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Descriptive analysis of suicidal hanging cases in a tertiary care hospital setting: A descriptive study

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Abstract
Backgrounds: When a body is discovered suspended, forensic pathologists are tasked with determining the manner of death, which may involve ruling out or confirming potential criminal involvement. While conclusions are straightforward in cases with classic findings, interpreting atypical findings presents a dilemma. This study aims to analyze autopsy findings in hanging-related deaths to gain insights into both typical and atypical presentations, thus highlighting the challenges in interpretation
Methods: This retrospective descriptive study examines post-mortem records of individuals who died by hanging over a three-year period, as brought to a tertiary care hospital. The analysis focuses on the findings of death investigations, encompassing background information, scene details, and autopsy examinations.
Results: A total of 112 records documenting deaths by suicidal hanging were reviewed, with 97 cases (86.6%) involving male individuals. The largest proportion of victims (37%) fell within the age range of 21 to 40 years. Complete suspension was identified in the majority of cases (79.5%), while coir rope emerged as the most common ligature material (25%). Sixty-nine cases exhibited a ligature mark forming an inverted 'V' shape. Classic signs were present in 47% of cases, with their occurrence significantly linked to partial suspension (p<0.001). Internal injuries, including fractures, were noted in 34% of cases, although their presence showed no significant association with the degree of suspension (p=0.11).
Conclusion: Variations in hanging findings are common, often presenting in diverse combinations and occasionally deviating from established norms. Understanding these variations and exceptions is vital for reaching accurate conclusions in suspected hanging cases, thus mitigating the risk of erroneous opinions.

Keywords: Hanging, ligature material, ligature mark, classic signs, internal injuries, fractures

Introduction
Hanging, a form of ligature neck compression that involves suspension by the neck is a common method of suicide [1]. The role of the forensic pathologist when body is found suspended is to give an opinion on the manner of death and to exclude or confirm other forms of neck compression prior to being hung. Correlation of the neck markings together with the internal findings are of extreme importance in arriving at a conclusion. It is easy to arrive at a conclusion when one finds the 'classical features' i.e. imprint/ patterned abrasion or parched appearance surrounding the neck with asphyxia features [2]. However all features are seldom present together. An autopsy of a hanged body will often reveal neck markings but the ligature may be absent.[1] Findings resulting from application of pressure on the neck quite vary [2]. Thus a Forensic pathologist is caught in a dilemma when there are atypical findings in addition to the typical ligature mark. A proper assessment of various post-mortem findings is therefore necessary to arrive at a conclusion.

The nature of the neck markings depends on the type of noose [1]. According to existing literature, a noose made of soft material like a saree or a scarf is known to leave only a few marks or no mark at all leading to difficulties in interpretation [1]. A rope or a cord noose will leave a deep furrow, often with accompanying abrasions. In the case of a typical suspension the mark will rise to an inverted "V" shape with a gap at the back. This is often used to distinguish a hanging from a ligature strangulation. However, in a hanging from a low suspension point, the marks on the neck tend to be horizontal rather than diagonal simulating ligature strangulation [3].

The pattern of external and internal injuries and other postmortem findings resulting from neck compression permit a Forensic pathologist to resolve many unanswered questions. However, there are many exceptions to the rule with atypical findings [4]. Thus, the experts in Forensic medicine must be aware of the exceptions in-order to arrive at balanced conclusions and scientifically based opinions. In order to have an insight into the typical and atypical findings related to hanging we have conducted a retrospective descriptive study on deaths due to suicidal hanging reported to a tertiary care hospital over a period of 3 years. The aim of the study was to analyze the findings of death investigation including autopsy in deaths due to hanging and to have an insight into the typical and a typical findings and the factors affecting them in order to appreciate the difficulties in interpretation.

Methods

A retrospective descriptive study was conducted on the post mortem records of the victims of hanging during 3 years from December 2014 January 2017 to brought to tertiary care hospital, Bhubaneswar. Autopsy reports, scene and postmortem photographs and other case materials such as copies of the police scene investigation findings were perused. The historical details, scene findings, findings of autopsy external and internal examinations, the results of the post-mortem investigations and the opinion and conclusions given were obtained according to a pro-forma designed to fulfil study objectives. All cases presented as suicidal hanging during the period were included. Bodies that were decomposed, suspicious of homicidal suspension and those with poor records were excluded from the study.

Results

During the period of 3 years, there were 112 cases of suicidal hanging deaths. Of them, 97 (86.6%) were males. Majority; 81 (72.3%) was in the age group of 21-60 years (Table: 1). Majority 78 (69.6%) were found hanging in their own home followed by 32 (28.6%) victims who were recovered from places that were known to the deceased. Only 2 (1.8%) victims were found hanging at an unknown place. There were 23 (20.5%) of partial suspensions and 89 (79.5%) complete suspensions. Problems or stress related to education were the reason for suicide in 44 (39%) victims. 40 (35.7%) had family disputes and 9 (8%) committed suicide due to broken love affairs. There were 8 (7.1%) who had multiple other reasons. Note of suicide was found in only 16 (14.3%) cases.

Table1: Age distribution of the study group

Age group	Frequency
≤20 yrs.	9 (8%)
21-40 yrs.	41 (36.6%)
41-60 yrs.	40 (35.7%)
>60 yrs.	22 (19.6%)
Total	112 (100%)

Sixty one (54.5%) had used a rope (coir (25%) or a nylon (29.5%) as ligature material. Twenty six (23.2%) had used a soft fabric and 12 others had used various other materials including belts (10.7%). Thirteen (11.6%) were brought without a ligature. Majority (102) were having only the imprint of ligature on the neck. While there were 6 having peri-ligature injuries in addition to the ligature mark. There were 4 (3.6%) with no injuries to the neck. The pattern of the ligature mark was continuous in 92 (82%). Twenty (20) out of 26 individuals who had used a soft fabric had a continuous ligature mark. The ligature mark was absent only in four of the victims and two of them were using a soft fabric (Table: 2).

Table 2: The ligature material and pattern of ligature mark

Pattern of ligature mark/ Ligature Material	Intermittent pattern	Continuous pattern	No ligature mark	Total
Soft fabric	4	20	2	26
Coir rope	4	24	0	28
Nylon rope	4	28	1	33
Belt	0	1	0	1
Other	1	10	0	11
Not present	3	9	1	13
Total	16	92	4	112

Ligature mark was rising to an inverted V in a majority 81 (72.3%). However, there were 8 (7.1%) with a horizontal ligature mark and 2 (1.8%) with multiple marks. There were 17 (15.2%) with variable pattern in their ligature mark while 4 (3.6%) were having no ligature mark. The mark was placed high on the neck in 100 individuals. Eighty two (82) out of them were complete suspensions. Out of the 7 individuals with low ligature mark, 4 were partial suspensions. There was a significant difference between the two groups (p=0.018). (Table: 3)

Table 3: The degree of suspension compared to the placement of the ligature mark

Placement of ligature/ Degree of hanging	High on the neck	Lower on the neck	No ligature mark	Total
Partial	18	4	1	23
Complete	82	3	4	89
Total	100	7	5	112

The gap or the point of suspension was found at the back of the neck (center of occiput) in a 52 (46%) while the mark was high on the neck in 51 (98%) out of them. 29 (85%) out of 34 individuals whose knot was found at the side had the ligature mark placed high on the neck.

Out of the 7 low lying ligatures majority were having the point of suspension at the side of the neck. This was a statistically significant finding (p=0.018). (Table: 4)

Table 4: Placement of the ligature and placement of the point of suspension

Placement of ligature/ Placement of gap	High on the neck	Lower on the neck	Other	No ligature mark	Total
Back of the neck (center of occiput)	51	1	0	0	52
Side behind the ear	29	5	0	0	34
Front of the neck	2	0	0	0	2
Other	1	0	1	0	2
No gap	17	1	0	0	18
No ligature mark	0	0	0	4	4
Total	100	7	1	4	112

On the other hand, the degree of suspension did not show any significant association with the type of hanging; typical or atypical (p=0.082) (Table: 5). Classical signs were found in 41 (36.6%) victims. Of them commonly observed classic sign was congestion (29, 25.9%) Twenty six out of 41 had petechial haemorrhages and 11 had oedema. Presence of classic signs showed a statistically significant association to partial suspension (p<0.001)) (Table: 6).

Presence of classic signs did not show any significant association to the placement of the ligature mark (p=0.6592) (Table: 7).

Table 5: Type of hanging with degree of suspension

Degree of hanging/ Placement of gap	Partial	Complete	Total
Typical hanging	7	45	52
Atypical hanging	16	44	60
Total	23	89	112

Table 6: Presence of classic signs with degree of suspension

Classical signs/ Degree of hanging	Present	Absent	Total
Partial	17	6	23
Complete	24	65	89
Total	41	71	112

Table 7: Placement of ligature mark with classic signs

Placement of Ligature/ Classic signs	High on the neck	Lower on the neck	Other	No ligature mark	Total
Present	36	4	0	1	41
Absent	64	3	1	3	71
Total	100	7	1	4	112

Internal injuries were observed in 38 (33.9%) and it was found directly underlying the external injuries in36. Commonly observed internal injuries were fractures (33). Underlying contusions were found among 10 and 2 had haematomas. In a majority, the fractures were placed on the thyroid cartilage & hyoid bone. There is no significant association of the ligature material used with the presence or absence of internal injuries (P = 0.351) (table: 8).

70% of the victims of complete suspension and 52% of the individuals with partial suspension had no internal injuries. Further, there is no significant difference between the two groups; partial and complete suspension concerning presence of internal injuries (p = 0.11) (Table: 9).

Table 8: Ligature material with internal injuries

Internal injury / Ligature Material	Present	Absent	Total
Soft fabric	10	16	26
Coir rope	12	16	28
Nylon rope	7	26	33
Belt	0	1	1
Other	5	6	11
Not present	4	9	13
Total	38	74	112

Table 9: The documents of partial or complete internal injuries

Internal injury/ Degree of hanging	Present	Absent	Total
Partial	11(48%)	12 (52%)	23
Complete	27 (30%)	62(70%)	89
Total	38	74	112

Discussion

In addition to the conventional autopsy findings, death due to hanging can present with various atypical findings. The appearance of ligature marks and other autopsy findings can be influenced by numerous factors. Consistent with findings from other studies, this research unveiled that the majority of hanging-related deaths predominantly involved young to middle-aged males [5]. The study found that the majority (70%) of hanging incidents occurred inside the victims' homes, a trend consistent with findings reported in

numerous other studies [6, 7, 8]. The easy accessibility and secluded environment within homes may contribute to the prevalence of hanging incidents indoors. This finding aligns with research indicating that individuals who survived near-fatal suicide attempts often considered hanging to be an accessible and straightforward method due to the ease of accessing materials and implementing the act [9]. This was further confirmed in our study as well. In this study, the majority (80%) of cases involved complete suspensions, a trend consistent with findings reported in various other studies conducted in India [8, 10, 11, 12]. though there were few studies in which they have found partial suspension as a common presentation [13].

Issues related to education were identified as the primary underlying reason for suicide among the majority of cases (39%), followed by family disputes. It's important to note that risk factors for suicide can vary significantly based on factors such as country, culture, religion, gender, age, and prevailing social values [14]. There is a growing concern surrounding study pressure and its impact on mental health. Research indicates a significant association between academic stress and depression among adolescents [15]. The findings underscore the importance of implementing preventive strategies tailored to address the challenges faced by individuals in highly competitive academic environments in the country. Additionally, research conducted among lower socioeconomic rural populations has identified depressive disorders, other psychiatric conditions, and family issues as major risk factors for suicide [16].

Discovering a suicide note serves as a compelling piece of evidence in determining the manner of death. However, in this study, a suicide note was only found in 16 cases (14.3%). This contrasts with findings from a study conducted in Japan, where the mean incidence of discovering a suicide note was reported to be 30.1% [17]. Cultural, ethnic, and racial factors may contribute to variations in suicidal behavior. In this study, 55% of the victims utilized coir or nylon rope as the ligature material, followed by soft fabric in 23% of cases. This prevalence could be attributed to the easy availability and accessibility of nylon or coir ropes commonly used for domestic tasks in Sri Lanka. Similarly, Vipu and other work. Found that 62% of victims in their study utilized a nylon rope as the ligature material. Additionally, numerous other studies from Asia have reported rope as the most common ligature material [18]. Indeed, there are additional studies that report soft fabric as the most common ligature material, which may indeed reflect cultural variations in suicide methods and materials [19].

In this study, a ligature mark was observed in 96% of cases, with associated peri-ligature injuries noted in 5.4% of individuals. In contrast, Mohammed Musaib M. Shaikh found peri-ligature injuries, such as abrasions, bruises, and rope burns, in 16.28% of cases of hanging [20]. Nail marks observed on the neck can often suggest manual strangulation, potentially leading forensic pathologists to draw erroneous conclusions. However, it's worth noting that these marks can also be self-inflicted by victims attempting to free themselves from the strangling grip of hanging at the last moment [21].

In 82% of cases, the pattern of the ligature mark was continuous. Interestingly, even among individuals who had used a soft fabric, the majority still exhibited a continuous ligature mark. Only 4 victims had an absence of a ligature mark, with 2 of them using a soft fabric. However, studies comparing the pattern of the ligature mark with the ligature material are scarce [19, 22, 23] Our study revealed that there is no significant correlation of the pattern of the ligature mark to the ligature material.

In our study, the ligature mark was detected high on the neck in 100 individuals, with 72% of them exhibiting a rising pattern forming an inverted "V" shape. We observed a statistically significant association between complete suspension and a high ligature mark. This finding aligns with other studies, where partial suspension is frequently linked with a low ligature mark. The presence of a high and rising/oblique ligature mark has been identified as a distinguishing feature of hanging compared to ligature strangulation, as consistently demonstrated in numerous studies [20].

In our study, the ligature mark was observed to rise towards the point of suspension or the knot was found at the back of the neck (typical hanging) in 46% of cases, followed by behind the ear in 30%. Thus, the majority fell into the category of atypical hanging where the knot is not located at the back of the neck. This observation is commonly described in many other studies as well [2, 25]. Our study revealed a significant association between the placement of the point of suspension (back, front, or side) and the placement of the ligature mark on the neck. Specifically, a high ligature mark was found to be associated with the point of suspension at the back, while a low-lying ligature mark was associated with the point of suspension at the side. However, there was no significant association between the degree of suspension and the placement of the knot. These findings are consistent with many other studies that have reported the majority adopting complete and atypical hanging methods [26].

The majority of victims did not exhibit classic signs (63%), with congestion being the most commonly observed followed by petechial hemorrhages. Classic signs were notably absent in the majority of complete suspensions, whereas they were more commonly observed in partial suspensions, showing a statistically significant association (p<0.001). Classic signs are attributed to purely mechanical vascular phenomena or obstructed venous return in the presence of continued arterial input. As pressure increases in venules and capillaries, particularly those with minimal surrounding connective tissue support like the conjunctivae and eyelids, vascular rupture leads to the formation of petechiae [27]. Indeed, in partial suspensions, where the veins are adequately obstructed while arterial supply continues, classic signs are theoretically more commonly observed. However, there is limited scientific evidence available to fully support this finding. Further research in this area could provide valuable insights into the prevalence and mechanisms underlying classic signs in hanging cases with different degrees of suspension [28]. Our study confirmed the theoretical assumption and demonstrated a significant difference in the presence of classic signs between partial suspensions and complete suspensions. However, the placement of the ligature mark, whether high or low, did not show any significant association with the presence of classic signs. Internal injuries were largely absent in the majority of cases, but when present, they were typically found directly underlying the ligature mark. The most common type of

internal injury observed was fractures, particularly involving the thyroid cartilage or hyoid bone. This finding contrasts with other studies where internal injuries, often soft tissue contusions, were more commonly observed [29]. As the study was conducted retrospectively, it's important to acknowledge the possibility of handling artifacts during evisceration and potential challenges in ensuring proper documentation and discrimination. This underscores the necessity for a prospective study to address these limitations. Additionally, our findings revealed no significant statistical association between the presence or absence of internal injuries and the type of suspension (partial or complete) or the ligature material used. Similar observations have been reported in other studies as well [30].

Conclusion

Correctly interpreting autopsy findings in cases of hanging is crucial for accurately diagnosing death due to hanging. Our study demonstrated that these findings can vary and manifest in various combinations, sometimes diverging from commonly accepted norms. It's essential to be aware of these variations and exceptions to ensure accurate conclusions in suspected hanging cases and to avoid erroneous opinions. While our findings often aligned with existing literature, there were some contrasts noted, particularly regarding the type of internal injury. This discrepancy was identified as a limitation inherent in retrospective studies, where handling artifacts may influence results. Therefore, further prospective research is warranted to validate these findings and minimize such limitations.

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