Innovations

A Cross-Sectional Study of Pattern and Histopathological Characteristics of Ligature Marks in Hanging-Related Deaths in the Kolar Region, Karnataka, India

[1]Dr. Srinivasa Reddy.P, [2] Dr. Rajkumar MG, [3] Dr. Kalyani R

[1]Professor, Department of Forensic Medicine & Toxicology
[2]Associate Professor, Department of Forensic Medicine & Toxicology
[3] Professor, Department of Pathology, Sri Devaraj URS Medical College, Constituent College of Sri Devaraj URS Academy of Higher Education, Tamaka, Kolar

Abstract:

Introduction*: Hanging stands out as one of the most prevalent methods of suicide in India, with the default assumption being that nearly all cases of hanging are suicides unless proven otherwise. The assessment of ligature marks plays a pivotal role in unraveling critical insights, particularly in distinguishing between antemortem and postmortem ligature marks. This investigation hinges on the comprehensive correlation of external, and internal findings, and microscopic examinations, all of which contribute significantly to establishing crucial facts in cases involving hanging.* ***Objectives: 1.****To study various patterns of ligature marks in case of hanging in comparison with age, sex, social status, mode of hanging, type of knot, and type of ligature material. 2.To study the histopathological changes in skin and subcutaneous tissue in case of hanging* ***Materials & Methods:*** *This study was conducted in the Departments of Forensic Medicine and Pathology at Sri Devaraj Urs Medical College in Kolar, spanning from January 2021 to December 2021. The study encompassed 38 cases of asphyxial deaths attributed to hanging, and a thorough examination of the ligature marks, both externally and internally, was conducted in all cases.* ***Results:*** *The study included a total of 38 cases. A significant majority (35%) of cases fell within the 3rd decade of life (21-30 years). Males constituted the majority of victims, accounting for 60%. Complete hanging was the most common type, observed in 40% of cases, with rope being the predominant material used in 45% of cases. Single ligature marks were the most prevalent, occurring in 80% of cases. Gross examination identified soft tissue changes in 82.25% of cases. Microscopic examination revealed distinctive features, including wrinkling, breaking, and compression of the epidermis, cell flattening with hemorrhages, collagen condensation, and thinning of the stratified squamous epithelium.* ***Conclusion:*** *This study relies on a comprehensive analysis, encompassing circumstantial evidence, morphological features, and histopathological examinations of neck structures. The correlation of external, internal, and microscopic findings plays a pivotal role in distinguishing between antemortem and postmortem cases of hanging, ultimately aiding in the delineation of these two categories.*

Introduction:

In recent years, there has been a significant rise in suicidal deaths, leading to a substantial surge in medicolegal cases. Investigating these medicolegal deaths is a crucial aspect of forensic medicine, demanding thorough examinations to address fundamental questions regarding the manner, cause, and time of death. Among the various global causes of death, hanging ranks among the top ten, accounting for

over a million fatalities annually. In India, hanging is a prevalent method of suicide, alongside poisoning, burning, and drowning (1).

Hanging, a form of asphyxia resulting from the suspension of the body by a ligature around the neck, involves constriction either by the body's weight (complete hanging) or a part of the body (partial hanging) (2). Strikingly, hanging is often perceived as a painless mode of death. The assessment of external signs, particularly the ligature mark, plays a pivotal role in hanging cases. Consequently, it is imperative to underscore the meticulous observation and examination of the ligature mark, which serves as the distinctive hallmark of hanging (3).

The ligature mark, appearing as a pressure groove on the neck at the ligature site, typically lies above the thyroid cartilage, between the larynx and the chin. It takes an oblique upward path along the mandible's line, reaching the mastoid processes behind the ears. While occasionally absent at the back, variations like faint or absent marks and ant bite artefacts are observed in routine autopsies, and multiple marks may be present. This underscores the critical role of the ligature mark in determining the cause and manner of death (4,5).

The ligature material can vary, encompassing everyday household substances. The characteristics of the mark may exhibit variations depending on various factors. Notably, the obliquity of the ligature mark, slanting upwards toward the knot, serves as a crucial criterion for distinguishing between hanging and ligature strangulation (6).

The appearance of the ligature mark is influenced by ligature type, positioning, and post-death suspension duration. Soft ligatures and immediate removal after death can result in no mark. A thick beard or neck clothing may cause a slight mark. The ligature material's pattern can imprint on the skin, creating diagonal marks when the rope is used (7). A wide cloth band on bare skin may create a narrow mark due to fabric tension. Usually, there's one groove with a pale, leathery base and red edges. Ecchymosis and abrasions are rare but can occur, especially in judicial hangings (8). Typically, one mark is present, but multiple marks may occur with multi-turn ligature or upward shifts due to a fall. The mark is usually above the thyroid cartilage, between the larynx and chin, obliquely following the mandible's line. Occasionally, it's below the thyroid cartilage, especially in partial hanging. It may be circular if the ligature starts at the nape and is drawn forward and upward behind the jaw (8, 9).

While some pathological findings like Simon's bleeding are conventional indicators in hanging deaths, others, including bowel wall hemorrhage, sternocleidomastoid muscle hemorrhage, and thyroid tissue observations, remain subject to debate (10). A notable sign, the line of congestion along the furrow's course, is often seen as significant, signifying an antemortem hanging event. This poses a challenge for forensic experts in differentiating between antemortem and post-mortem hanging, especially in cases where homicides are staged with a hanging scene (11).

To tackle this challenge effectively, it is imperative to include the histopathological examination of skin and subcutaneous tissue from the ligature site as a routine part of autopsy procedures. These findings can provide invaluable insights into the circumstances of death, particularly in cases that are still unresolved or later discovered to be fabricated.

The present study is done to study external, internal, and gross features and histopathology of ligature tissue to attain a better understanding of cases of suicide-hanging deaths.

Objectives:

1. To study various patterns of ligature marks in case of hanging in comparison with age, sex, social status, mode of hanging, type of knot, and type of ligature material.
2. To study the histopathological changes in skin and subcutaneous tissue in case of hanging

Materials & Methods:

Study Design: This cross-sectional study was conducted at the R.L. Jalappa Hospital mortuary in Kolar over the period from January 2021 to December 2022. The study focused on cases of hanging brought to the mortuary for medico-legal autopsy. To select the cases for this study, detailed information about the deceased and the circumstances of death was gathered from both the police and the deceased's relatives.

The study involved a comprehensive examination, including an external assessment of the ligature mark and the dissection of neck structures beneath the ligature mark. In addition, a portion of the skin from the ligature site, as well as normal skin as a control sample, was collected. These skin samples were preserved in 10% formalin and subsequently sent for histopathological examination.

Inclusion Criteria: All cases brought to the mortuary with a documented history of hanging were considered for inclusion in the study.

Exclusion Criteria: Cases meeting the following criteria were excluded from the study:

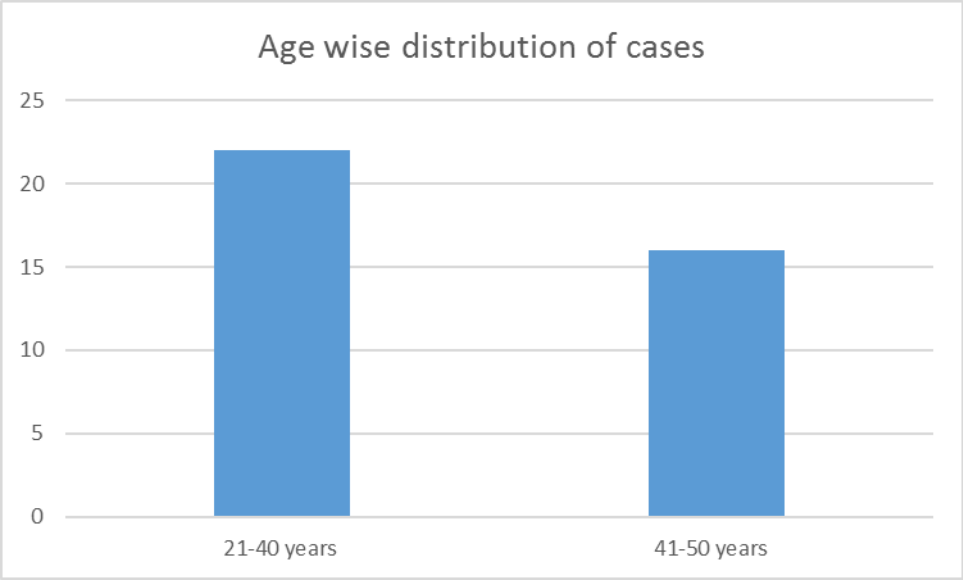
1. Decomposed bodies where the ligature mark was obscured.
2. Bodies with burn injuries cover the neck region.
3. Decapitated bodies.

Statistical Analysis:

Data was entered into a Microsoft Excel data sheet and analyzed. Categorical data was represented in the form of Frequencies and proportions. Continuous data was represented as mean and standard deviation.

In the mortuary at R L Jalappa Hospital, Kolar, from January 2021 to December 2021, a total of 275 autopsies were conducted. Among these, 38 cases (15.96%) were attributed to asphyxial deaths resulting from hanging. These cases were meticulously examined, with a focus on assessing the ligature mark through gross and histopathological examinations.

The study revealed that the majority of cases involved young adults in their third decade of life, specifically 21 to 30 years old, accounting for 22 cases (57.8%), followed by individuals in their fourth decade, aged 41 to 50 years, which constituted 16 cases (17.5%). In terms of gender distribution, there were 28 (65%) male victims and 10 (42.1%) female victims. Most of the victims belonged to the middle and lower socioeconomic strata, comprising 18 (47.3%) and 20 (52.6%) cases, respectively. Additionally, the study found that a larger proportion of victims resided in rural areas, with 28 cases (73.6%), compared to urban areas, which accounted for 10 cases (26.3%).



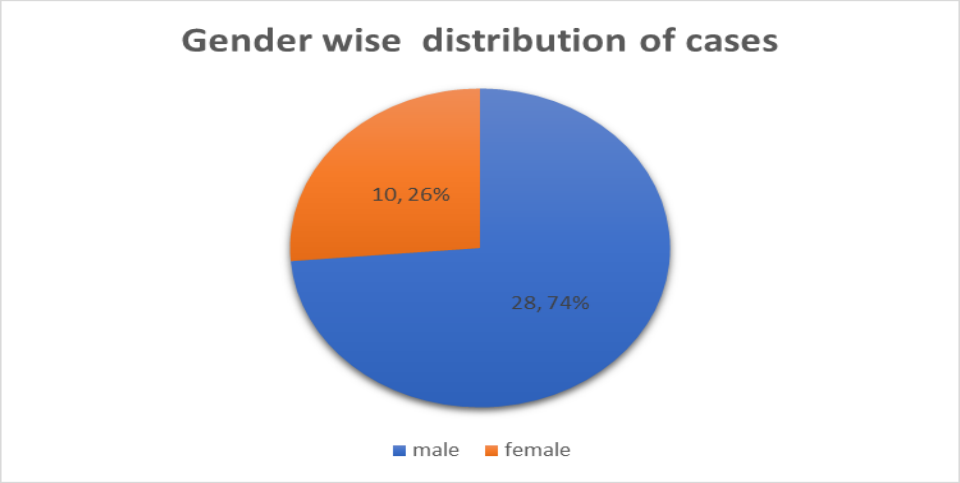


Table No 1: Residence of the study population

Residence	Number	Percentage
Rural areas	28	73.6%
Urban areas	10	26.3%

Typical hanging, where the knot was located behind the neck in the occiput region, was observed in only 20 cases (52.6%), while atypical hanging, characterized by the knot being on either the right or left side of the neck, was reported in 18 cases (47.3%). The ligature material was present in all examined cases, with rope being the most commonly used material by victims, in 22 cases (57.8%), followed by chunni in 12 cases (31.5%), and other materials such as saree and bed sheets were also used (Table 2).

Table No 2: Type of ligature material used in hanging

Ligature material	Number	Percentage
Rope	22	57.8%
Chunni	12	31.5%
Plastic material	03	7.8%
saree	01	2.6%

The pattern of the ligature mark was present in all cases, with a single ligature mark observed in 35 cases (92.1%) and multiple rows in 2 cases (5.2%). In this study, two types of knots were identified: a slip knot in 8 cases (21%) and a fixed knot in 30 cases (78.9%).

In the postmortem findings, protrusion of the tongue was seen in 4 cases (10.5%), possibly due to the constricting force of the ligature causing upward pressure on the neck structures, leading to tongue elevation. Salivary stains were present in 18 cases (47.3%) of hanging, often seen dribbling from the angle of the mouth down the chin. This is considered a reliable sign of antemortem hanging, as saliva secretion is a vital function that cannot occur after death. Notably, hyoid bone fracture was not found in any of the hanging cases in this study. The study also highlighted that the frequency of hyoid bone fracture increased with age, particularly in victims over 40 years, as the bone had become ossified.

Table No 3: Postmortem examination findings in hanging cases

Findings	**Number of cases**	**Percentage**
Protrusion of tongue	06	15.7%
Salivary stains	18	47.3%
Bleeding from ear/nose/mouth	06	15.7%
Sub-Conjunctival haemorrhage	05	13.1%
Postmortem lividity	03	7.8%

Histopathological evaluation was conducted in all 38 cases, revealing various skin changes and tissue reactions. These observations included epidermal discontinuity with congestion in approximately 6 (15.7%) cases, epidermal discontinuity with congestion and hemorrhage in about 10 (26.3%) cases, epidermal discontinuity with underlying muscle showing hemorrhage in about 5(13.1%) cases, epidermal discontinuity with inflammatory cell infiltration in 7 (18.4%) cases, and epidermal discontinuity with all the mentioned changes such as congestion, hemorrhage, and inflammatory changes in 9(23.6%) cases.

Table No. 4: Histopathological changes in cases of hanging

Sl.No:	Microscopic detail	No of cases (38)	Percentage (%)
Skin changes and tissue reaction			
1	Epidermal discontinuity(breaking, wrinkling) with congestion only	06	15.7
2	Epidermal discontinuity with congestion and hemorrhage	10	26.3
3	Epidermal discontinuity with underlying muscle showing haemorrhage	05	13.1
4	Epidermal discontinuity with inflammatory cell infiltration	07	18.4
5	Epidermal discontinuity with all the changes such as congestion, hemorrhage, and inflammatory changes	09	23.6

Discussion:

The study conducted at the R L Jalappa Hospital mortuary in Kolar, spanning from January 2021 to December 2021, delves into the intricate details of asphyxial deaths due to hanging. This study provides profound insights into the demographics of victims, the materials used for ligatures, and the postmortem characteristics associated with hanging cases. It underscores the vital importance of a meticulous examination of ligature marks, which should encompass a systematic sequence of procedures, including inspection, palpation, internal examination, and comprehensive histopathological assessments. The nature of the ligature material and whether the hanging was complete or partial are key factors in establishing correlations within individual cases.

Our findings reveal that 38 out of 275 post-mortems conducted over this period from January 2021 to December 2021 were related to hanging, constituting 13.3% of cases. This trend suggests a growing concern, emphasizing the urgent need for measures to address this social issue. Notably, the majority of hanging victims were male (67.5%), with the highest incidence occurring in the 21-30 age group (50%), aligning with previous studies by authors such as Sharma BR et al and Kumar et al.(12,13)

The burden of hanging cases is significantly borne by individuals from middle and lower socioeconomic strata, with 47.3% of cases in the middle-income category and 53.7% in the lower-income category. Familial issues, financial struggles, and miscellaneous concerns seem to be pivotal factors contributing to psychological distress and increased suicidal tendencies among individuals in these strata. (14,15)

Geographically, rural areas accounted for 73.6% of hanging cases, while urban areas contributed 26.3%, in line with findings by Prasad, K.J. et al. [16,17]

Rope and chunni emerged as the most common ligature materials in our study, consistent with previous research where rope and cloth materials, including chunni, were consistently identified as the most prevalent ligature materials, followed by saree and plastic materials. (18)

The observation of both typical and atypical hanging cases in this study is consistent with the existing literature (Reference 8, Reference 9). This variation in knot placement underscores the complexity of hanging cases and the importance of a detailed forensic examination. (19)

An interesting observation in our study was the absence of hyoid bone fractures in all hanging cases, which aligns with several previous studies reporting variable findings regarding hyoid bone fractures in hanging cases. (20,21) This variation may be attributed to factors such as age, force applied during hanging, and the position of the ligature.

Histopathological examinations played a pivotal role in our study, shedding light on the physiological responses of tissues in hanging-related deaths. Histopathology involves the microscopic examination of tissue samples to detect structural abnormalities or cellular-level changes. We identified specific histopathological findings commonly associated with hanging cases, including epidermal discontinuity, congestion, hemorrhage, and inflammatory cell infiltration. These findings provide crucial insights into tissue responses in hanging victims and serve as valuable forensic indicators, aiding in understanding the mechanisms of injury and establishing the cause and manner of death. (11, 22)

Conclusion:

The study's results emphasize the importance of considering multiple factors when investigating deaths related to asphyxia. In addition to looking at circumstantial evidence and physical traits, a thorough examination of the tissues below the ligature mark, which includes the epidermis, dermis, connective tissue, and muscles, can provide more conclusive information about how and why the person died.

Consistently applying this comprehensive approach in cases of hanging deaths, simplifies the process of making firm conclusions, especially in situations where there is uncertainty. This systematic method helps differentiate between ligature marks created while the person was alive (ante mortem) and those made after death (post-mortem), which in turn aids in determining the cause and manner of death. This structured approach establishes a clear foundation for ensuring a fair legal process.

References:

1. *Singh OP. Startling suicide statistics in India: Time for urgent action. Indian J Psychiatry. 2022 Sep-Oct;64(5):431-432*
2. *Vidyullatha V. Shetty. "Medicolegal Aspects of Asphyxia concerning Hanging". Journal of Evidence-based Medicine and Healthcare; Volume 1, Issue 11, November 17, 2014; Page: 1463-1470.*
3. *Dinesh Rao. An autopsy study of death due to Suicidal Hanging– 264 cases. Egy J For Sci.2016; 2:248-254.*
4. *Barman S, Bairagi K (July 26, 2023) Analysis of Socio-Demographic Profiles of Suicidal Hanging Cases to Formulate a Preventive Strategy: An Autopsy-Based Study Conducted at a Tertiary Care Hospital in the North-East Region of India. Cureus 15(7): e42483*
5. *Mallikarjun SB, Dayananda R, Karthik SK, Priyanka M, Sujathan G. Study of ligature mark in hanging cases in Bangalore east region. J Ind Acad For Med. 2016; 38:18–20.*
6. *Pradipkumar K, Keisham S, Deepen C, James DW S, Lynda B Z. Epidemiological study of hanging deaths in Imphal. Indian J Forensic Community Med 2020;7(4):166-169.*
7. *Shrivastava M, Thakur P.S, Pateria D, Singh B. K, Soni S. K. Autopsy based one-year prospective study of death due to hanging. Indian J Forensic Community Med. 2018;5(4):240-244.*

8. *Arya A, Kumar A, Awasthi P, Sachan R, Osawa M, Verma A. Study of Knot and Profile of Ligature Materials used in Asphyxial Deaths caused by Hanging in Kanpur; a Metropolitan City of India. Indian Journal of Forensic Medicine & Toxicology. 2018;12(2).*
9. *Yadav, A., Gupta, B.M. Histopathological changes in skin and subcutaneous tissues at ligature site in cases of hanging and strangulation. 2009; JIAFM 31(3): 200-204.*
10. *Shaikh, M. M. M., Chotaliya, H.J., Modi, A.d., et al. A study of gross postmortem findings in cases of hanging and ligature strangulation. 2013; JIAFM 35(1): 63-65.*
11. *Anil Yadav, Gupta BM. Histopathological changes in skin and subcutaneous tissues at ligature site in cases of hanging and strangulation.2012; JIAFM 31(3):200-204.*
12. *Sharma, B.R., Harish, D., Singh, V.P., et al. Ligature mark on the neck: How informative? 2005 JIAFM 27(1): 10-15.*
13. *Kumar, Sharma GA & Resident, Senior & Murty, Om & Dogra, Tirath & Professor, (2002). Study of ligature marks in asphyxial deaths of hanging and strangulation. International Journal of Medical Toxicology and Legal Medicine.*
14. *Heigrujam, Meera, and Singh, M. (2011). Pattern of neck findings in suicidal hanging: A study in Manipur. J Indian Acad Forensic Med. 33:352-354.*
15. *Buchade, DhirajD & Bharti, Rohit & Amarnath, Arthy & Mittal, AnilKumar & Khanna, SunilKumar. (2019). Analysis of Hanging Cases Brought to Mortuary of Lok Nayak Hospital, New Delhi: A 3-Year Retrospective Study. MAMC Journal of Medical Sciences. 5. 69.*
16. *Prasad KJ, Khalid MA, Narayana BL, Prakash GB, Kumar DS, Reddy KB. Ligature Mark in Hanging–Gross and Histopathological Examination with Evaluation and Review. Prof. RK Sharma. 2017 Jan;11(1):22.*
17. *Dr. TTK Reddy, Dr. V Krishnamurthy, Dr. N Poorna Chandra Rao, Dr. K Ram Prakash, Dr. K Satish Kumar. A study of various patterns of ligature marks produced in cases of hanging brought to the mortuary, GGH, Guntur. Int J Clin Diagn Pathol 2019;2(2):33-37.*
18. *Prasad KJ, Khalid MA, Khader Faheem N, Lakshmi Narayana B, Arumalla VK. Ligature Mark In Hanging – Gross And Histopathological Examination With Evaluation And Review. J Addict Depend. 2016 Mar 28;16:18.*
19. *Rao D. An autopsy study of ligature mark in 634 cases of suicidal hanging. IP Int J Forensic Med Toxicol Sci 2021;6(4):147-152.*
20. *Talukder MA, Mansur MA, Kadir MM. Incidence of typical and atypical hanging among 66 hanging cases. Mymensingh Med J. 2008 Jul;17(2):149-51. PMID: 18626449.*
21. *Angoules AG, Boutsikari EC. Traumatic hyoid bone fractures: rare but potentially life-threatening injuries. Emergency Med. 2013;3(1):e128*
22. *Naik Shrabana Kumar, Patil DY. Fracture of hyoid bone in cases of asphyxial deaths resulting from constricting force around the neck. Journal of Indian Academy of Forensic Medicine. 2005 Jul; 27(3): 149-153.*
23. *Perju-Dumbrava, Dan & Rebeleanu, Codrin & Daniel, Ureche & Pop, Ovidiu & Bulgaru-Iliescu, Diana & Radu, Carmen. (2018). The medico-legal value of histopathological examination in hanging. Romanian Journal of Legal Medicine. 26. 349-353.*