Original Article

Spectrum of Internal Neck Injuries in Hanging: A Decadal Autopsy-Based Study (2011-2020)

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Abstract

Background: Hanging is one of the most commonly employed methods for suicide globally, particularly in Asian countries. Hanging forms a major proportion of all medico-legal autopsies. Although external post-mortem findings are well illustrated in the literature, internal neck manifestations and their association with demographic and mechanical variables remain inadequately explored. This study aimed to evaluate internal neck injuries in hanging and analyse their correlation with the type of suspension, age, gender, and ligature material. **Material and Methods:** A retrospective analytical study was conducted on 169 established cases of hanging over ten years (2011 to 2020). Internal findings included sternocleidomastoid haemorrhage, carotid artery intimal tears, hyoid bone fractures, thyroid cartilage fractures, cervical vertebral fractures, spinal cord contusions, and thyroid gland haemorrhages. Statistical analysis was performed using the Chi-square test and Fisher's exact test where appropriate. **Results:** Sternocleidomastoid haemorrhage was the most frequent finding (78.70%), followed by hyoid fracture (17.16%) and carotid intimal tear (15.38%). Significant associations were observed between complete hanging and sternocleidomastoid haemorrhage ($p < 0.001$) as well as carotid injury ($p = 0.04$). Hyoid fractures showed a significant association with increasing age ($p = 0.004$). No association was observed with gender or ligature material. **Conclusion:** These findings highlight the influence of mechanical and anatomical factors in determining internal injury patterns and reinforce the importance of analytical evaluation in medico-legal interpretation.

Keywords: Hanging, Hyoid bone fracture, Carotid artery injury, Internal neck injuries.

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Introduction

Hanging continues to be the most prevalent method of ending one's own life globally, contributing to a considerable proportion of suicide-related fatalities. According to the World Health Organisation, approximately 700,000 deaths occur annually due to suicide, with hanging constituting a major proportion, particularly in Asian countries.[1] In India, hanging constitutes more than half of all suicides, guided by sociocultural, economic, and accessibility factors.[2,3]

Forensic investigation of hanging fatalities necessitates the incorporation of scene findings, external examination, and internal anatomical features. External post-mortem findings such as ligature marks and salivary dribbling are distinctive; however, internal neck injuries provide decisive insight into the pathophysiology of death, including vascular occlusion, airway compromise, and neuromuscular injury.[4,5]

Preceding studies have predominantly focused on descriptive documentation of internal neck injuries, with limited emphasis on analytical correlations with biomechanical and demographic variables.[6-8] This gap limits the revelatory value of such findings in medico-legal practice, particularly in differentiating suicidal hanging from other forms of neck compression.

Materials and Methods

This retrospective analytical study was undertaken in the Department of Forensic Medicine and Toxicology of A.J. Institute of Medical Sciences and Research Centre, Mangalore, a tertiary care teaching institution in South India. The study period extended over ten years, from January 2011 to December 2020. During this interval, a total of 1,842 medico-legal autopsies were performed, of which 169 cases were identified as deaths due to hanging. All cases included in this study were autopsied at A.J. Institute of Medical Sciences and Research Centre, Mangalore,

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ensuring uniformity in autopsy technique, documentation, and interpretation of findings. The diagnosis of hanging was established through a comprehensive and corroborative assessment of autopsy findings, police inquest reports, scene investigation records, and other relevant circumstantial evidence obtained from law enforcement authorities.

Only cases classified as suicidal hanging with complete and verifiable documentation were included in the analysis. Cases were excluded if records were incomplete or inconsistent, if decomposition significantly obscured relevant anatomical findings, or if the manner of death remained undetermined.

Complete hanging was defined as suspension in which the body was completely suspended, without any part of the being supported, whereas partial (incomplete) hanging referred to cases where some part of the body remained in contact with the ground or another surface.[9*]

Autopsies were performed in accordance with established medico-legal protocols. All autopsies were conducted by qualified forensic medicine specialists following standardised dissection protocols, minimising inter-observer variability.[10,11] Internal neck examination was performed using bloodless layer-by-layer dissection.

Data were analysed using the Statistical Package for the Social Sciences (SPSS), version 23 (IBM Corp., Armonk, NY, USA). Associations between categorical variables were evaluated using the Chi-square test or Fisher's exact test where appropriate. A p-value <0.05 was considered significant.

Ethical approval was obtained, and confidentiality was maintained.

Results

The findings of this study demonstrate that sternocleidomastoid haemorrhage/contusion (SCM haemorrhage) was the most frequent internal neck injury, reflecting the leading effect of muscular compression and traction in hanging, as elucidated in Table No. 1. The comparatively minimal frequency of skeletal and vascular injuries suggests that while these structures are involved, they are less affected in comparison to soft tissue. The rarity of cervical vertebral fractures and spinal cord injuries suggests that high-force trauma is uncommon in suicidal hanging, which typically involves gradual suspension and not the sudden drop.

Table 1: Internal Neck Injuries (n = 169)

Internal Neck Injury	Number of Cases	Percentage (%)
SCM haemorrhage	133	78.70
Hyoid fracture	29	17.16
Carotid tear	26	15.38
Cervical vertebral fracture	11	6.51
Spinal cord contusion	4	2.37
Thyroid cartilage fracture	3	1.78
Thyroid haemorrhage	2	1.18

The substantial correlation of sternocleidomastoid haemorrhage and carotid artery injury with complete hanging, as depicted in [Table 2], indicates that full body weight exerts significant mechanical force, resulting in increased tissue damage and vascular compromise.

Table 2: Association between Internal Neck Injuries and Type of Hanging

Internal Neck Injury	Complete Hanging	Incomplete Hanging	p-value
SCM haemorrhage	105	28	<0.001
Hyoid fracture	23	6	0.14
Carotid tear	22	4	0.04

The increasing incidence of hyoid fractures with age, as illustrated in [Table 3], reflects corresponding ossification, which decreases tractability and increases vulnerability to fracture.

Table 3: Association between Age and Hyoid Bone Fractures

Age Group	Present	Absent
<30 years	3	65
30–50 years	11	99
>50 years	15	35

Sternocleidomastoid haemorrhage/contusion was constantly noted across all sorts of ligature material [Table 4], with comparable proportions among rope (78.76%), cloth (78.57%), and wire/cable (75.00%). Although all cases wherein the belt is used as the ligature material showed haemorrhage, the small sample size restrains interpretability. Statistical analysis using the Chi-square test revealed no significant association between ligature material and the occurrence of sternocleidomastoid haemorrhage ($\chi^2 = 0.32$, $p = 0.95$).

Table 4: Association between Ligature Material and Sternocleidomastoid Haemorrhage (n = 169)

Ligature Material	SCM Haemorrhage Present n (%)	SCM Haemorrhage Absent n (%)	Total
Rope (n=113)	89 (78.76%)	24 (21.24%)	113
Cloth (n=42)	33 (78.57%)	9 (21.43%)	42
Wire/Cable (n=12)	9 (75.00%)	3 (25.00%)	12
Belt (n=2)	2 (100.00%)	0 (0.00%)	2
Total	133 (78.70%)	36 (21.30%)	169

The frequency of internal neck injuries was almost similar between males and females [Table 5]. Sternocleidomastoid haemorrhage was the most frequent finding in both genders, followed by hyoid bone fractures and carotid artery injuries.

Statistical analysis demonstrated no significant association between gender and internal neck injuries ($\chi^2 = 0.41$, $p = 0.94$), implying that gender does not substantially impact the occurrence of these injuries in suicidal hanging.

Table 5: Association between Gender and Internal Neck Injuries (n = 169)

Internal Neck Injury	Male (n = 108) n (%)	Female (n = 61) n (%)
SCM haemorrhage	85 (78.70%)	48 (78.69%)
Hyoid fracture	18 (16.67%)	11 (18.03%)
Carotid tear	17 (15.74%)	9 (14.75%)
Cervical fracture	7 (6.48%)	4 (6.56%)
Spinal cord contusion	3 (2.78%)	1 (1.64%)
Thyroid cartilage fracture	2 (1.85%)	1 (1.64%)
Thyroid haemorrhage	1 (0.93%)	1 (1.64%)

Discussion

The present study demonstrates a detailed analytical insight into the internal neck injury pattern in suicidal hanging. The findings emphasise the predominance of mechanical and anatomical determinants in shaping these patterns. The most dominant observation was the high frequency of sternocleidomastoid haemorrhage, which was seen in almost four-fifths of cases. This observation is in sync with multiple studies conducted across India, where neck muscular haemorrhage has been described as the most frequent internal finding in hanging, with occurrence ranging from 70% to 85%.[5,12,13] The comparison in findings can be ascribed to analogous hanging practices across India, which typically involve low suspension or partial suspension, resulting in gradual, measured and sustained constricting force around neck musculature rather than sudden traumatic injury.

Comparable patterns have been observed in other South Asian countries including Sri Lanka and Nepal, where sociocultural and environmental dynamics contribute the method of hanging.[14] In these territories, the use of immediately accessible ligature materials and domestic settings results in related biomechanical conditions. In contrast, analyses from Europe and North America have illustrated reasonably lower frequencies of muscular haemorrhage.[15,16] This difference may be due to variations in suspension methods opted, including a higher frequency of partial suspension and early rescue interventions due to efficient emergency response systems. These findings emphasise the impact of regional practices and healthcare infrastructure on injury patterns.

The significant correlation between complete hanging and increased internal neck injury observed in this study underlines the role of gravitational force in determining injury severity.[17] In a complete hanging, the full body weight acts on the neck structures, leading to increased constriction of neck muscles, vessels, and nerves. This results in more explicit haemorrhage and vascular injury.[5] Similar findings have been reported in studies from African countries, particularly from South Africa and Ghana, where complete suspension has been associated with higher rates of internal injury.[7,11] However, studies from developed nations have reported lower rates of such injuries, which may be due to variations in emergency response systems and the possibility of early intervention before irreversible damage occurs.[15]

Carotid artery intimal tears observed in this study highlight the critical role of vascular mechanisms in the pathophysiology of hanging. Obstruction of blood flow through the carotid arteries leads to cerebral ischemia and rapid loss of consciousness, often preceding airway obstruction. The presence of intimal tears indicates significant vascular compromise and vindicates the proposition that vascular occlusion is a principal mechanism of death in most hangings.[18-20] Variations in the prevalence of vascular injuries across different studies may be linked to differences in ligature position, tightness, and duration of suspension.

The correlation between hyoid bone fractures and increasing age observed in this study is consistent with global forensic literature.[21] As the age advances, like any other bone, the hyoid bone too undergoes ossification, resulting in reduced elasticity and increased fragility. This makes it more liable to fracture under pressure. This finding has been consistently reported across Indian, Asian, European, and North American studies, indicating that anatomical considerations play a dominant role in determining skeletal injury patterns, irrespective of geographical variation.

The reasonably low incidence of cervical vertebral fractures and spinal cord injuries seen in this study further supports the observation that most suicidal hangings involve low-force mechanisms. In contrast to judicial hanging or high-drop hanging, which produce sudden force and are associated with cervical vertebral and spinal cord injuries, suicidal hanging typically involves gradual suspension, resulting in nominal skeletal damage. This finding is consistent with studies from India and other developing regions.[11] In contrast, Western forensic literature reports higher rates of cervical injuries in cases

involving atypical or high-drop hanging, reflecting differences in the method and mechanics of suspension and constriction.[14]

The absence of a significant correlation between ligature material and internal neck injuries indicates that the nature of the ligature material has a limited impact on injury patterns. As a substitute, factors such as suspension dynamics, knot position, and body weight play a more critical role. This observation is consistent across multiple studies and reinforces the importance of mechanical factors over material characteristics. Similarly, the lack of gender-based variations in internal neck injury patterns shows that biological sex does not substantially influence the incidence of internal neck injuries in hanging.

From a medico-legal perspective, the findings of this study have important implications in differentiating suicidal hanging from other forms of neck constriction/compression, such as ligature strangulation. Strangulation is normally associated with more widespread soft tissue damage, deeper haemorrhages, and a higher incidence of skeletal injury due to external force applied by another individual in the course of accomplishing his guilty act. In contrast, suicidal hanging demonstrates relatively less severe but consistent internal findings, particularly muscular haemorrhage and occasional vascular injury.[10-11] Understanding these differences is crucial for the accurate determination of the manner of death. Collectively, the findings of the present study demonstrate strong alignment with the data from the Indian and South Asian populations, while emphasising important differences when compared with African and Western cohorts. These variations likely multifactorial, reflecting variations in suspension methods, environmental context, emergency response systems, and sociocultural practices. Accordingly study underscores the need for context-specific interpretation of forensic findings, integrating regional epidemiological patterns with biomechanical determinants.

Conclusion

Internal neck injuries in hanging exhibit consistent patterns predominantly influenced by mechanical forces and anatomical factors. The significant associations observed with the type of suspension and age emphasize the importance of biomechanical and demographic factors in determining injury patterns. Analytical evaluation of such findings enhances diagnostic precision and strengthens medico-legal interpretation, particularly in differentiating suicidal hanging from other forms of neck compression.

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Conflicts of interest

There are no conflicts of interest.

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