relevant and representative case series of dismemberment homicides, selected based on victim characteristics, temporal range and geographic distribution, and to propose a multidisciplinary investigative protocol capable of enhancing the forensic analysis of such cases. Through the collection and examination of 30 cases, including 22 from Italy and 8 from the United States, the research sought to establish a foundational dataset and, more importantly, to suggest a methodological framework that could support future investigations and academic inquiry. Many of the Italian cases, in particular, remain unsolved or only partially documented. The lack of judicial documentation and limited access to autopsy records continues to hinder a full reconstruction of the criminodynamics involved.

In response to this gap, the study proposes an integrated protocol, combining post-mortem imaging, forensic photography, toxicology, genetic and immunohistochemical analyses, and psychological

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autopsy through the PASIC model, which could serve as a template for future case evaluations, even in the absence of complete medico-legal documentation. The protocol is not intended as a conclusive solution, but as a starting point, a scalable and interdisciplinary tool to assist practitioners, researchers, and judicial authorities in forming a more holistic perspective on these crimes. Ultimately, this study seeks not only to enrich scientific knowledge but also to promote methodological rigor in the investigation of this kind of violent crimes.

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Conflicts of Interest:

The authors have no conflicts of interest to declare.

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