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ORIGINAL ARTICLE

Patterns of Ligature Marks in Hanging Versus Strangulation: A Comparative Autopsy Study

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ABSTRACT

Background: Death due to hanging and strangulation is a critical medico-legal issue with significant forensic and public health implications. Differentiating these two types of deaths is essential for determining the cause, manner, and medico-legal consequences of death.

Objectives: To compare the socio-demographic characteristics and medico-legal findings between deaths due to hanging and strangulation and to evaluate their associations with sex and type of death.

Study Design & Setting: This retrospective study included 70 patients fulfilling inclusion criteria, with data collected from hospital records, medicolegal registers, and autopsy reports at Sheikh Zayed Medical College, Rahim Yar Khan (Jan 2021–Jan 2023), excluding incomplete records while maintaining confidentiality.

Methodology: A total of 70 cases were included, consisting of 45 deaths due to hanging and 25 due to strangulation. Data regarding age, sex, ligature material, ligature mark site, and other relevant medico-legal parameters were collected. Statistical analysis was performed using the chi-square test to assess associations, with a p-value of <0.05 considered significant.

Results: Most cases of hanging were reported in the 21–30 years age group (40.0%), while strangulation cases were more frequent in the 31–40 years group (36.0%). Hanging was predominant among males (62.2%), while strangulation had relatively higher female involvement (44.0%). The majority of cases in both categories involved rope as the ligature material. No statistically significant association was found between sex and type of death (p = 0.62).

Conclusion: Hanging remains the most common cause of asphyxial death, particularly among young males, whereas strangulation is less frequent but relatively more common among females. Thorough medico-legal evaluation is crucial for accurate diagnosis.

Keywords: Autopsy, Forensic medicine, Hanging, Medico-legal, Strangulation

INTRODUCTION

Hanging and strangulation are among the most frequent forms of asphyxial deaths encountered in forensic practice, representing a significant proportion of medicolegal autopsies worldwide.[1] Both mechanisms of death involve constriction of the neck by a ligature or other force, yet they differ markedly in their pathophysiology, manner of occurrence, and medicolegal implications.[2] Hanging is generally considered a form of suicidal asphyxia in which the constricting force is generated by the weight of the body suspended by a ligature.[3] In contrast, strangulation, whether manual or ligature-mediated, typically results from external force applied by another individual and is more often associated with homicidal intent.[4]

One of the most important parameters in distinguishing these two types of deaths is the pattern of ligature marks. Ligature marks are pressure abrasions or contusions on the neck produced by the material used for constriction, and their morphology is influenced by several factors including the type and width of the ligature, the duration of suspension or compression, body weight, knot position, and the dynamics of the assault.[5,6] In hanging, ligature marks are usually oblique, non-continuous, and situated above the thyroid cartilage, often running upward toward the point of suspension. Conversely, in strangulation, the marks are more commonly horizontal, circumferential, and located at or below the thyroid cartilage, reflecting the direct encirclement and constriction of the neck. These characteristic differences provide valuable forensic clues; however, overlaps and variations can occur, particularly in cases of partial suspension, atypical hangings, or when soft ligatures are used.[7]

The importance of correctly interpreting ligature mark patterns extends beyond academic interest, as errors in diagnosis can lead to serious consequences, including misclassification of suicide as homicide or vice versa.[8] Previous studies have highlighted that factors such as decomposition, clothing, postmortem changes, and the type of ligature material can complicate interpretation, making systematic comparative studies essential. By analyzing and documenting the morphological characteristics of ligature marks in both hanging and strangulation cases, forensic pathologists can refine diagnostic criteria, reduce ambiguity, and improve the reliability of medicolegal opinions.[9,10,11]

In countries like Pakistan and other South Asian nations, where both suicidal hanging and homicidal strangulation are frequently reported in forensic centers, the need for region-specific data is particularly pressing. Socio-cultural factors, availability of ligature materials, and patterns of violence may influence the presentation of such cases. A comparative autopsy-based approach, therefore, not only aids in distinguishing between hanging and strangulation but also contributes to local forensic databases and enhances training for medical examiners. This study aims to systematically compare the patterns of ligature marks observed in autopsy cases of hanging and strangulation, thereby contributing to the body of knowledge necessary for accurate forensic differentiation and assisting in the pursuit of justice.

MATERIALS AND METHODS

This retrospective study was conducted on data of 70 patients fulfilling the inclusion criteria. Data was retrospectively collected from the hospital records of Sheikh Zayed Medical College, Rahim Yar Khan, covering the period from January 2021 to January 2023. Medicolegal registers, autopsy reports, and patient files were reviewed, and incomplete records were excluded. Confidentiality of patient information was strictly maintained.

Cases of hanging in which the body was suspended by a ligature material and cases of ligature strangulation where constriction of the neck was produced by an external force were included. Cases with advanced decomposition, severe neck trauma from other causes, or incomplete records were excluded. A

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detailed autopsy examination was carried out in each case, with special emphasis on the neck structures and ligature marks.

The ligature material, point of suspension, and type of knot were noted whenever available. The pattern of ligature marks was carefully examined and recorded in terms of site, direction, continuity, level in relation to thyroid cartilage, and nature of margins. In hanging cases, attention was given to whether the ligature mark was oblique, non-continuous, and above the thyroid cartilage, while in strangulation cases, emphasis was placed on horizontal or circumferential marks located at or below the thyroid cartilage. Internal examination of the neck was performed to assess underlying hemorrhages, soft tissue bruising, and fracture of hyoid bone or laryngeal cartilages. The demographic variables including age, sex, and manner of death were also recorded. All observations were documented on a predesigned proforma.

Data were analyzed statistically using SPSS software version 26.0. Descriptive statistics were calculated for demographic variables. Frequencies and percentages were used to describe the distribution of ligature mark patterns in hanging versus strangulation. Comparative analysis was performed using chi-square test to determine statistical significance, with a p-value of <0.05 considered as significant.

RESULTS

In Table 1, hanging was the most frequent type of case, as it was observed in 45 cases (64.3%), while strangulation was less common and was found in 25 cases (35.7%). In Table 2, Out of the total 70 cases, 45 (64.3%) were due to hanging and 25 (35.7%) due to strangulation. Males predominated overall with 42 cases (60.0%), including 62.2% of hanging cases and 56.0% of strangulation cases, whereas females accounted for 40.0% of cases. The most affected age group was 21–30 years (37.1%), followed by 31–40 years (25.7%). Adolescents (11–20 years) contributed 14.3%, while middle-aged individuals (41–50 years) represented 15.7%. Only 7.2% of cases occurred in those aged above 50 years.

In Table 3, the pattern of ligature marks was different between hanging and strangulation cases. In hanging, the most common pattern was oblique, above the thyroid cartilage, which was seen in 34 cases (75.6%), while this pattern was present in only 3 cases (12.0%) of strangulation. A horizontal ligature mark at or below the thyroid cartilage was uncommon in hanging (5 cases, 11.1%) but was the predominant finding in strangulation (16 cases, 64.0%). Circumferential and complete ligature marks were observed in 2 cases (4.4%) of hanging and 4 cases (16.0%) of strangulation. Indistinct or partial marks were present in 4 cases (8.9%) of hanging and 2 cases (8.0%) of strangulation. Overall, oblique marks were most frequent in hanging, whereas horizontal marks were most frequent in strangulation.

In the present study, subcutaneous neck hemorrhage was observed in 12 cases (26.7%) of hanging, whereas it was more frequent in strangulation, being present in 18 cases (72.0%). Hyoid bone fracture was noted in 3 cases (6.7%) of hanging and in 7 cases (28.0%) of strangulation. Thyroid cartilage fracture was identified in 2 cases (4.4%) of hanging compared to 5 cases (20.0%) of strangulation. Notably, no significant internal injury was found in the majority of hanging cases, 28 (62.2%), while this was less common in strangulation, seen in only 5 cases (20.0%). Overall, subcutaneous neck hemorrhage was the most common internal finding (42.9%), followed by hyoid bone fracture (14.3%) and thyroid cartilage fracture (10.0%), whereas 33 cases (47.1%) had no significant internal injury given in table 4.

In Table 5, the association of type of death with internal neck injuries was presented. Internal injuries were present in 17 (37.8%) cases of hanging, while a much higher proportion, 20 (80.0%) cases, were observed in strangulation. On the other hand, internal injuries were absent in 28 (62.2%) cases of hanging and only 5 (20.0%) cases of strangulation. Overall, out of 70 cases, internal injuries were found in 37 (52.9%) cases, whereas 33 (47.1%) cases showed no internal injury. The association between type of death and presence of internal neck injuries was statistically significant (p = 0.001).

In Table 6, the association of type of death with sex was presented. Among 45 cases of hanging, 28 (62.2%) were males and 17 (37.8%) were females, whereas in 25 cases of strangulation, 14 (56.0%) were males and 11 (44.0%) were females. Overall, out of 70 cases, 42 (60.0%) were males and 28 (40.0%) were females. The difference between type of death and sex was not statistically significant (p = 0.62).

Table 1: Distribution of Cases According to Type of Death (n = 70)

Type of Case	Frequency (n)	Percentage (%)
Hanging	45	64.3
Strangulation	25	35.7

Table 2: Demographic Distribution of Cases (n = 70)

Variable	Hanging (n = 45)	Strangulation (n = 25)	Total (n = 70)
Sex			
Male	28 (62.2%)	14 (56.0%)	42 (60.0%)
Female	17 (37.8%)	11 (44.0%)	28 (40.0%)
Age Groups			
11–20 years	7 (15.6%)	3 (12.0%)	10 (14.3%)
21–30 years	18 (40.0%)	8 (32.0%)	26 (37.1%)
31–40 years	11 (24.4%)	7 (28.0%)	18 (25.7%)
41–50 years	6 (13.3%)	5 (20.0%)	11 (15.7%)
>50 years	3 (6.7%)	2 (8.0%)	5 (7.2%)

Table 3: Patterns of Ligature Marks in Hanging Versus Strangulation (n = 70)

Ligature Mark Pattern	Hanging (n = 45)	Strangulation (n = 25)	Total (n = 70)
Oblique, above thyroid cartilage	34 (75.6%)	3 (12.0%)	37 (52.9%)
Horizontal, at/below thyroid cartilage	5 (11.1%)	16 (64.0%)	21 (30.0%)
Circumferential, complete	2 (4.4%)	4 (16.0%)	6 (8.6%)
Indistinct/partial mark	4 (8.9%)	2 (8.0%)	6 (8.6%)

Table 4: Internal Neck Findings in Hanging Versus Strangulation (n = 70)

Internal Injury Findings	Hanging (n = 45)	Strangulation (n = 25)	Total (n = 70)
Subcutaneous neck hemorrhage	12 (26.7%)	18 (72.0%)	30 (42.9%)
Hyoid bone fracture	3 (6.7%)	7 (28.0%)	10 (14.3%)
Thyroid cartilage fracture	2 (4.4%)	5 (20.0%)	7 (10.0%)
No significant internal injury	28 (62.2%)	5 (20.0%)	33 (47.1%)

Table 5: Association of Type of Death with Internal Neck Injuries (n = 70)

Internal Injury Findings	Hanging (n = 45)	Strangulation (n = 25)	Total (n = 70)	p-value
Present	17 (37.8%)	20 (80.0%)	37 (52.9%)	0.001*
Absent	28 (62.2%)	5 (20.0%)	33 (47.1%)	
Total	45	25	70	

*Chi-square test applied; significant at p < 0.05.

Table 6: Association of Type of Death with Sex (n = 70)

Sex	Hanging (n = 45)	Strangulation (n = 25)	Total (n = 70)	p-value
Male	28 (62.2%)	14 (56.0%)	42 (60.0%)	0.62
Female	17 (37.8%)	11 (44.0%)	28 (40.0%)	
Total	45	25	70	

*Chi-square test applied; not statistically significant.

Figure 1: Typical ligature mark in hanging. Oblique, non-continuous ligature mark encircling the neck with upward angulation towards the mastoid region, characteristic of hanging

Figure 2: Typical ligature mark in strangulation. Horizontal, continuous ligature mark at the mid-neck level, characteristic of strangulation

DISCUSSION

Hanging and strangulation are two of the most frequently encountered asphyxial deaths in forensic practice.[1] Hanging is usually suicidal, while strangulation is more often homicidal in nature. Both types of deaths show distinctive medico-legal implications and require careful examination to establish the cause and manner of death. Variations in age, sex, and socio-demographic profiles often influence the pattern of these cases. In developing countries, hanging has been reported as the predominant method of suicide. Understanding the epidemiology of these deaths provides valuable insights for both prevention and criminal investigations.

In the present study, hanging constituted 64.3% of cases while strangulation accounted for 35.7%, which contrasts with Nimavat et al. (2016),[16] who reported 97% of deaths due to hanging and only 3% due to ligature strangulation in Ahmedabad. Similarly, Singh et al. (2022) and Ghodake et al. (2023)[19] found hanging to be the predominant mode of death, while our study showed a comparatively higher proportion of strangulation cases, highlighting regional variations in patterns of neck compression deaths.[18]

With respect to internal neck findings, subcutaneous hemorrhage was present in 72% of strangulation cases and only 26.7% of hanging cases in our series. This agrees with Ma et al. (2016), who reported subcutaneous hemorrhage, exfoliation, and blistering as strong antemortem reactions in strangulation, while such findings were less common in hanging.[13] Shabbir et al. (2019) also reported extravasations of blood in all strangulation cases, while in hanging the subcutaneous tissues beneath the mark appeared glistening white, supporting our finding of more frequent hemorrhagic changes in strangulation.[15]

Fractures of neck structures were more common in strangulation in our study, with hyoid bone fractures seen in 28% and thyroid cartilage fractures in 20% of cases, compared to only 6.7% and 4.4% respectively in hanging. This is consistent with Ma et al. (2016), who reported fractures in ~17% of victims overall, with higher occurrence in strangulation. Similarly, Kumari (2023) noted thyroid cartilage fractures in 10% of hanging cases, which closely aligns with our lower fracture rate in hangings. These findings emphasize that internal structural injuries are more strongly associated with strangulation than hanging.[17]

Regarding the presence or absence of internal injuries, 80% of strangulation victims in our study had internal injuries compared to only 37.8% of hanging victims, a statistically significant difference ($p = 0.001$). This supports the observations of Shabbir et al. (2019) and Reddy et al. (2019),[14] who found microhemorrhages and inflammatory changes in strangulation much more frequently than in hanging. Rao (2022) also highlighted the absence of petechial hemorrhages in complete hangings, while our study demonstrated that nearly two-thirds (62.2%) of hangings lacked significant internal injuries, confirming the subtle internal pathology in such cases.[20]

Demographically, males predominated in our study, accounting for 60% of cases, which is comparable to Kumari (2023) who reported 58% male predominance, and Ghodake et al. (2023) who found 77% of victims were males. The most affected age group in other studies ranged between 20–30 years, such as Reddy et al. (2019) with 50% cases and Ghodake et al. (2023) with 37%, which mirrors the younger age predominance reported in Kumari (2023) as well. Though age distribution was not the prime focus in our dataset, the literature consistently points toward younger adults as the most vulnerable group, particularly in hanging.[17]

Collectively, our study strengthens the established forensic distinction that hanging is more often associated with the absence of significant internal injuries, oblique and incomplete ligature marks, and lower fracture rates, whereas strangulation is characterized by complete horizontal ligature marks, higher frequency of subcutaneous hemorrhage, and a greater proportion of hyoid and thyroid cartilage fractures. These findings align with both national and international evidence and reaffirm that careful evaluation of ligature marks along with internal injuries is critical in distinguishing between hanging and strangulation in forensic practice.

The study provided a clear comparison between hanging and strangulation cases in terms of frequency, demographic profile, and patterns. A reasonably adequate sample size strengthened the statistical reliability. Use of standardized medico-legal methods enhanced validity. However, the study was limited to a single-center setting, reducing generalizability. Lack of detailed psychosocial background of victims was another limitation. Also, the cross-sectional design restricted causal inference.

CONCLUSION

Hanging was found to be the most common type of asphyxial death, while strangulation was less frequent but carried greater homicidal implications. Both types showed no significant gender

differences. The findings highlight the need for detailed medico-legal investigation in all asphyxial deaths.

REFERENCES

1. Singh A. Death due to Asphyxia: A Forensic Prognosis. Indian Journal of Forensic Medicine and Pathology. 2021 Jul;14(3):669-74.
2. Lockyer B. Death by hanging: examination of autopsy findings and best approach to the post-mortem examination–an update. Diagnostic Histopathology. 2023 Jan 1;31(1):14-21.
3. Sharma K, Sahu A, Inchulkar SR, Kaushik Y. Hanging and it's Medicolegal Importance. Journal of Ayurveda and Integrated Medical Sciences. 2020 Oct 31;5(05):266-71.
4. Pritchard AJ, Reckdenwald A, Nordham C. Nonfatal strangulation as part of domestic violence: A review of research. Trauma, Violence, & Abuse. 2017 Oct;18(4):407-24.
5. Mansueto G, Feola A, Zangani P, Porzio A, Carfora A, Campobasso CP. A clue on the skin: a systematic review on immunohistochemical analyses of the ligature mark. International Journal of Environmental Research and Public Health. 2022 Feb 11;19(4):2035.
6. Pednekar AY, Lyngdoh NN, Kokatanur CM. To Evaluate The Pattern Of Ligature Marks And Their Relationship To Death Mode. Journal of Positive School Psychology. 2022 Dec 20;6(10):86-91.
7. TD C, George TP, R S, SS S. Pattern of Ligature Mark in Hanging—An Autopsy-based Study. Journal of Indian Academy of Forensic Medicine. 2023;46(3):383-90.
8. Cordner S, Clay FJ, Bassed R, Thomsen AH. Suicidal ligature strangulation: a systematic review of the published literature. Forensic Science, Medicine and Pathology. 2020 Mar;16(1):123-33.
9. HauTEO C, Hamzah SP, Osman K, Ghani AA, Hamzah NH. Post mortem changes in relation to different types of clothing. The Malaysian journal of pathology. 2013 Jun 1;35(1):77.
10. Viero A, Montisci M, Pelletti G, Vanin S. Crime scene and body alterations caused by arthropods: implications in death investigation. International journal of legal medicine. 2019 Jan 14;133(1):307-16.
11. Lockyer BE. Death by hanging: examination of autopsy findings and best approach to the post-mortem examination. Diagnostic Histopathology. 2019 Nov 1;25(11):423-30.
12. Commins C, Bolster M, Mulligan L. To investigate the pattern of neck injuries and the role of toxicology in cases of hanging and manual/homicidal ligature strangulation in Ireland between 2016–2020: A retrospective review and analysis. Journal of forensic and legal medicine. 2023 Apr 1;103:102686.
13. Ma J, Jing H, Zeng Y, Tao L, Yang Y, Ma K, Chen L. Retrospective analysis of 319 hanging and strangulation cases between 2001 and 2014 in Shanghai. Journal of forensic and legal medicine. 2016 Aug 1;42:19-24.
14. Reddy TTK, Krishnamurthy V, Rao NP, Prakash KR, Kumar KS. A study of various patterns of ligature mark produced in cases of hanging brought to the mortuary, GGH, Guntur. Int J Clin Diagn Pathol. 2019;2(2):33-7.
15. Shabbir S, Rehman HU, Dureshehwar, Arif M, Murad T, Masood R. Analysis of injuries over neck and its association with ligature mark in hanging and strangulation (gross and microscopic examination of ligature mark on neck in cases of ligature strangulation and hanging). Int J Pathol. 2019;17(3):132-6.
16. Nimavat KK, Joshiyara RV, Shaikh MM, Padmraj RY, Shah KA. A Prospective Study of Pattern of Ligature Mark in Cases of Death Due to Compression of Neck Brought to Mortuary in Civil Hospitalahmedabad. Journal of Forensic Medicine and Toxicology. 2016;33(1):43-5.
17. Kumari J. A prospective study of pattern of ligature marks and its correlation with the manner of death. Int J Toxicol Pharmacol Res. 2023;14(10):112-8.
18. Singh SB, Devi SE, Phanjoubam M, Devi TM. Analysis of ligature marks in hanging: a retrospective study of autopsies in the mortuary of a tertiary health-care center in North East India from 2011 to 2019. Journal of Medical Society. 2022 Jan 1;36(1):26-31.
19. Ghodake D, Sonawane S, Sharma H, Tetarbe T. An autopsy study of ligature mark in cases of hanging. Int J Acad Med Pharm. 2023;5(5):1179-83.
20. Rao D. An autopsy study of ligature mark in 634 cases of suicidal hanging. Ip International journal of forensic medicine and toxicological sciences. 2022;6(4):147-52.

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