

ORIGINAL RESEARCH

To examine the characteristics of ligature marks and their potential correlation with the manner of death

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ABSTRACT

Aim: To examine the characteristics of ligature marks and their potential correlation with the manner of death. **Materials and methods:** The current investigation was conducted within the Department of Forensic Medicine. A total of 100 cases were selected for inclusion in this prospective study. Comprehensive data pertaining to the deceased individual and the circumstances surrounding their demise was obtained through collaboration with law enforcement authorities and close family members. In certain cases, this information was augmented through either on-site visits to the scene of occurrence or through the examination of photographs depicting the scene of occurrence. **Results:** In the present study it is observed that complete suspension were noted in 80 cases (80%) as compared to 20cases (20%) of partial suspension. Atypical ligature mark was noticed in 85 cases (85%) as compared to typical ligature mark in 15 cases (15%). In the present study in 56cases (56%) soft ligature material like lungi, duppatta, saree etc. were used and in 44 cases (44%) hard ligature material like nylon rope in 15 cases, electric cord in 3 cases, coir rope in 22 cases, plastic binder in 1 case. In the present study it is observed that in 95 cases (95%) there was no fracture the thyroid cartilage and only in 5 cases (5%) there was a fracture of the superior horn on the left side of the thyroid cartilage. In the present study in 96 cases (96%) no fracture was detected and only in 4 cases (4%) showed fracture of the greater cornu on the right side of the hyoid bone. **Conclusion:** The presence of atypical ligature marks, characterized by complete hanging, contrasts with the more common occurrence of typical ligature marks, which involve partial hanging. In instances of complete hanging, prominent ligature marks are typically observed.

Keywords: Ligature marks, Death, Hanging, Knot

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INTRODUCTION

Hanging is a type of asphyxia that occurs when the body is suspended by a ligature that encircles the neck, with the constriction resulting from the weight of the body [1]. Occasionally, hanging is employed as a final recourse when alternative methods of self-inflicted death, such as poisoning or throat laceration, have proven ineffective in achieving the intended outcome. The contemplation of engaging in self-hanging may arise either gradually or spontaneously. Hanging is a frequently employed method in cases of suicide-related deaths in India. In the year 2012, a total of 800,000 suicide cases were documented globally, with India alone accounting for 134,600 cases. Among these cases, 41,726 individuals (31%) were identified as victims of hanging. Therefore, it was determined that hanging emerged as the second

most prevalent cause of suicide-related fatalities in India during the year 2012. The predominant factor leading to mortality is pesticide ingestion. The identification of the "mark of hanging" on the victim is contingent upon several factors, including the height at which the suspension point is located, the characteristics and composition of the ligature material employed, the weight of the body, the duration of the suspension, and any intervening objects between the ligature material and the skin of the neck. The accurate determination of the cause and manner of death in such cases necessitates the expertise and meticulousness of skilled professionals. The presence of multiple iterations of ligature tightly encircling the neck, featuring two or more securely fastened knots, necessitates careful consideration in the process of determining the cause and manner of

death. Additional injuries to the neck region, as well as bodily injuries in general, have the potential to further complicate this assessment. Therefore, the presence of a ligature mark is of significant importance when it comes to the diagnosis and assessment of a deceased individual. Therefore, the analysis of ligature material and marks is an essential component of the autopsy process. The process of ligature results in the formation of a visible indentation or groove in the tissue. Initially, this mark appears pale in color but gradually transitions to a yellow or yellowish-brown hue. Over time, the affected area becomes dry and acquires a hardened texture, resembling parchment. This transformation is attributed to the drying of the slightly abraded skin. Occasionally, the presence of blood and serous fluid exudation is also observed. As time elapses, the furrow undergoes desiccation and assumes a brownish grey hue. The visibility of a ligature mark is enhanced in instances where the ligature is of a narrow nature and composed of a rigid material. The duration of suspension is directly correlated with the visibility of the ligature mark. The visual distinction between reddish and paler bands of skin can be enhanced through the application of appropriate photographic techniques. Therefore, the technique known as "bracketing" or color saturation [3] is employed, wherein multiple photographs are captured at various intervals until the autopsy is concluded. Typically, a single line or mark is observed. However, it is worth noting that in certain instances of spiral turns, multiple marks may also be observed, as well as multiple turns around the neck or the upward displacement of material following application resulting from a fall. In the majority of instances, the mark is located superior to the thyroid cartilage, positioned between the larynx and the chin, and typically exhibits an oblique orientation. The mark exhibits an upward orientation, running parallel to the mandible line. It is not fully formed at the posterior end and displays an indistinct impression of the knot where it is typically suspended, commonly at the mastoid process of one side. In instances of partial hanging, it is possible for a mark to be observed either on or beneath the thyroid cartilage. If a ligature is wrapped around the neck multiple times, the resulting mark will exhibit a circular and oblique shape. A mark in the shape of an inverted "V" is observed in close proximity to the knot [4,5]. The identification of hanging and ligature strangulation can be facilitated by the presence of characteristic features. However, it is rare for all features to be present simultaneously. The act of applying pressure to the neck frequently leads to outcomes that exhibit considerable variability. Hence,

it is imperative to conduct a comprehensive evaluation of diverse post-mortem observations in such situations. In addition to the customary ligature mark, there are instances of unconventional ligature marks that elicit considerable intrigue in the autopsy surgeon's routine postmortem examination.

MATERIALS AND METHODS

The current investigation was conducted within the Department of Forensic Medicine. The study received approval from the institutional ethical and research committee. A total of 100 cases were selected for inclusion in this prospective study. Comprehensive data pertaining to the deceased individual and the circumstances surrounding their demise was obtained through collaboration with law enforcement authorities and close family members. In certain cases, this information was augmented through either on-site visits to the scene of occurrence or through the examination of photographs depicting the scene of occurrence. This study encompassed all cases that were associated with a historical record of hanging. The study excluded decomposed cadavers in which the ligature mark was concealed. The hanging victims were classified on various characteristics as follows: Type of suspension: Complete and Partial. Type of ligature mark produced: Typical and Atypical.

The autopsy encompassed both external and internal examinations of the deceased individual, allowing for comprehensive observations to be made. The ligature material was examined when it was in its original position. The ligature materials were categorized into two distinct groups, namely hard ligature materials and soft ligature materials. Various types of materials, such as ropes and metallic chains, were regarded as being characterized by a high level of hardness. Traditional Indian garments such as saree, dupatta, lungi, and towel have historically been regarded as materials suitable for use as soft ligatures. An examination of the neck was conducted in order to study the ligature mark(s). The skin covering the ligature mark was submitted to the Department of Pathology for histopathological analysis in order to determine whether the mark was formed before or after death.

RESULTS

It is observed from the table 1 that maximum number of hangings in the study population are seen in the age group 20-30 years (35%) followed by 10-20 years (26%) and 30-40 years (24%). In the sex distribution pattern males accounted for 60 cases (60%) as compared to 40 cases (40%) in females. (Table 1)

Table 1: Gender and age of the cases

Sex	No. of cases	%
Male	60	60
Female	40	40
Age (years)		

10-20	26	26
20-30	35	35
30-40	24	24
40-50	10	10
50-60	4	4
> 60	1	1

The influencing factors for the above distribution being unemployment, love disappointment, marital disharmony, financial problems, dowry harassment etc. In the present study it is observed that complete suspension were noted in 80 cases (80%) as compared to 20cases (20%) of partial suspension. Atypical ligature mark were noticed in 85 cases (85%)

as compared to typical ligature mark in 15 cases (15%). In the present study in 56cases (56%) soft ligature material like lungi, duppatta, saree etc. were used and in 44 cases (44%) hard ligature material like nylon rope in 15 cases, electric cord in 3 cases, coir rope in 22 cases, plastic binder in 1 case. (Table 2)

Table 2: Degree of Suspension, Ligature mark and Materials used

Degree of Suspension	No. of cases	%
Partial	20	20
Complete	80	80
Ligature mark		
Typical	15	15
Atypical	85	85
Materials used		
Soft	56	56
Hard	44	44

In the present study it is observed that in 30 cases (30%) the knot was in the right occipital region, in 22 cases (22%) it was below the right ear, in 21 cases (21%) it was in the left occipital region, in 17 cases (17%) occipital knot, in 9 cases (9%) below the left year and in 1 case (1%) below the chin. Right and left

and occipital positioning of knot were considered as posterior hangings, knot marks on the left and right anterior aspect of the neck below the ears were considered anterior hangings. In 56 cases (56%) running noose with a slipping knot were used and fixed knot in 44 cases (44%).(Table 3)

Table 3: Position of the knot and types

Position of the Knot	No. of victims	%
Right occipital	30	30
Below the right ear	22	22
Left occipital	21	21
Occipital	17	17
Below the left ear	9	9
Below the chin	1	1
Type of knot		
Slipping	56	56
Fixed	44	44

In the present study it is observed that in 95 cases (95%)there was no fracture the thyroid cartilage and only in 5 cases(5%) there was a fracture of the superior horn on the left side of the thyroid cartilage.

In the present study in 96 cases (96%) no fracture was detected and only in 4 cases (4%) showed fracture of the greater cornu on the right side of the hyoid bone. (Table 4)

Table 4: Fracture of thyroid cartilage and Hyoid bone

Fracture of thyroid cartilage	No. of victims	%
Present	5	5
Absent	95	95
Fracture of Hyoid bone		
Present	4	4
Absent	96	96

DISCUSSION

A comprehensive and thorough examination of the ligature mark in cases of hanging is necessary. A systematic approach involving inspection, palpation,

internal examination, and subsequent histopathological examination is necessary. The characteristics and composition of the ligature material, as well as the method of hanging (complete

or partial), are important factors in establishing a connection between the observed evidence and the specific cases under investigation. In the majority of cases, the partial examination or omission of certain trivial yet significant findings can result in the generation of incorrect and inconclusive evidence, subsequently leading to confusion (6).

The study population exhibits the highest frequency of hangings within the age bracket of 20-30 years (35%), followed by 10-20 years (26%) and 30-40 years (24%). In terms of sex distribution, there were 60 cases (60%) attributed to males, while females accounted for 40 cases (40%). The aforementioned distribution is influenced by various factors, including unemployment, romantic disillusionment, marital discord, financial difficulties, and dowry harassment. The aforementioned studies conducted by B.K. Sen Gupta [7], Gary. P. Paparo and Siegel. H[8], Andrew Davison and Marshall T.K.[9], Ryk James and Paul Sillock s[10], A. Momonchand, et al[11], and G.A. Sunil Kumar Sharma et al[12] yielded similar findings. The results observed by James L. Luke [13] and David A.L.L Bowen [14] present a contrasting perspective. These studies were conducted in developed countries characterized by abundant employment opportunities, a westernized culture, and well-established governmental support programs.

The current study reveals that a total of 80 cases (80%) exhibited complete suspension, while 20 cases (20%) demonstrated partial suspension. A total of 85 cases (85%) exhibited atypical ligature marks, while 15 cases (15%) displayed typical ligature marks. The aforementioned observations exhibited similarities to the findings documented by Andrew Davison and Marshall T.K.[9] In the academic literature, several authors have contributed to the discussion on the topic at hand. Notably, Jorn Simonson [15], Elfawal M.A et al [16], and Feigin Gerald [17] have made significant contributions to the field.

The primary determinants of this study's population composition were adult individuals who had engaged in suicidal behavior, resulting in a higher prevalence of complete hanging cases. The atypical nature of the majority of the mark can be attributed to the positioning of the knot or any intervening object, such as clothing, bony projections (such as the angle of the jaw), long plaits in Indian women, and also the presence of a beard. In contrast to the findings reported by Paparo [9], Morild [18], and Jonathan et al. [19], the present study yields different results. The individual referred to as Balabantaray J.K [20]. The study population was limited to individuals in the lower age group who had experienced accidental or homicidal hanging.

In the current investigation, it was observed that soft ligature materials such as lungi, duppatta, and saree were utilized in 56 cases, accounting for 56% of the total sample. In contrast, hard ligature materials, including nylon rope (15 cases), electric cord (3 cases), coir rope (22 cases), and plastic binder (1

case), were employed in 44 cases, representing 44% of the sample. The studies conducted by G.A. Sunil Kumar Sharma et al. [12], Jitendra .K. Balabantaray [20], and B.K. Sen Gupta [7] yielded comparable results. The individual who engages in suicidal behavior utilizes ligature materials that are readily accessible and easily obtainable. The findings reported by Jonathan P. Wyatt et al. [19] and Feigin Gerald [17] present a contrasting perspective. These studies highlight the utilization of various materials such as dogs lead, dressing gown cord, electric cable, suit case webbing, telephone cord, shoe strings, and bath robe belt as ligatures.

The current study reveals that the knot was located in the right occipital region in 30 cases (30%), below the right ear in 22 cases (22%), in the left occipital region in 21 cases (21%), occipital knot in 17 cases (17%), below the left ear in 9 cases (9%), and below the chin in 1 case (1%). The positioning of the knot on the right and left sides, as well as at the occipital region, was regarded as indicative of posterior hangings. Conversely, knot marks observed on the anterior aspect of the neck, specifically below the ears on both the left and right sides, were considered characteristic of anterior hangings. In 56 instances, a running noose with a slipping knot was employed, accounting for 56% of the cases. Conversely, a fixed knot was utilized in 44 cases, representing 44% of the total. The studies conducted by Nicolic Slobodan et al[21], Betz P. and Eisenmenger.W.[22], and Jorn Simonson[15] yielded comparable results. Jitendra K. Balabantaray is a researcher mentioned in reference [20].

The current study reveals that out of a total of 100 cases, 95 cases (95%) did not exhibit any fracture in the thyroid cartilage. Conversely, only 5 cases (5%) displayed a fracture specifically in the superior horn on the left side of the thyroid cartilage. The individuals affected by the incident were found to be in their fourth and fifth decades of life. There are several factors that contribute to the complete suspension of the victim, including the progressive ossification that occurs with age, particularly after the age of 30. Additionally, the pressure exerted on the spine due to increased traction on the horns is another significant factor. The studies conducted by Nikolic Slobodan et al. [21], Betz P. and Eisenmenger S. [22], Feigin Gerald [17], and Jitendra Balabantaray [20] yielded comparable results. H. Green and colleagues [23], Ryk James [10], Jorn Simonson [15], and Gary P. Paparo.[8]

In the current study, it was observed that out of the 96 cases examined, no fractures were detected in 96% of the cases. However, in only 4% of the cases, fractures were observed specifically in the greater cornu on the right side of the hyoid bone. The age of the victim exceeds 60 years. The incidence of fractures tends to rise in correlation with advancing age, particularly in cases involving typical and complete hanging. This is often observed in instances where there is a pronounced ligature mark on the posterior aspect of

the neck, a prolonged period of suspension, and the use of a taut and rigid ligature material. The studies conducted by A. Momonchand et al[11], Ryk James[10], C.B. Jani and B.D.Guptha[24], M.P. Sarangi[25], Betz.P. and Eisenmenger.S.[22], Nikolic Slobodan et al[21] and Feigin Gerald[17] yielded similar findings.

CONCLUSION

The presence of atypical ligature marks, characterized by complete hanging, contrasts with the more common occurrence of typical ligature marks, which involve partial hanging. Posterior knot positioning was frequently utilized in conjunction with soft ligature materials, with the slipping knot being the prevailing type of knot employed. In instances where a narrow and resilient or rigid ligature material is utilized, an identifiable indentation or groove of the same dimensions and design as the ligature material can be observed. In instances of complete hanging, prominent ligature marks are typically observed. When employing ligature materials that are softer and more expansive, a less prominent mark becomes apparent. External observations of antemortem hanging, such as the presence of dribbling of saliva and Le facie sympathique, were made. In certain instances, the skin containing the ligature mark was subjected to histopathological analysis. However, the findings did not provide conclusive evidence regarding the origin of the ligature mark, whether it occurred before or after death. The analysis of deaths resulting from hanging revealed that all cases were determined to be suicides based on a comprehensive examination of historical records, circumstantial evidence, ligature material analysis, and specific characteristics of the ligature marks. These characteristics include a single, interrupted, oblique mark located above the level of the thyroid cartilage, along with evidence of ligature mark slippage. Additional factors taken into consideration were periligature injuries and internal findings observed during the dissection of neck tissues.

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