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Original Research Article

A Prospective Study of Pattern of Ligature Marks and its Correlation with the Manner of Death

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Abstract

Introduction: Hanging is a common method of suicide, though it can also be accidental or homicidal, especially in dowry cases. Ligature marks play a crucial role in determining the cause of death, with variations in their characteristics based on the ligature used, bodily weight, and suspension time. This study aims to examine ligature patterns, improving postmortem accuracy in identifying ligature-related deaths.

Methods: The study, conducted From July 2021 to June 2023 at Hind Institute of Medical Sciences, Sitapur, Luknow. Examined 30 hanging-related deaths after receiving ethical approval. 30 patients data were gathered from family, police, and scene visits. Patients were categorized by suspension type (complete or partial) and ligature marks (typical or atypical). Both internal and external autopsies were performed, with ligature materials classified as soft or hard. Histological examination determined whether ligature marks were antemortem or postmortem.

Results: The highest number of cases occurred in the 20-29 age group (33.33%), followed by 10-20 years (26.67%). Males accounted for 58% of cases. Complete suspension was more common (73.33%) than partial. Atypical ligature marks (80%) were predominant, and soft materials were used in 53.34% of cases. Knots were mostly positioned in the left occipital region. Slipping knots were observed in 54% of cases. Thyroid cartilage fractures were less common (10%) compared to absent fractures (56.67%).

Conclusion: Suicidal cases are more common in younger age groups, particularly 20-29, with a slight male predominance, while older age groups (above 50) show a higher proportion of homicidal cases. Atypical hangings are more prevalent overall, with complete suspension linked to homicides and partial suspension to suicides.

Keywords: Asphyxia, Autopsy, Hanging, Ligature, Suicide.

Introduction

Every living being die eventually with time. Only humans are intended to take their life themselves and die soon [1]. Hanging is a common practice to commit suicide in civilized world with modern lifestyle causing millions of deaths every year. However, hanging can be the cause of accidental death or homicidal cases (dowry) [2]. Accidental hanging can be observed in children where other cases can be seen in adults and adolescents [3,4]. Hanging is most preferred choice of death since it gives painless death and cost-effective [5]. Different causes of hangings can be determined by histological abnormalities, external neck observations or external appearances [6].

Most of the unnatural deaths occur due to violent asphyxia, in which hanging and strangulations are commonest seen at the time of autopsy. The body suspends through a ligature surrounding the neck and the weight of the body is responsible for constraining action [7]. Ligature mark is a pressure abrasion mark that appears as a groove, and the characteristic of the marks depends upon the type of ligature, bodily weight, suspension time, and how long the ligature was twisted around the neck. The application of a running or fixed noose also modifies the mark's trajectory [8].

However, variations of ligature marks are typical; such can be thin or even absent, artifact, for example ant bites, or circular when the cloth is tied round the neck several times. There may also be multiple ligature markings, usually caused by slippage of the ligature. The twisted round the neck several times and knotted may leave an inverted V-shaped mark adjacent to the ligature marks [8]. In India, hanging oneself to commit

suicide occurs frequently after the failure of sliting throat or poisoning [1].

A classic characteristic of antemortem hanging is a mark of saliva drip, albeit this is not always the case. This is because family members or medical professionals wiped their mouths while attempting to revive the patient. A medico-legal expert can also provide insight into the antemortem nature of hanging by pointing out additional characteristics such as peri-ligature damage [9]. In cases involving multiple neck ligatures with two or more fixed knots, additional injuries to the head, neck, or torso may complicate the process to identify the reason and manner of death [9].

The ligature mark is quite helpful in figuring out what happened to the body because of this. Investigating the type of ligature used and any marks made on the body during the autopsy is essential. It creates a scar in the tissue that looks like a furrow that is first white and eventually turns yellow or yellowish brown as it dries, especially when ligature materials are thin and dense. There may occasionally be some blood and serous fluid leaking [10].

Multiple images (bracketing) are needed to distinguish such colours in the skin until the autopsy is completed [10]. In general one line can be seen around the neck, alongside the mandibular line and this mark could be spiral, multiple turns or upward lifting due to fall after hanging. Imprints could be observed diagonally above the thyroid cartilage. Soft ligature materials (clothing materials) are more accessible than the hard one (electric wire or nylone rope) [11].

The objective of this prospective study is to examine the relationship between the means of death and the patterns of ligature marks in different cases. This study will help improve postmortem examination accuracy by establishing more distinct forensic markers that will aid in differentiating between ligature-related deaths.

Method

Research Design

The study was carried out in Hind Institute of Medical Sciences, Luknow, from July 2021 to June 2023. The approval had been taken from Institutional Ethical and Research Committee. This prospective study finally included overall 30 patients of both males and females (out of 45 patients), which were presented with hanging related deaths. The history and complete records of death patients had been enquired and received from family members and police personnel. In certain instances, photographic or visits to the scene of the death were used to augment the data.

Inclusion Criteria: All of the individuals that possess a history of hanging, were included in the study

Exclusion Criteria: Bodies that had deteriorated to the point where the ligature mark was obscured by the decomposition met the exclusion criterion. The hanging patients were categorized according to a number of traits, including:

1. **Suspension Type:** Complete or Partial
2. **Kind of Ligature Mark:** Typical or Atypical

Both internal and external investigations were carried out at the time of autopsy. In the event that the ligature material continued to remain in place, it was examined and divided into 2 distinct groups: soft ligature materials, which included towels, sarees, dupattas, lungis or metal chains, and hard ligature materials, which included ropes. Each of the parameter has been correlated with the manner of death, namely, suicidal and homicidal.

The goal of the external inspection of the neck was to locate and examine the ligature marks. To ascertain if the ligature mark was antemortem (prior to death) or post-mortem (post death), skin from the ligature mark region was sent for histological examination.The objective of this thorough investigation was to shed light on the events that led to underlying hanging-related deaths in the cases that were chosen (Table 1).

Table 1: Categorization of Ligature marks as per their high topography

Level	Topography
1	Right infront of the neck
1,2	Lower to the right ear
2	Right back of the neck
2,3	Center of the back (occipital, typical ligature mark)
3	Left back of the neck
3,4	Lower to the left ear
4	Left infront of the neck

Result

Table 2 categorizes cases based on age groups and differentiates between suicidal and homicidal cases, along with the percentage of the total cases for each age group. Individuals between 20-29 years account for the highest number of cases (10), with a predominance of suicidal cases (8), making up 33.33% of the total cases. The 10-20 age group

follows with 8 cases, of which 5 are suicidal and 3 are homicidal, representing 26.67%. The 30-39 and 40-49 age groups each have fewer cases (5 and 4, respectively), with a near-equal distribution between suicides and homicides. The lowest incidence is found in the 50-59 and over 60 age groups, together representing only 10% of the total, and all cases are primarily homicidal.

Table 2: Age Distribution of the patients

Age (years)	No. of Cases	Suicidal	Homicidal	Percentage (%)
10-20	8	5	3	26.67
20-29	10	8	2	33.33
30-39	5	2	3	16.67
40-49	4	1	3	13.33
50-59	2	0	2	6.67
>60	1	0	1	3.33

Figure 1 shows the sex distribution. Males account for the majority of cases, with 18 total cases, split between 10 suicidal and 8 homicidal instances. In comparison, females have 12 cases, evenly divided between 6 suicidal and 6 homicidal cases. This data suggests a slightly higher rate of suicidal cases in males, while both genders show similar proportions in homicidal cases.

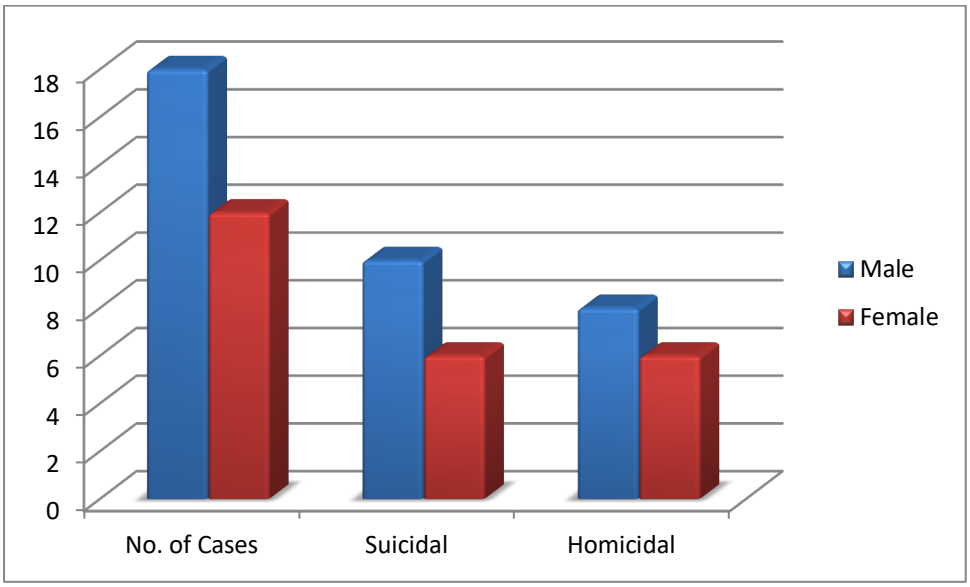

Figure 1: Sex distribution of the patients in this study

Figure 2 shows the degree of suspension in these cases. Complete suspension is noted in 22 cases, where 10 are suicidal and 12 are homicidal. Partial suspension is observed in 8 cases, predominantly suicidal (6 cases), with only 2 homicidal instances.

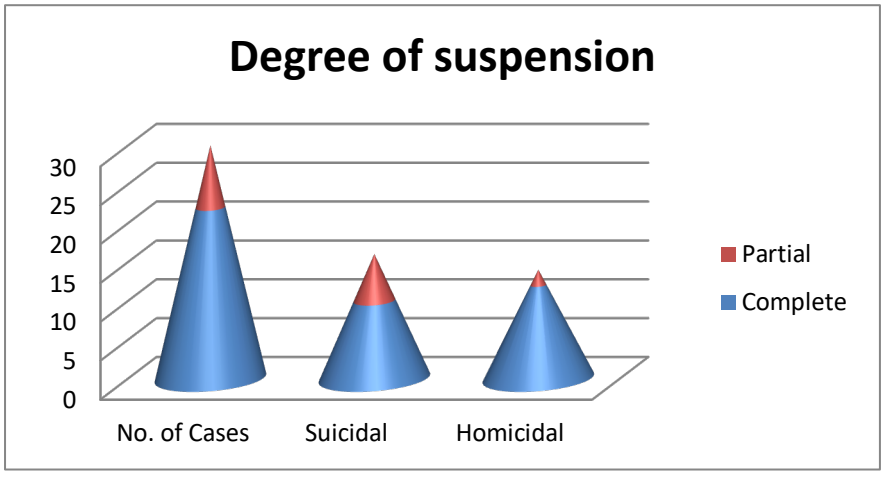

Figure 2: Degree of Suspension with respect to the manner of death of the patients in this study

Figure 3 shows the categorization between typical and atypical cases shows that atypical cases are far more prevalent, totaling 24 cases, with 13 being suicidal and 11 homicidal. Typical cases are fewer, with only 6 cases, evenly split between 3 suicides and 3 homicides.

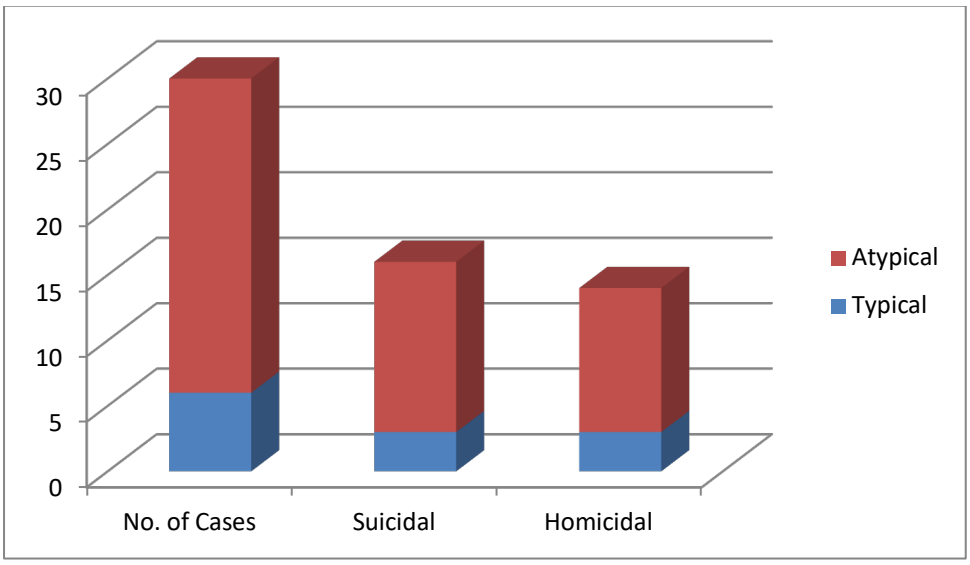

Figure 3: Degree of Suspension of the patients in this study

Table 3 assesses the type of materials used in these cases. Soft materials (such as lungi, dupatta, saree) were used in 16 cases, making up 53.34% of the total, with 10 suicidal and 6 homicidal cases. Hard materials (e.g., nylon rope, electric cord) were used in 14 cases, comprising 46.67% of the total, with a slightly higher number of homicidal cases (8) compared to suicidal ones (6). Table 3 also shows the position of the knot is detailed. The left occipital position has the highest frequency with 8 cases (3 suicidal and 5 homicidal), accounting for 26.67% of the cases. Occipital and right occipital positions follow closely with 7 cases each, representing 23.33% each. Below the right ear accounts for 6 cases, while below the left ear and below the chin have the lowest counts, each with 1 case, all of which are suicidal.

Table 3: Material Used and Position of the Knot with respect to the manner of death

Materials Used	**No. of patients**	**Suicidal**	**Homicidal**	**%**
Soft (Lungi, Dupatta, Saree, etc.)	16	10	6	53.34
Hard (Nylon rope, Electric cord, Coir rope, etc.)	14	6	8	46.67
Position of the Knot	**No. of patients**	**Suicidal**	**Homicidal**	**%**
Right occipital	7	3	4	23.33333
Below the right ear	6	4	2	20
Left occipital	8	3	5	26.66667
Occipital	7	4	3	23.33333
Below the left ear	1	1	0	3.333333
Below the chin	1	1	0	3.333333

Figure 4 describes the types of knots used. Slipping knots are the most common, making up 53.34% of cases, with 11 suicidal and 5 homicidal instances. Fixed knots account for 46.67% of cases, with a higher prevalence in homicidal cases (9) compared to suicidal ones (5).

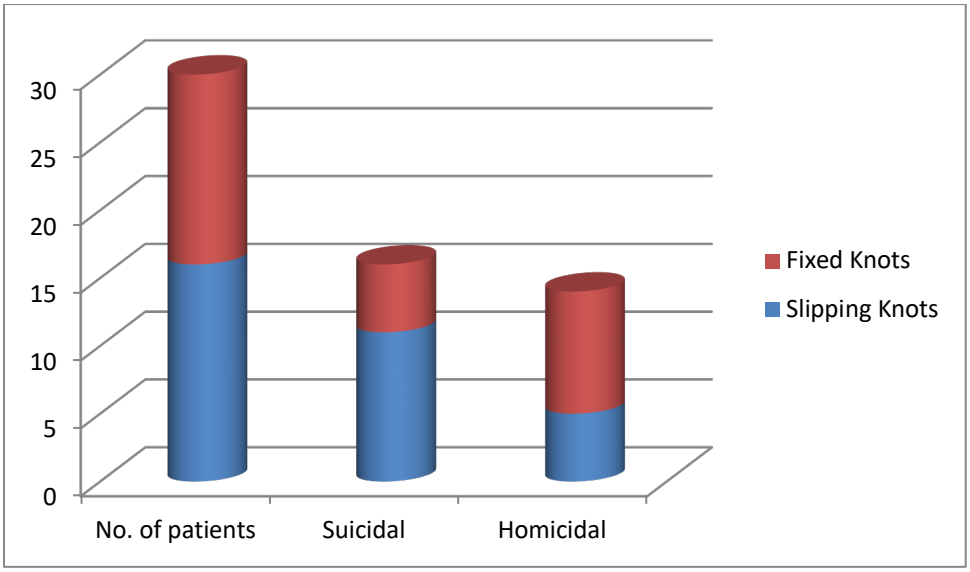

Figure 4: Fixed and Slipping Knot, with respect to the manner of death of the patients in this study

Table 4 focuses on the type of fractures present in the cases. Thyroid cartilage fractures are observed in 3 cases, all homicidal. Cases without thyroid fractures total 17, with a higher prevalence in suicidal cases (11). Hyoid bone fractures are present in 4 cases, with 3 being suicidal, while absence of hyoid fractures occurs in 6 cases, predominantly homicidal. This data may suggest correlations between the type of fractures and the nature of the cases (suicidal or homicidal).

Table 4: Fracture type of the patients with respect to the manner of death

Fracture Type	No. of patients	Suicidal	Homicidal
Fracture of Thyroid Cartilage	3	0	3
Absent Thyroid Fracture	17	11	6
Fracture of Hyoid Bone	4	3	1
Absent Hyoid Fracture	6	2	4

Discussion

The aforementioned distribution is influenced by a number of factors, including financial difficulties, marital discord, unemployment, and harassment of the dowry. Studies by B.K. Sen Gupta [12] and Andrew Davison and Marshall T.K [13] revealed similar results. Contrast findings were observed in the study of Luke [14] and Bowen [15], however these studies were conducted in a developed country that followed western culture with full of job opportunities.

The observations made above aligned with the conclusions given by Andrew Davison and Marshall. T.K.[13]. The study samples consisted of adults who had committed suicide, which increased the number of complete hangings, one of the contributing factors. Most of the marks found were atypical due to the placement of the knot or any intervening objects, such as clothing, bony protrusion, lengthy plaits on Indian women, and presence of beards. Opposite results were observed by Gary P. Paparo,[16] and Luke [17] since their study populations belonged to the lower age range and had either been the patients of homicidal or accidental hanging.

The hanging ligature mark needs to be examined meticulously. In fact, the corroboration of the findings of the specific case depends upon whether it was an incomplete or full hanging and type of material used for ligature. In most cases, incomplete analysis or the exclusion of a few negligible yet vital findings lead to inconclusive evidence that causes further confusion [18]. The high incidents are generally observed in young adults in their third decade followed by their second decade and maximum cases occur in males [7,17,19–20].

A study mentioned that 20-40 years old individuals are involved in suicidal cases due to their unsuccessful lives, affairs or love issues, financial struggle or frustration and in most of the cases females were indulged into suicide in younger ages [6]. The ligature material usually utilized in hanging is nylon rope followed by odhni or dupatta, jute ropes and saree [21–23].

The existence or lack of circumstantial evidence in the form of suicide notes is merely an antiquated finding and does not imply suicidal intent in the relevant case; in all such cases, the autopsy surgeon had carried out a thorough and meticulous post

mortem to rule out any suspicious death or foul play, ending rumors that surfaced, particularly among the deceased's relatives and aiding law enforcement in cases that were questionable [6].

The mark's hanging placement is determined by how the gadget was anchored and the suspension point [24]. Reddy KSN stated that the mark of hanging is typically located in 80% of cases above the thyroid cartilage level and 15% at the site of thyroid cartilage, and almost 5% below the level of thyroid cartilage (during partial hanging) [5]. The ligature mark is said to be essentially a postmortem feature, and any inner neck structure injury indicating ligature mark intravitality is to be identified to determine the antemortem hanging [25].

Regarding ligature points and places of hanging, houses were most frequent, then farms, deserted regions, and forests. In addition, women mostly are involved in such kind of suicide as evidenced by the fact that just one woman's body was found in a forest or on an empty plain. Reports by Vijayakumari [26] and Ahmad and Hossain [27] stated that approximately 95% preferred hanging through attaching the ligature around the neck. This is probably because of accessible ligature materials and quiet surroundings that are easily available at home. However, beams along with ceiling hooks or fans were the next most choice of ligature locations in hanging deaths, followed by trees [23].

Mode of death could be because of multiple reasons. A study reported suicide, with the exception of two cases involving children under 10 years old who were involved in a dyadic death in which the husband had strangled his wife, hanged both of his children, and then killed himself, and there was a case of a man who was unintentionally hung while at work and became entangled in wires and chains that ultimately result in partial hanging death (6). Suarezpenaranda et al. [28] similarly found that all occurrences in Spain were suicidal hangings, with the exception of two cases of unintentional initiation in kids (Crib death).

According to the Ranjbar MR et al., 3% instances were extremely suspicious of non-suicidal circumstances, and 97% bodies had suicide as the mode of death which was clarified by the toxicological testing [29]. In a study conducted in Maharashtra, one homicidal case was found where husband hanged his newly married wife probably due to dowry demand and other 98.81% cases were purely suicidal in nature [30].

Due to the growing number of these cases that are being reported on a daily basis, numerous research projects using advanced diagnostic and imaging techniques are currently being carried out in various parts of the world, where new and noteworthy findings are expected.

Conclusion

The study findings indicate distinct patterns in suicide and homicide cases concerning demographic, physical, and material factors. Suicidal cases are more prevalent in younger age groups, particularly those aged 20-29, and show a slight male predominance. In contrast, older age groups, such as those above 50, have a higher proportion of homicidal cases, though their overall occurrence is low. Atypical hangings are more frequent than typical ones, with complete suspension being more common in homicidal cases, while partial suspension is associated with suicidal cases.

Regarding materials used, soft materials like sarees and dupattas are more commonly associated with suicide, while harder materials like nylon ropes are more frequently used in homicide cases. Knot positions also reveal interesting trends, with left and right occipital placements being common in homicidal cases, while suicidal cases exhibit a wider variety of knot positions. Knot type further differentiates the cases, as slipping knots are predominant in suicides, while fixed knots are more prevalent in homicides, highlighting the potential intentionality behind the knot choice in homicidal cases. Finally, the type of fractures present provides a potential forensic indicator. Thyroid cartilage fractures are exclusively seen in homicidal cases, whereas hyoid bone fractures appear more in suicides. This differentiation in fracture type underscores the utility of fracture analysis in determining the manner of death. Overall, the findings suggest that specific physical and demographic factors, including age, gender, type of suspension, material, knot type, and fracture presence, can provide critical insights into the nature of hanging cases, aiding forensic experts in distinguishing between suicidal and homicidal deaths.

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