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Suicidal decapitation by hanging: A systematic review of the literature and comparison with case reports

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ABSTRACT

Introduction: Suicidal hanging resulting in decapitation is rarely documented. This discussion involves a case of a 35-year-old man found decapitated in his residence's garden. A systematic literature review on hanging-induced decapitation was conducted to comprehensively investigate and compare the case to existing literature. The study aims to identify frequently described post-mortem findings in cases of suicidal hanging leading to decapitation.

Case report: A 35-year-old man was found decapitated in his garden, with a jute strap and chimney debris nearby. The cervical region was completely severed along the dorsoventral and craniocaudal plane, exposing internal structures. A ligature mark was present, along with Amussat's sign and Simon's bleeding.

Methods: The systematic review of the literature followed PRISMA standards, analyzing 3622 publications from Google Scholar, PubMed, and Scopus databases up to 2023. Inclusion criteria comprised cases of complete or incomplete decapitation resulting from hanging, available in full-text and written in English.

Results: 16 articles on hanging-induced decapitation met the selection criteria; 22 cases were analyzed. Studies, mostly from Europe, showed a mean victim age of 44.3, all male. Fall height ranged from 1 m to 18 m, with various suspension media. Most cases displayed complete decapitation, primarily between cervical vertebrae C1 and C3. Some cases noted collateral findings.

Conclusions: Complete crime scene investigation and thorough post-mortem examination are crucial for reconstructing events, especially with confounding elements. Precise evidence collection and literature comparison are essential to understand the case and substantiate the forensic pathologist's hypothesis in court.

1. Introduction

Decapitation refers to the separation of the head from the body and can result from suicide, homicidal dismemberment, traumatic accident, or judicial execution [1]. Nowadays, it is mostly seen in railway or road accidents, or cases of post-mortem mutilation.

Hanging with suicidal intent resulting in decapitation is itself an infrequently documented event in the literature, although suicide by hanging alone is commonly reported [2].

Regarding the incidence of decapitation, the 2004 study by Byard reported that less than 1 % of suicides result in detachment of the head from the rest of the body, whereas the overall frequency of death by decapitation was 0.1 % [3]. The study conducted by Byard et al. in 2018 revealed the frequency of decapitation in hanging suicides is close to 0.2 % [4].

The rarity of cases of hanging with decapitation may be attributed to the fact that the majority of suicide hangings occur in domestic settings, with very limited or absent falls, such as inside a house, garage, or

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garden, or under a porch or pergola.

Decapitation by hanging becomes possible when a body is dropped from a height as the kinetic energy is gained through acceleration [5]. As long as the body descends without tensioning the rope, the acceleration becomes significant, taking into consideration both the weight of the body and the acceleration due to gravity ($g = 9.81$ m.sec^2).

In complete decapitation, the head is fully separated from the rest of the body, while in incomplete decapitation, the head remains connected to the neck through soft tissue [6,7].

The occurrence of complete decapitation as opposed to incomplete decapitation can be explained by numerous factors such as the characteristics of the rope, the type of knot tied, and the resistance of muscles, skin, and cervical bones.

From a pathological perspective, the injuries observed during autopsies following hangings are influenced by various factors, including the fall height, the weight of the body, and the type of ligature [2,5]. In short-drop hangings (less than one meter), distinctive signs such as a parchment-like ligature mark around the neck may be evident, with possible injuries to the hyoid bone and horns of the thyroid cartilage [8].

Other signs include bleeding under the anterior longitudinal ligament of the lumbar spine, i.e. Simon's sign, transverse intimal tears of the carotid artery, i.e., Amussat's sign, and bleeding at the clavicular insertion of the sternocleidomastoid muscles [9,10].

In this study, a case of a 35-year-old man found decapitated in the garden of his residence is discussed. From reconstructions leading up to the event of decapitation, it appears that the man attempted to hang himself from the chimney of his house. The wall of the house exhibited a conspicuous bloodstain indicating a mid-height severing of the neck during the descent.

Given the peculiarity of the phenomenon, a systematic review of the literature on decapitation resulting from hanging was conducted to provide a comprehensive investigation and compare the presented case to the existing literature.

Furthermore, the objective of the study is to identify the most frequently described post-mortem findings in cases of suicidal hanging resulting in decapitation.

2. Case report

The body of a 35-year-old man was found in the garden of his house by his family members. Upon initial assessment of the circumstances of the man's death, it appeared that he hanged himself with a jute ratchet strap attached to the chimney and proceeded to jump. He had been under house arrest for several months and was suffering from major depressive disorder.

2.1. Examination of the scene

Fragments and debris from the destroyed chimney were observed on the grass and the pavement surrounding the back of the building; a 5-meter jute strap for large vehicle traction was found among the debris of the chimney. The wall was 12 m tall, where blood stains with an arc pattern were observed (Fig. 1). Drops of blood were also detected across the pavement surface.

The head of a male subject was located on the grass in a prone position, facing down (Fig. 2a), while the decapitated body was in front of the wall in a semi-prone position (Fig. 2b). The dorsal region of the body displayed multiple drops of blood.

2.2. External examination

The body appeared in good nutritional condition, measuring approximately 172 cm in length (155 cm length of the body plus 17 cm length of the head and the severed portion of the cervical tract) and weighing approximately 85 kg.

The detached head exhibited a sickle-shaped laceration on the frontal region, with exposure of the underlying cranial bone structure.

Fig. 1. Detail of the wall in front of the falling point, where approximately halfway up the wall, two main bloodstains are visible, indicative of an arc pattern, reasonably located near the decapitation point.

In the portion of the cervical region that was still attached to the head, an oblique ligature mark was evident, with a back-to-front and up-to-down orientation, with a maximum thickness of approximately 2 cm and a depth of approximately 0.2 mm. Dorsally, the ligature mark was positioned 3 cm from the severance plane, which was also oblique.

The cervical region was completely severed along the dorsoventral and craniocaudal plane, with exposure of a portion of the larynx, which was also severed in its upper third. Additionally, the following structures were exposed: the epiglottis, the posterior wall of the hypopharynx, the third vertebral body with its corresponding spinal canal with protrusion of the spinal cord, and the common carotid arteries.

In the anterior portion of the cervical region, there was an oblique ligature mark, which was interrupted at the severance plane with similar features to the one described at the level of the head (Fig. 3).

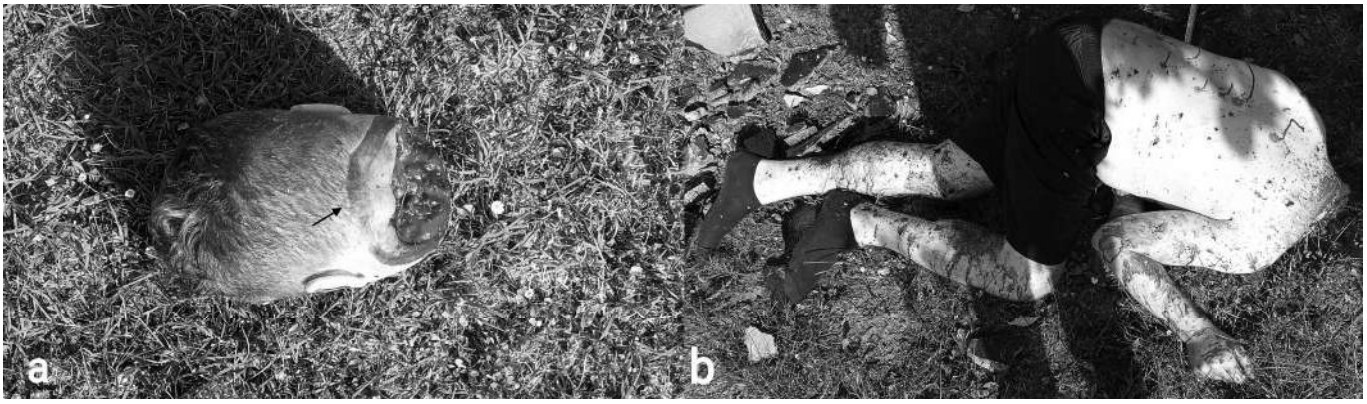

Fig. 2. Detail of the head and body found separated and at a considerable distance. (a) Head in a prone position, showing a ligature mark in the posterior cervical region with an abraded appearance (black arrow) and located above the severance plane. (b) The headless body was 1.33 m from the wall and 2.77 m from the head. The body was in a semi-prone position with the pelvis resting on its left side. The left upper limb was adducted below the chest. The right arm was completely adducted to the side, with the forearm slightly flexed at 45°. The right lower limb was flexed at the thigh and at the knee, both at approximately 90°. The left lower limb was extended with a slight flexion of the left leg. Note the bloodstains in the dorsal region, indicating a 'drip' pattern of blood deposition after the impact of the body on the ground.

Fig. 3. Ligature mark on the cervical region of the body with the following features: a back-to-front and up-to-down orientation, with a maximum thickness of approximately 2 cm and a depth of approximately 0.2 mm.

2.3. Autopsy

During the autopsy, the frontal region exhibited a depressed fracture about 8 cm in length. Numerous other fractures were observed in the cranial region, following a radial pattern along the cranial vault, along the midline, in the right parietal region, and in the left temporal fossa, with diastasis of the cranial sutures (Fig. 4). A multi-fragmented fracture was documented in the right zygomaticofrontal arch.

The brain appeared to be edematous and congested without signs of subarachnoid hemorrhage. The anterior cranial fossa appeared completely fractured.

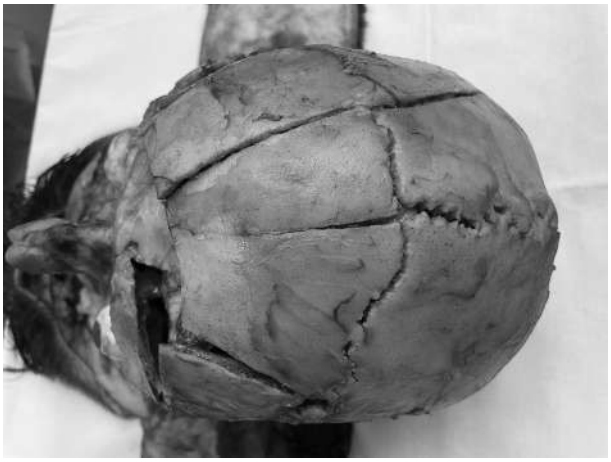

Fig. 4. Top view of the head showing the removal of soft tissues from the skull (facial mask technique). Note the radial fracture lines relative to the frontal fracture, presumed to be the point of impact on the ground.

The decapitation occurred between C2 and C3 and examination of the neck revealed a disruption of the upper third of the larynx, with preservation of the epiglottis. The thyroid gland was partially damaged in its upper third. The carotid arteries were severed, the left carotid at the bifurcation and the right carotid immediately below the bifurcation.

Upon opening of the carotids, fissures were observed in the intimal layer, as in Amussat's sign (Fig. 5a). Additionally, Simon's bleeding at the level of the anterior longitudinal ligament was detected (Fig. 5b).

The thoracic cage was intact, with no signs of rib fractures nor intercostal tissue hemorrhagic infiltration. The lungs presented sub-pleural petechiae bilaterally, with signs of parenchymal congestion (Fig. 6).

2.4. Histological examinations

Microscopic examination of the brain revealed signs of parenchymal congestion. The cardiac specimens exhibited only minimal perivascular fibrosis. Histological examination of the lungs showed sub-pleural emphysema, with congestion and edema in some areas. No significant findings were noted in the kidneys and liver, except for minimal hepatic

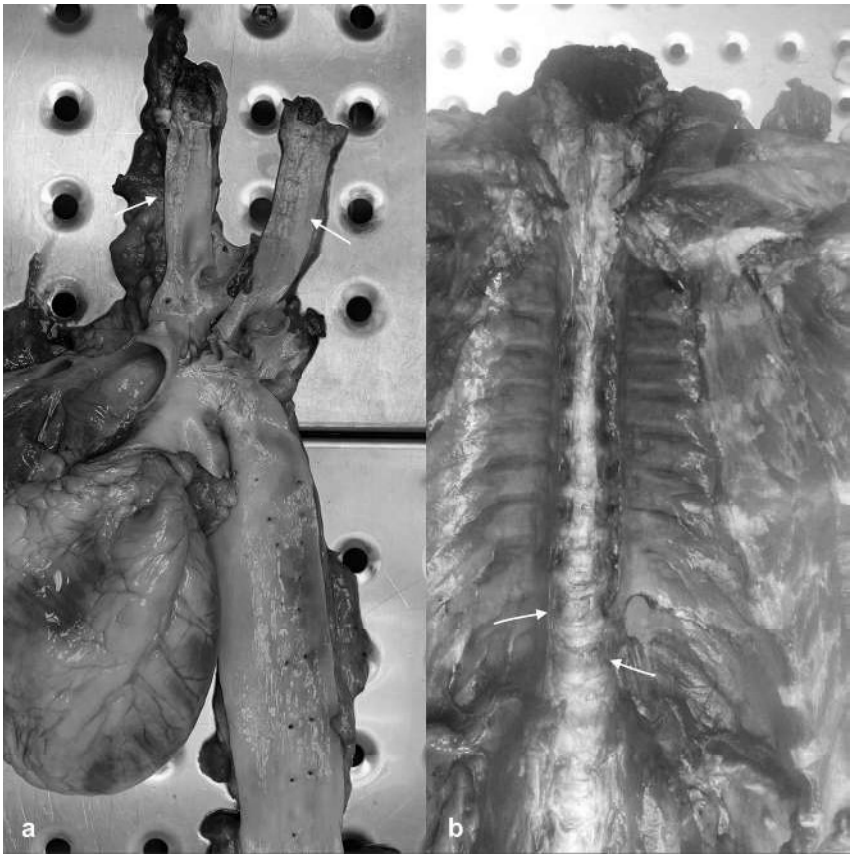

Fig. 5. Amussat's sign (a) and Simon's bleeding (b) (a) Intimal tears on both the common carotid arteries (arrows). (b) Hemorrhagic infiltration of the lumbar vertebrae (arrows).

steatosis.

The skin sampled from the ligature mark exhibited a diffuse erythrocyte infiltrate in the subcutaneous tissue, in proximity to the cervical muscle tissue.

Skin sampled from the margins of the severed cervical region showed minimal erythrocyte infiltrate.

Ultimately, the dynamics of the suicidal event were reconstructed as follows: the individual performed hanging using a tow rope attached to the chimney of the building where they resided, positioned at a height of approximately 12 m from the ground. Based on the collected evidence, such as the analysis of the blood stains and the length of the rope (5 m), it was postulated that the body fell while fixed to the rope for a considerable distance before it was abruptly arrested; this phase was likely followed by the collapse of the chimney, which was subsequently found in many fragments near the body.

Bloodstains along the chimney indicate that the separation of the head from the rest of the body occurred at the mid-height of the structure, approximately 6 m below the chimney, where bloodstains with an arc pattern were observed. The presence of jagged droplets on the dorsum of the body suggests decapitation during the fall, with blood sprayed upward before the impact of the head with the ground.

3. Systematic review

3.1. Materials and methods

This scoping review was developed according to the Preferred Reporting Items for Systematic Review (PRISMA) standards [11]. A systematic literature analysis and a critical review of the collected studies were conducted. An electronic search was performed using three different databases (Google Scholar, PubMed, and Scopus databases) up to 2023.

Using MeSH terms, accessible terms, and combinations: "hanging" AND ("decapitation" OR "decapitated" OR "beheading" OR "beheaded").

The following inclusion criteria were applied: articles containing cases of both complete and incomplete decapitation resulting from hanging without the use of motorized vehicles; case reports included in literature reviews and original articles; English-language articles; articles accessible through major search engines (Google Scholar, PubMed, and Scopus databases).

Only those meeting the criteria were considered when multiple case reports were presented.

The exclusion criteria are as follows: decapitation resulting from methods different from hanging, hanging without decapitation, articles that are not written in the English language, and the unavailability of full-text articles.

The bibliographies of all located documents were examined and cross-referenced to identify relevant literature further. A methodological evaluation of each document was conducted, referring to the PRISMA standards, including an evaluation of bias. The data collection process included study selection and data extraction. Three researchers independently examined all the papers with titles or abstracts that seemed to be pertinent and selected those that investigated only cases of decapitation during suicidal hanging. Investigators resolved their divergence concerning work eligibility by consensus. Two investigators completed data extraction, and two other researchers corroborated them, which were newly verified by two additional investigators.

The following data was recorded from the chosen papers: Author and year of publication, country, number of cases for each paper, age and gender, weight, height before tensioning the rope (or distance between the rope and the car), complete or incomplete decapitation, level of

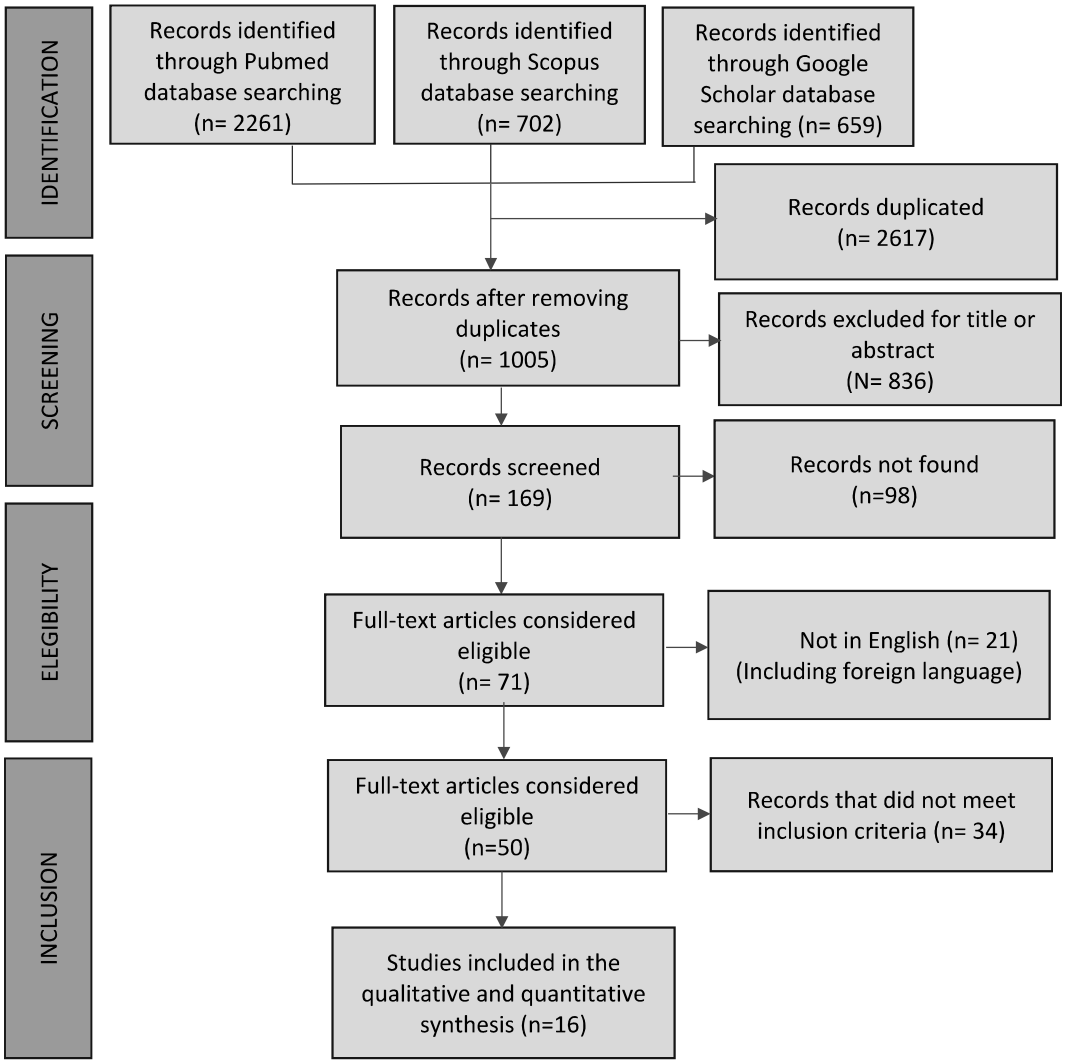

Fig. 6. PRISMA flow diagram.

decapitation, means of hanging, additional investigation adopted for each case and additional pathological findings.

This systematic review was exempt from institutional review board approval as it did not include human subjects.

3.2. Results

In total, 3622 publications that meet the search criteria have been found. An additional 2617 duplicate articles among the search engines were excluded. After detailed consideration for meeting the primary inclusion criteria, 836 publications were subsequently excluded for title or abstract, and further selection was made from 169 full-text articles. 98 full-text papers could not be retrieved. Additionally, 21 papers not written in English have been excluded. The remaining 50 articles underwent careful evaluation and ultimately 16 articles about decapitation resulting from hanging met all the selection criteria (Fig. 1).

Table 1 provides the details of the selected 16 studies [2–5,12–25]. Of these, 11 were performed in Europe (67 %), and the remaining studies were from Japan (3 papers), Australia, India, and China.

12 studies had a single reported case of suicidal hanging resulting in decapitation [2,3,5,12,14,16,17,19,20,22–25], while one study had 2 cases [21]. In two separate studies, 3 and 4 cases were described, respectively [4,9]; therefore, a total of 22 cases were analyzed

The age of the subjects ranged from 22 to 59 years, with a mean age of 44.3 years. It is noteworthy to mention that in four studies, the age of the subjects was not reported, accounting for a total of 4 cases where information regarding age was not available. In all cases, the victims were male; however, the gender of the victim was not mentioned in two individual cases.

The weight of the subjects ranged from 49 to 144 kg, with an average weight of 76.5 kg. In six studies, the weight of the subjects was not reported.

The fall height from the suspension point to decapitation ranged from 1 m to 18 m with a mean height of 5.5 m (Table 2). In five articles, the descent gap was not described.

In a total of 17 cases, the complete decapitation height at the vertebral level was described. Specifically, decapitation occurred between C1 and C2 in 6 cases (35.3 %), between C2 and C3 in 8 cases (47.1 %), between C3 and C4 in 2 cases (11.8 %), in a single case the section occurred between C4 and C5 (5.9 %), in 1 case between C5 and C6 (5.9 %), in 1 individual case through the C2 vertebra (5.9 %) with consequent fracture, while in 2 cases the section height was not described.

About the suspension medium, in 11 cases, a nylon rope was used (50 %), in 2 cases a hemp rope (10 %), in 3 cases a plastic rope (11 %), in 2 cases a synthetic polymer rope (polyethylene rope and synthetic rope) (10 %), in 1 case a metal rope (4.5 %), in 2 cases, the nature of the medium was not described (10 %), while in 1 case, the medium consisted of a belt (4.5 %).

Table 3 includes the only three studies (11 %) in which radiological investigations were carried out, with CT conducted in a single case [2]

Table 1
The table shows the 16 studies that were selected. For each, the height of fall, the subject's weight, age and country of origin were studied. Major autopsy findings were also reported. Radiological examinations were performed in only four cases.

Author and year	Country	N. case (s)	Age and Gender	Weight	Height of fall into rope	Complete or incomplete and vertebral segment involved	Tool	Additional investigations	Autoptical findings
Ito A, 2023 [12]	Japan	1	50 (M)	81 Kg	18 m	Complete (C2–C3)	Polyethylene rope	–	Full circumferential coarse abrasions; Subcutaneous and intramuscular hemorrhages around the severed edge.
Russo MC, 2020 [2]	Italy	1	38 (M)	70 Kg	8.4 m	Complete (C2–C3)	Nylon rope	CT	Tears of the common carotid arteries; Amussat's sign on the left carotid.
Kanchan T, 2019 [14]	India	1	–	–	–	Complete	Rope	–	–
Byard RW, 2018 [4]	Australia	3	47 (M)	–	3 m	Complete (C1–C2)	Nylon rope	–	–
			55 (M)	–	–	Complete (C3–C4)	Threeply synthetic rope	–	–
			32 (M)	–	–	Complete (C2–C3)	Nylon rope	–	Hangman's fracture (C2).
Leccia C, 2017 [5]	France	1		85 Kg	5 m	Incomplete (C1–C2)	Nylon rope	–	Hemorrhage of cerebellum.
Hejna P, 2013 [15]	Germany	4	29 (M)	105 Kg	7.2 m	Complete (C1–C2)	Nylon rope	XR	Tears of common carotid arteries, internal jugular veins, and vertebral arteries. Hemorrhages at the clavicular origins of the sternocleidomastoid muscles. Simon's sign Th11–L2.
			47 (M)	100 Kg	4.8 m	Incomplete (C2–C3)	Hemp rope	XR	Tears of common carotid arteries, internal jugular veins and vertebral arteries. strain-induced bleeding of both sternocleidomastoid muscles. Simon's sign T11–L2 and L3–L5. Air embolism positive examination.
			54 (M)	86 Kg	5.90 m	Complete (C2–C3)	Plastic rope	–	Fracture of great horns of the hyoid bone and left superior horn of the thyroid cartilage, bleeding of sternocleidomastoid muscles with incomplete avulsion of the left sternocleidomastoid muscle; Tears of the common carotid arteries and jugular veins.; Simone's sign T11-L1; Subendocardial hemorrhages. Air embolism.
			27 (M)	95 Kg	6.50 m	Complete (C1–C2)	Plastic rope	–	Tears of the carotid arteries and internal jugular veins. Air embolism examination.
Hayashi T, 2012 [16]	Japan	1	38 (M)	49 Kg	1 m	Complete (C4–C5)	Belt	–	Advanced decomposition and putrefaction
Morild I, 2012 [17]	Norway	1	– (M)	109 Kg	–	Complete (C5–C6)	Nylon rope	–	–
Törő K, 2008 [19]	Hungary	1	52 (M)	95 Kg	5.1 m	Incomplete (C2–C3)	Nylon rope	–	Laceration of the spinal cord, dura, muscles, cervical vessels, and nerve. Multiple fractures of the hyoid bone. Break of the superior horns of the thyroid cartilage were broken. Tears at the carotid arteries. Signs of blood aspiration. Acute lung emphysema. Strain-induced bleeding, and hemorrhages under the anterior longitudinal ligament in the cervical region.
Dedouit F, 2007 [20]	France	1	– (M)	74 kg	7.2 m	Complete (C3–C4)	Nylon rope	Skull XR	Tears of the internal Carotid Arteries. –Severance Plane: Marked blood extravasation in wound surfaces. Significant in sternocleidomastoid muscles. Bleeding at clavicular insertion of the right muscle. Laceration of dura and nerves.
Byard RW, 2004 [3]	Germany	1	47 (M)	–	–	–	Long-drop hanging	–	–

(*continued on next page*)

Table 1 (*continued*)

Author and year	Country	N. case (s)	Age and Gender	Weight	Height of fall into rope	Complete or incomplete and vertebral segment involved	Tool	Additional investigations	Autoptical findings
Tsokos M, 2004 [21]	Germany	2	52 (M)	89 Kg	3.5 m	Complete (C2–C3)	Plastic rope	–	Blood aspiration; Lungs acute emphysema; Hemorrhages underlongitudinal anterior ligamentum in lumbar region.
		2	42 (M)	92 Kg	8.1 m	Complete (C1–C2)	Metal rope	–	Blood aspiration. Lungs acute emphysema. Fresh hemorrhages underlongitudinal anterior ligamentum in lumbar region.
Zhu BL, 2000 [22]	Japan	1	59 (M)	54 kg	3.7 m	Complete (C2)	Nylon rope	–	Laceration of cervical vessels, spinal cord and dura, muscles, and nerves.
Rothschild MA, 1999 [23]	Germany	1	47 (M)	144 kg	Shortest fall: approximately 1.8 m. Fall from sliding over the bannister: 2.15 m. Fall from sitting or squatting on the bannister rail: 2.8 m	Complete (C2–C3)	Hemp rope	–	Fracture of hyoid bone, break of both superior horns of the thyroid cartilage. Tears of carotid arteries. Extravasation of blood on the entire severance plane. Strain-induced bleeding at clavicular insertions of both sternocleidomastoid muscles. Transversely rupture of ventral aspect of Th4.
Tracqui A, 1998 [24]	France	1	22 (M)	87.5 kg	3.70–5.30 m	Complete (C1–C2)	Nylon rope	–	Sharp decapitation wound with circumferential skin abrasion and cervical spine transection at C1–C2. Break of superior horns of the thyroid cartilage, hyoid bone, and epiglottis.
U Raja Senior registrar, 1997 [25]	United Kingdom	1	59 (M)	–	1.5 m	Complete	Nylon rope	–	Carotid blood spurt marks near the body.

Table 2
The table summarizes the average data regarding age, weight, and height of the fall. For each item, the maximum and minimum values are also shown.

	Age (years)	Weight (kg)	Height of fall (m)
Maximum	59	144	18
Minimum	22	49	1
Mean	44.3	75.6	5.5

Table 3
The table shows the only three studies in which radiological investigations were carried out. Only XR and CT were performed, and the main findings are reported for each examination.

	Fall of height	RX	TC	Radiological findings
Dedouit F, 2007 [20]	74	Skull	–	Air in the meningeal spaces, in both lateral and third ventricles.
Russo MC, 2020 [2]	70	–	Whole body	Complete neck transection, at the C2–C3 level along an oblique line through the laryngotracheal junction. C2 was intact and continuous with the atlas. Clockwise rotation of C2 on C1 (30 degrees)
Hejna P, 2013 [15]	105	Skull and chest	–	Air in the meningeal spaces and in both lateral and third ventricles. The severance plane was between the first and second cervical vertebrae. Air embolism, pneumomediastinum.
	100	Skull and chest	–	Air in the meningeal spaces, surrounding the cerebral circumvolutions, in the third and lateral ventricle. Air embolus in the right atrium and ventricle.

while X-ray imaging was performed in three cases [15,20]. In two out of three cases, the authors performed a joint x-ray of the skull and chest. In all cases where X-ray imaging was performed, air in anomalous locations, such as in meningeal spaces and ventricles, in the right atrium, and in the ventricle of the heart was noted.Table 4..

In 17 cases, collateral pathological findings were described (77.2 %). Amussat's sign was described in only one case (4.5 %). In a single case, decapitation was attributed to advanced decomposition and putrefaction (4.5 %) [16].

4. Discussion

As reported in the forensic literature, decapitation can occur in hangings with elevated fall gaps and requires the complete suspension of the body [2]. In this sense, the potential for decapitation depends on various factors, including the weight of the deceased and the elastic properties of the material of the ligature.

According to the cases extracted from the review of the literature, the distance ranged from 1.5 m to 18 m. In the case reported in this article, the fall distance was greater than 5 m, as the rope was 5 m long. The average weight of the bodies was 76.5 kg, with weights ranging from 54

Table 4
The table summarizes cases of complete and incomplete decapitation based on the rope used. The average height of the subjects and the average fall height (compared to the number of those cases) are also reported.

Material	Complete	Incomplete	Mean Weight (Kg)	Mean Height (m)
Nylon	7	2	84.9	5.1
Plastic/ polyethylene	4	0	89.2	8.5
Hemp	1	1	100	3.7
Metal	1	0	92	8.1
Belt	1	0	49	1

kg to 109 kg [16]. The case presented in this article involved a male subject weighing approximately 85 kg, higher than the average reported in the literature, who fell from a considerable height; therefore, the kinetic energy amounted to approximately 4250 J, while the intrinsic force of the body was 833 N. Hejina et al. [9] described 3 cases of hanging (two complete and one incomplete) of three subjects weighing more than 80 kg (respectively 105 kg, 100 kg, and 86 kg). Essentially in the case of suicidal hanging, all the force of gravity released by the body is discharged in the cervical area.

Regarding the plane of the cut, in the case reported in this article, decapitation occurred along an oblique plane passing between C2 and C3, which aligns with the review of cases reported in the literature, as it is the most frequently affected region. Generally, the section point is found in correspondence with the first three cervical vertebrae, more rarely reaching the level of C5-C6. Only Morild et al. [17] described a case of decapitation after hanging in a subject weighing approximately 109 kg who had hanged himself using a nylon rope.

In the case reported in this article, examination of the cervical region revealed the presence of a ligature mark which was located on the anterior cervical region of the body and the occipital region of the head, below and above the plane of the cut, respectively. This indicates that the skin mark resulting from compression of the neck does not necessarily coincide with the severance plane, a finding documented in other cases as well with overlapping features [2–5,12–15,17–25].

This phenomenon can be attributed to two or more loops of cord around the neck, where the tightness of the loop lacerates the tissues, following its path and intersecting the groove. In the presented case, a "double track" appearance on the anterior side indicates at least two loops, where the tightness of the uppermost loop has led to the severing of the cervical tissues. Additionally, a mechanism related to the movement and the material of the cord can be hypotized. In fact, in case of rigid and inelastic tissue as metallic cord, the cord tension with the friction and gravity, acting in different directions, could result in a cutting plane and groove that do not perfectly coincide.

The methods of execution, primarily hanging, have shown variations in fall height and vertebral decapitation level. Notably, different types of ropes have been employed as a suspension medium; in the presented case, a rigid material such as a jute rope used for truck towing was utilized. In the case of ropes with more elastic media (plastic/polyethylene), a higher average weight was recorded, albeit by a few kilograms, compared to more rigid materials (nylon, metal), in which decapitation can be achieved with lower weights and heights of fall. Not much can be said about the use of metal strings, where the only case described in the literature by Tsokos et al. [21] shows a 92 kg subject hanged from a height of 8.1 m. This weight and height, compared with the average values of other types of ropes, are still sufficient to cause decapitation.

Regarding the use of the belt, Hayashi et al. [16] present a case of decapitation by hanging in a subject weighing 49 kg and 1 m tall. Considering the low weight and height, it is believed that the decapitation is not strictly related to the hanging mechanism, but rather to the advanced state of putrefaction in which the corpse was found.

Neck dissection often reveals bleeding in the soft tissues near the decapitation line and at the clavicular origins of the sternocleidomastoid muscle. Other signs of vitality include fractures of the hyoid bone and/or the upper horns of the thyroid cartilage, multiple tears in the intimal layers of the carotid arteries and jugular veins, and the presence of signs such as Simon's bleeding in the lumbar region of the vertebral column While in the case reported in this article both Amussat's and Simon's signs were both observed, in the reviewed cases Amussat's sign was described only by Russo [2] in a case of a subject who hanged himself from a height of approximately 8.4 m. The infrequency of this sign in cases of decapitation may be due to the violent impact of the rope used, which favors the tissue-cutting mechanism over the stretching mechanism. Similarly, Simon's bleeding in the anterior aspect of the intervertebral discs of the lumbar region, which is considered a sign of vitality, has rarely been described in the literature [15]. This significant sign indicates that the subject was still alive at the time of the traumatic event. However, its absence does not exclude the subject's vitality, which is also determined thanks to hemorrhagic extravasations in the other muscular structures.

Overall, the comparison of the presented case with previously published cases highlights the variability of the conditions and evidence in cases of suicidal hanging resulting in decapitation, where a high body weight, a high fall height, and the use of rigid materials are frequently observed. Although a ligature mark can be generally recognized, when this is absent or undetectable the dynamics of decapitation may be unclear. Additionally, the study of pathological signs, such as hemorrhagic infiltration of the soft tissues of the neck, Amussat's and Simon's signs can suggest the vitality of the act and ultimately distinguish between suicidal hanging and post-mortem suspension of the body.

5. Conclusion

A complete crime scene investigation and a thorough post-mortem examination are crucial in the reconstruction of the event, especially in the presence of confounding elements. Careful evidence collection and comparison with the literature are mandatory to achieve the comprehension of the case and support the forensic pathologist's hypothesis in court.

In conclusion, this systematic review provides a comprehensive overview of the characteristics and variables associated with suicidal decapitation by hanging. Its relevance to clinical and forensic practice suggests the importance of further studies and investigations to address this complex and delicate issue.

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Conflicts of interest

All Authors declare no conflict of interest.

Authors' contribution

All authors contributed to the study conception and design. Material preparation, data collection and analysis were performed by LT, ACC and AMM. CG, PF, RS and EM provided the medico-legal reports and clinical charts the case and for Review. Prof. ML coordinated the drafting of the article. All authors read and approved the final version of the manuscript.

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