

# Comprehensive Exploration of the Forensic Value of Ligature Marks in Hanging Cases: A Detailed Case Series Analysis

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## Abstract

The Forensic expert frequently confronts cases involving suicide deaths by hanging, which is a prevalent method of suicide in India and poses a significant public health challenge. The diagnosis of hanging as a cause of death typically relies on the presence of ligature marks around the neck. However, determining the cause of death as asphyxia or hanging requires a comprehensive approach, including both external and internal examination. This detailed analysis is essential, particularly when the possibility of homicide arises, as it can be difficult to distinguish between suicidal and homicidal hanging.

**Aim:** To establish that the diagnosis of suicidal hanging can be conclusively determined through- Ligature marks - The physical evidence on the neck, Circumstantial evidence - Supporting information from the surrounding context, which can help confirm the cause of death as suicide.

**Case Analysis:** Four distinct cases of hanging are presented, each with unique features that require deeper investigation. These cases involve individuals with varied psychological backgrounds. Autopsy findings consistently indicated that asphyxia was the primary cause of death. However, in some cases, the circumstances raised suspicion about the possibility of homicide, requiring further investigation.

**Discussion:** In-depth exploration of four cases of hanging deaths, the role of ligature marks, psychological factors, circumstantial evidence and homicide suspicious, the importance of internal examination, and the role of forensic experts in suicide and homicide differentiation.

**Conclusion:** The research emphasizes the importance of meticulous documentation and the integration of psychological autopsy, and accompanying injuries provide a structured framework for understanding the circumstances.

**Keywords:** Ligature mark, Hanging, suicidal hanging, Asphyxial death, Ligature Points.

## Introduction :

Do ligature marks and signs of asphyxia alone confirm a case of suicidal hanging ? Hanging is a type of death resulting from a ligature around the neck, in which the body's weight acts as an obstructing and constricting force, preventing oxygenated blood from reaching the brain or air from reaching the lungs. In contrast, strangulation involves a ligature around the neck where the constriction force is not solely due to

the body's weight [1]. Suicide is a significant public health concern worldwide, and hanging is one of the most prevalent methods of suicide, particularly in countries like India. The act of hanging, often associated with mental health issues such as depression, anxiety, and overwhelming life stressors, leads to asphyxia, which is the primary cause of death in such cases. National Crime Record Bureau's 2022 - there is a surge in suicidal rates with male suicide rates surpassing female rates [2]. However, despite the commonality of hanging as a method of suicide, forensic experts often face the challenge of distinguishing between suicide and homicide in cases involving hanging. This is because the circumstances surrounding a hanging death, such as the location, type of ligature used, and the positioning of the body, can sometimes suggest foul play rather than self-inflicted injury.

## Case Presentation

### Case 1:

A deceased male of 61 years, was brought for post-mortem examination at AIIMS Rishikesh. According to information provided by a distant relative, the deceased was asleep on the day of Holi and did not wake up for an extended period after consuming food. Concerned co-occupants notified the employer. He was transported directly to the AIIMS Rishikesh mortuary via ambulance. The police were notified by mortuary staff. Subsequently, the police investigated the case, and an inquest paper was presented on the same day, indicating an initially unsuspecting death. "Information as per the inquest paper: The deceased died at home and was brought to AIIMS Rishikesh mortuary to determine the cause of death.

The information acquired from relatives: Following food consumption, the individual was asleep, and despite attempts to awaken, he remained unresponsive. Further inquiry revealed marks on the neck, attributed to an injury sustained while lifting heavy stones at work a week prior. On postmortem examination: Cloths were examined; no stains were evidenced, and the mouth was partially opened with evidence of cyanosis. Drooling of saliva was evidenced at the right angle of the mouth, there was seminal discharge. Hypostasis over the back, rigor mortis present throughout, and no signs of decomposition. There was no ligature material present during the autopsy examination. On inspection of the neck: ligature mark details as mentioned in the column above. Nail marks are present around the ligature. On palpation: A parchment area is present in two places. Internal examination: all visceral organs were within normal limits and congested. The cause of death was given as asphyxia.



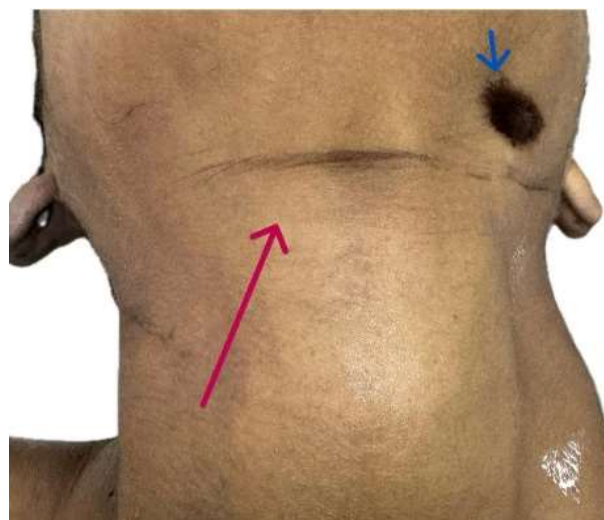
**Figure 1: Evidence of ligature mark in external examination in a case of concealed hanging**

**Case 2:** Deceased female of 48 years with the history of hanging (from a ceiling fan) received for post-mortem examination at AIIMS Rishikesh. Findings as described in table. Opinion given as antemortem hanging.



**Figure 2: Faint ligature mark**

**Case 3:** Deceased of 31-year female, with the history of sudden illness at home, admitted to hospital, diagnosed as chronic drug abuser, received for post-mortem examination. On examination, a thin line of “ligature mark” was evidenced across the front of the neck; on further inquiry revealed hanging at home; on examination, features of asphyxia were present. opined as antemortem hanging.



**Figure 3: Thin line of ligature mark with abrasion (red arrow).**

Case 4: Deceased of 45- year male, with the history of hanging received for PM examination; findings are mentioned in the table, opined as asphyxia due to antemortem hanging.



**Figure 4: Evidence of ligature mark with the knot below chin**

## Discussion

The study provides an in-depth exploration of four cases of hanging deaths, highlighting the complexities involved in distinguishing between suicide and homicide in Forensic investigations. While hanging is commonly associated with suicide, various factors must be thoroughly considered during Forensic examination to avoid misinterpretation and ensure an accurate diagnosis.

### Classification of Hanging

**Knot position:** Typical hanging: The knot is positioned at the occiput (back of the head). Atypical hanging: The knot is positioned elsewhere. **Position of the feet:** Complete hanging: Feet are off the ground. Incomplete hanging: Feet or other body parts touch the ground. **Manner:** Suicidal, Homicidal, Accidental, or Judicial hanging [3]. Death in cases of hanging can result from various causes, including Asphyxia, occlusion of neck blood vessels, reflex vagal inhibition of the heart, fracture, and dislocation of cervical vertebrae [3].

### On external examination:

Postmortem staining. Head is usually inclined to the side opposite to that of the knot. Neck appears elongated. Pale face, with occasional congestion. La facies sympathiques, where the ligature knot presses on the cervical sympathetic nerve, the eye on the same side as the knot may be open with a dilated pupil, the other eye is closed with a constricted pupil; this was once believed to be a hallmark. Petechial haemorrhages are absent in typical hanging when the knot is in the front; petechiae may be prominent; if the knot is on one side, sub-conjunctival haemorrhages may be present. Nostrils may show bloody froth. The tongue may be protruded and swollen. Saliva may dribble from the mouth, which may be blood-stained and considered the surest sign of antemortem hanging. The penis may be semi-erect, and semen may be found at the tip. Relaxation of sphincters may result in the escape of urine and faeces [3].

### Internal examination:

The neck is examined after the removal of the brain to create a bloodless field. The ligature mark may show dry, white, and glistening tissues underneath, with scattered haemorrhages. Adjacent muscles might have occasional ecchymosis, and strap muscles may be torn. Amussat's sign, seen in the carotid artery, may be present. Epiglottis and larynx may show petechial haemorrhages. Trachea may be congested and show petechial haemorrhages. Lungs may appear congested, edematous, and exude bloody serum. Abdominal organs may also be congested. Brain may appear normal, congested, or pale. Hyoid bone may show fractures, typically anteroposterior compression fractures. Thyroid gland's superior horns may show fractures from pressure. Vertebral column may show Simon's sign [3].

In partial hanging, the position of the deceased may be completely lying down. In this scenario, the weight of the body is distributed not only on the ligature but also on all points of contact with the ground. This distribution of weight results in less constrictive force on the ligature compared to full hanging, and congestive changes are more pronounced in partial hanging cases.

**Differentiating Hanging from Strangulation:** Hanging typically leads to an oblique ligature mark, located above the thyroid cartilage, while strangulation tends to produce a horizontal mark below the thyroid cartilage. However, the mark could be oblique (as when someone is hanging) if the victim was crushed by a rope while lying down or if the victim was seated when the perpetrator used force to tie a ligature around their neck while they were standing behind them and moving upward and backward [4][5]. The presence of discontinuity in the ligature mark, often caused by clothing or hair, can also point towards hanging rather than strangulation. The suspension peak refers to the point where the noose and the vertical part of the rope are pulled upward away from the skin, considering the weight of the body. This leads to no ligature being left at the back. The presence of a suspension peak is a distinguishing feature of hanging compared to strangulation because in hanging, the weight of the body pulls the noose upward [3].

#### Role of Ligature Mark:

A ligature mark is a type of pressure abrasion on the neck that is brought on by continuous pressure from the ligature. The skin is pale at first but eventually turns yellowish, dry, and parchment-like, resembling a furrow or groove in the tissue [6]. Ligature mark around the neck are the most important and visible sign of hanging and are commonly used to confirm the method of death. However while these marks are indicative of hanging, they alone are not sufficient to definitely determine the cause of death.

In some cases the ligature may leave atypical marks that raise suspicion of other causes of death, such as homicide. For instance a rope or cord used for hanging might be manipulated in ways that could leave injuries inconsistent with suicide. A detailed examination of the ligature, its positioning, and the nature of the marks is crucial for making a proper assessment. Examining the ligature material becomes a crucial component of the autopsy, as the ligature becomes a vital tool in the diagnosis and evaluation of the body. This mark usually extends upward, forth, and backward from the midline of the neck. Before the ligature is removed, the first step is to take a close-up picture [6].

The knot's location and how long the body is suspended after death are some of the variables that affect a ligature mark's characteristics. If there is any material wrapped around the neck, it should always be detailed. This includes specifying the type of material (such as bed sheets, rope, wire, etc.), its colour and composition, the pattern and texture, whether it's intact or cut, any additional material on it, its length, width, and how many layers there are. Other details to note are its strength, circumference, how tight it is, whether there's padding, any signs of it breaking spontaneously, and how it's knotted. The kind of knot needs to be stated, whether it's a reef knot, granny knot, slip knot, or fixed knot [3].



Details should be recorded during the examination, including the ligature mark's location with respect to the thyroid cartilage, its orientation (continuous or interrupted), and its depth in proportion to body weight (deeper markings are associated with larger bodies). Complete suspension typically yields a deeper imprint than partial suspension; thus, the degree of suspension is important as well. Signs of ligature slippage and the presence of fibers in the groove (which can be examined by lifting them with cello tape and observing under a microscope) are also important details to record [3]. If the ligature mark appears as a patterned abrasion, it should be photographed and described in terms of its pattern.

When the ligature mark is present despite the absence of hanging, it may occur shortly after death when a ligature is wrapped around the neck and the body is dragged along the ground, resulting in a mark similar to that of hanging. In infants and obese individuals, skin folds can resemble a ligature mark, especially if subcutaneous fat has solidified due to refrigeration. Additionally, the presence of jewellery or clothing around the neck, swelling of neck tissue during decomposition, or other factors can lead to false marks resembling those of hanging. During autopsy, the external examination of the body, several findings may be observed.

In case no 1, initial suspicion arose from the patient's history; they were discovered deceased in bed in an unconscious state, with no initial mention of a ligature mark on the neck. The autopsy revealed neck marks, prompting the surgeon to inquire about them, and the attendants disclosed a prior injury from a stone sustained a week earlier. Despite further inquiry about a faint ligature mark, the attendants denied any history of hanging, emphasizing that their home lacked a solid structure and ceiling fan. The suspicion of homicidal ligature strangulation was raised by the presence of a ligature mark, the absence of any ligature material, and the method of death (suspicious history with a ligature mark). Ligature marks with many characteristics, one of which is obliquity, which directs us towards suicidal hanging. The ligature mark in our instance is obliquely running and located above the thyroid cartilage. The ligation mark above the thyroid cartilage was noted by Mohammed Musaib et al. (72.09%), Shar (85%), and Saisudheer and Nagraja (88%), among others [7][8]. In hanging, the ligature mark was located above the laryngeal prominence, higher in the neck. The fixed device and the suspension point determine the position of mark's in hanging [9].

One more factor to be seen here is defence wound. Examining the defence wounds on homicidal victims is essential for the autopsy surgeon. It is possible to conclude that the victim was conscious, understood the attack, and offered resistance based on the presence of these injuries [10]. According to the research that Saurabh carried out, 48% of the homicidal victims had defence wounds, indicating that in all of these cases, the victim may have known about the attack right before it happened and had thus endured defence in order to defend themselves. The distinction between homicide, suicide, and accidental death is made easier by the defence wounds [11].

When a victim drinks alcohol right before an attack, their defences are weakened. In the absence of a defence wound, the probability of homicide could not be ruled out. In many situations, it is notable that there are no defence wounds since the victim was unable to defend himself from the attack. This could be the result of an intoxicating effect that prevents the victim from responding to the attack, a single lethal blow, an unexpected attack, or the victim being taken off guard because the perpetrator is a known relative [11]. The ligature mark was surrounded by nail marks, also raised the possibility of homicide. Nail marks near the ligature 'scratch abrasion' over the front of the neck and chin - injuries resulting due to the attempt of the victim to ward off the ligature compression cannot be ruled out [12].

In order to preserve the dignity of the departed individual and their family, it is often common for friends and relatives to conceal both the suicide note and the incident. There is also a misperception that telling the police about a person's history of hanging will unnecessarily cause trouble to their friends and family, even in cases of suspicion where it is unclear whether the person is suicidal or homicidal based on the circumstances and investigation [13].

In the encountered case, there is no extravasation of blood in the neck muscle, no fracture of the hyoid and thyroid cartilage, no defence wound other than the abrasion across the neck, and an oblique ligature. With all of these findings, the cause of death can be opined to a certain extent, that is death is due to asphyxia - produced by the ligature around the neck, still hanging or strangulation can be proved based on the circumstantial evidences.

In case no. 2, there is an absence of a ligature mark. If there is no ligature mark present, it does not rule out the possibility of hanging. The absence of a ligature mark can be due to various reasons such as the use of soft ligature materials like scarves or towels, the entrapment of objects like beards or clothing between the ligature and the skin, decomposition of the body, or pressure applied only to the front of the neck, for example, by a chair [3]. Here ligature material was not brought by the police, there is video evidence of hanging shown by the investigating officer to the autopsy surgeon. After ruling out all the homicidal features, the cause of death is given as antemortem hanging with a suicidal manner.

Psychological factors: Psychological autopsy plays a pivotal role in determining the intent behind hanging [14]. Each of the four cases presented in this study had distinct psychological backgrounds that provided essential clues regarding the victim's state of mind. In case no. 3 a very fine line of ligature was evidenced. It appeared to be a line on the neck fold at first glance, but a thin line of ligature mark was later discovered on the neck extension. There are several needle prick marks on the forearm. A psychological autopsy revealed that the deceased had a history of drug misuse, made several attempts at suicide [15][16]. In this case as well, the families withheld the history of hanging. Suicide risk is most highly correlated with multiple drug use, diagnosis of combined drug and alcohol addiction [15][16].

Circumstantial Evidence and Homicide suspicions: A critical element in forensic pathology is the consideration of circumstantial evidence. In several of the cases studied, certain aspects raised concerns about the possibility of homicide. These included: Inconsistency in location of hanging: For example, if the hanging occurred in an unusual place (such as public space or an area not typically accessible to the deceased), body positioning - if the body was found in a way that was inconsistent with typical suicide hangings, it might raise suspicions of foul play, type of ligature - the use of certain materials or knots that are uncommon in self-inflicted hangings could suggest that someone else was involved.

In case no. 4 evidenced discontinuous ligature mark. With video evidence, all signs lead to the opinion of antemortem hanging. Differentiating between the 'suicidal' and 'homicidal' is crucial since hanging is largely a suicidal act, whereas strangling is primarily a homicidal one [17]. Another crucial factor in characterizing ligature marks of hanging and strangulation is discontinuity along the mark's length. It has been noted by authors that hanging marks seldom encircle the neck entirely. In Strangulation, unless the killer is pulling upwards, there will be no gap in the mark [12][18][19]. However there can be discontinuity along the course of the ligature mark due to interposing cloth, hair, or fingers of the victim in both hanging and strangulation. Although discontinuity is highly suggestive of hanging, its absence does not prove or disprove strangulation. [20].

The role of Forensic experts in suicide and homicide differentiation: Forensic experts must rely on a combination of scientific evidence, psychological analysis, and circumstantial factors to reach an accurate

conclusion. In cases where homicide is suspected, a thorough investigation should include: Interviews with witnesses: to understand the deceased's recent behaviour and any potential threats or interactions with others. Examining the crime scene: to ensure that no evidence points to foul play or tampering. Psychological profile. Challenges in suicide investigations: The challenges of distinguishing between suicide and homicide in hanging deaths underscores the need for a multidisciplinary approach in forensic investigations.

## Conclusions

This study reinforces the need for a thorough and multifaceted approach to the forensic investigation of hanging deaths. Ligature marks, psychological autopsy, and circumstantial evidence are essential components of the investigative process. By carefully considering all these elements, forensic experts can reduce the risk of misdiagnosing suicides and ensure that homicides are not overlooked. Ultimately, this comprehensive framework can enhance the accuracy of forensic conclusions, contributing to better public health responses and justice in cases of suspicious deaths.

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