



ANATOMY OF THE HYOID BONE AND ITS FORENSIC SIGNIFICANCE IN STRANGULATION CASES

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ABSTRACT

Background: The hyoid bone is a small but vital structure situated in the anterior neck, serving as an important landmark in cases of asphyxial deaths. Its fracture is often regarded as a crucial indicator of manual strangulation, though the finding must be carefully interpreted in relation to age, ossification, and type of force applied. Understanding the anatomical variations and fracture patterns of the hyoid bone provides valuable insights in differentiating between various forms of neck compression deaths.

Methodology: This descriptive and observational study was carried out at Khairpur Medical College Khairpur Mir's over a period of one year, from January 2023 to December 2023, on 72 medicolegal autopsy cases of suspected strangulation. The hyoid bone, along with adjacent laryngeal structures, was carefully dissected and examined for shape, ossification status, fusion, and fracture. Associated soft tissue and histological changes were also assessed. Data were statistically analyzed using the Chi-square test, and a p-value less than 0.05 was considered significant.

Results: Fractures of the hyoid bone were observed in 50% of the cases, most frequently involving the greater horns. The U-shaped configuration was predominant (72.2%), and complete fusion between the body and greater cornua was seen in 55.6%. A significant correlation was noted between fusion status and fracture incidence ($p = 0.012$), and between type of strangulation and fracture presence ($p = 0.001$). Fractures were most common in older individuals and in cases of manual strangulation, whereas younger victims and ligature strangulations showed fewer fractures. Soft tissue hemorrhage and histological evidence of bleeding confirmed the antemortem nature of most injuries.

Conclusion: The study highlights the forensic value of examining the hyoid bone in deaths due to neck compression. The incidence and pattern of hyoid fractures depend strongly on age, ossification, and mechanism of strangulation. While fracture presence supports a diagnosis of manual

strangulation, its absence does not exclude asphyxial death. A comprehensive evaluation of bony, soft tissue, and histological findings is essential for accurate interpretation in forensic investigations.

Key Words: Anatomy, Hyoid Bone, Forensic Significance, Strangulation Cases

INTRODUCTION

The hyoid bone is unique, body is unique, position, forensic. for the body. Anatomically, the hyoid bone is located at the junction b/w the floor of the mouth & the neck, with no direct b/w the hyoid and any other bone in the body. For one to asphyxinate, the hyoid bone has to be broken. Small but anatomical- hyoid bone serves as key components in the diagnosing in mechanical asphyxia, diagnosing in strangulation and hanging cases. When the homicide is of strangulation, the case is hyoid bone fractures in a dx manner can explain theta the death was strangulation and can explain the mechanism in which death occurred [1-3].

Several elements determine the possibility of hyoid fracture, including the age, sex, bone structure, and degree of ossification. With age, bones become brittle and structurally weaker due to advanced ossification, making them more fracture-prone. In contrast, younger individuals possess a more cartilaginous and pliable bone structure, which greatly decreases the likelihood of fracture, even with lethal compression to the neck. Such differences in anatomy render the hyoid bone a unique and intricate structure to interpret in forensics [4, 5].

The significance of examining the hyoid bone does not rest solely on validating instances of strangulation, but also on distinguishing among the various forms of deaths: manual, ligature, and hanging. Older research has underlined the fact that hyoid fractures and laryngeal cartilage damage are more prevalent in cases of manual strangulation than any other types of asphyxia. The existence of accompanying soft tissue hemorrhage more conclusively demonstrates antemortem trauma and eliminates the possibility of a postmortem artifact [6-8].

This study focused on the morphology and fracture patterns of the hyoid bone, demonstrating their relevance to the variables of age, sex, and type of strangulation, while delineating their importance in forensics, specifically in the elucidation of the cause and manner of death. By integrating anatomical observations, this study aims to enhance forensic hyoid bone examination as a vital element in postmortem assessments of asphyxial fatalities.

METHODOLOGY

The present study was a descriptive and observational investigation conducted over a period of one year, from January 2023 to December 2023. The study aimed to examine the anatomical features of the hyoid bone and to analyze its forensic significance in cases of strangulation. A total of 72 samples were included in the research. These samples were collected from medicolegal autopsies performed at the Department of Forensic Medicine, Khairpur Medical College Khairpur Mir's. This study was conducted in accordance with the ethical standards of medical research and forensic examination. Official permission was obtained from the institutional authority, and confidentiality of the deceased individuals and case details was strictly maintained throughout the study.

All cases included in this study were medicolegal autopsies in which death was attributed to asphyxia resulting from manual or ligature strangulation. Cases with extensive decomposition, severe neck trauma unrelated to strangulation, or congenital anomalies of the hyoid-laryngeal complex were excluded to ensure the reliability of observations. Each case was carefully selected to represent a wide range of age groups and both sexes for comparative evaluation of ossification and fracture incidence.

During autopsy, the neck dissection was performed by the standard anterior approach. The hyoid bone, along with surrounding soft tissues, larynx, and upper trachea, was carefully removed as a single block to avoid damage. The structures were cleaned, examined, and preserved in 10% formalin until further analysis. For bones requiring detailed observation, the surrounding tissues were dissected gently to expose the hyoid without fracturing its delicate parts.

Each hyoid bone was inspected for its shape, size, and degree of ossification. The fusion status between the body and the greater cornua was recorded as *complete*, *partial*, or *non-fused*. Morphometric measurements, including the *length of the greater cornua*, *width and height of the body*, and *total transverse length*, were taken using a digital vernier caliper accurate to 0.01 mm. The findings were noted on a standardized data sheet prepared for the study.

Special attention was given to the presence or absence of fractures of the hyoid bone. When a fracture was identified, the site, type, and laterality were recorded. Associated injuries to neck structures such as the thyroid cartilage, cricoid cartilage, strap muscles, and vascular structures were also documented. The position and nature of ligature marks, the type of ligature material, and the manner of death (homicidal, suicidal, or accidental) were noted from autopsy findings and case records. In selected cases, histopathological examination of peri-hyoid soft tissues was performed to detect hemorrhage and confirm antemortem origin of the injuries.

All data were organized into categorical variables such as age, sex, ossification status, type of strangulation, and presence of fracture. The results were compiled and statistically analyzed using the Chi-square test to determine the level of association between selected parameters. A p-value of less than 0.05 was considered statistically significant. The analyzed data were represented through tables and graphs for clear visualization of trends and correlations.

RESULTS

In the present study of 72 post-mortem cases, the majority of victims were males, comprising 69.4% (n=50), while females accounted for 30.6% (n=22). The age of victims ranged from 15 to 78 years, with the largest proportion belonging to the 21–40 year age group (38.9%). This was followed by individuals aged 41–60 years (36.1%), whereas those younger than 20 years and above 60 years represented 8.3% and 16.7%, respectively.

This age-sex distribution reflects that young to middle-aged adult males were more frequently involved in strangulation cases, which aligns with the pattern of interpersonal violence and homicidal encounters commonly seen in forensic practice.

Table 1. Demographic Profile of Study Cases (n = 72)

Variable	Category	Number (n)	Percentage (%)
Age group (years)	< 20	6	8.3
	21–40	28	38.9
	41–60	26	36.1
	> 60	12	16.7
Sex	Male	50	69.4
	Female	22	30.6

Anatomical examination of the hyoid bone showed that the U-shaped form was predominant in 72.2% of the cases, whereas V-shaped bones were observed in 27.8%. Regarding the degree of fusion, complete fusion between the body and greater cornua was noted in 55.6%, partial fusion in 27.8%, and non-fusion in 16.7% of the bones.

These results indicate that ossification of the hyoid continues well into adulthood and that complete fusion tends to occur more frequently in middle-aged and older individuals, which has implications for the likelihood of fracture during neck compression.

Table 2. Morphological and Ossification Characteristics of the Hyoid Bone

Parameter	Category	No. of Cases (n)	Percentage (%)
Shape of hyoid	U-shaped	52	72.2
	V-shaped	20	27.8
Ossification status	Complete fusion	40	55.6
	Partial fusion	20	27.8
	Non-fused	12	16.7

Fractures of the hyoid bone were identified in 36 cases (50%). The greater horn was the most frequent fracture site, involved either unilaterally (25%) or bilaterally (13.9%). Body fractures were less common (11.1%). The remaining 36 cases exhibited no bony injury.

This distribution supports the established forensic observation that the greater horns are the most vulnerable portions of the hyoid due to their exposed and slender structure.

Table 3. Distribution of Hyoid Bone Fractures in Strangulation Cases

Fracture Site	Frequency (n)	Percentage (%)
Greater horn (unilateral)	18	25.0
Greater horn (bilateral)	10	13.9
Body	8	11.1
No fracture	36	50.0

A statistically significant correlation ($p = 0.012$) was observed between the fusion status of the hyoid and the presence of fracture. Cases with complete fusion showed a higher incidence of fracture (60%) compared with partial (40%) or non-fused (33%) bones. This finding implies that as ossification progresses and flexibility decreases, the susceptibility of the hyoid bone to fracture increases during compressive neck trauma.

Table 4. Correlation Between Hyoid Fusion Status and Fracture Incidence

Fusion Status	Fracture Present (n = 36)	Fracture Absent (n = 36)	Total	p-value
Complete fusion	24	16	40	0.012*
Partial fusion	8	12	20	
Non-fused	4	8	12	
*Significant at $p < 0.05$				

The occurrence of hyoid fracture increased with age. Only 33% of cases below 40 years showed fracture, whereas 62% of those aged 41–60 years and 83% of those over 60 years had detectable fractures. Statistical analysis revealed a significant association ($p = 0.021$) between age group and fracture incidence. The progressive ossification and brittleness of the hyoid with advancing age likely account for this trend.

Table 5. Association Between Age Group and Hyoid Fracture

Age Group	Fracture Present (n = 36)	Fracture Absent (n = 36)	Total	p-value
< 20 years	2	4	6	
21–40 years	8	20	28	
41–60 years	16	10	26	0.021*
> 60 years	10	2	12	
*Significant at $p < 0.05$				

The manner of death was homicidal in the majority of cases (72.2%), followed by suicidal (19.4%) and accidental (8.3%) incidents. Ligature strangulation was slightly more frequent (55.6%) than manual strangulation (44.4%).

Rope was the most common ligature material (25%), followed by dupatta/cloth (19.4%) and wire/electric cord (11.1%). In half the cases, the ligature mark lay at the level of the thyroid cartilage. Associated neck injuries and soft-tissue hemorrhage were observed in 61.1% and 63.9% of victims respectively, while histological evidence of hemorrhage was positive in 66.7% of cases, confirming antemortem trauma.

Table 6. Forensic Variables Associated with Strangulation Cases (n = 72)

Variable	Category	No. of Cases (n)	Percentage (%)
Manner of Death	Homicidal	52	72.2
	Suicidal	14	19.4
	Accidental	6	8.3
Type of Strangulation	Manual	32	44.4
	Ligature	40	55.6
Ligature Material	Rope	18	25.0
	Dupatta/cloth	14	19.4
	Wire/electric cord	8	11.1
Position of Ligature Mark	Above thyroid cartilage	22	30.6
	At thyroid cartilage level	38	52.8
	Below thyroid cartilage	12	16.7
Associated Neck Injuries	Present	44	61.1
	Absent	28	38.9
Soft Tissue Hemorrhage	Present	46	63.9
	Absent	26	36.1
Histological Hemorrhage	Positive	48	66.7
	Negative	24	33.3

A significant association ($p = 0.001$) was found between the **type of strangulation** and **presence of hyoid fracture**. Fractures were observed predominantly in **manual strangulation (81%)**, whereas only **25%** of ligature strangulation cases showed hyoid damage.

This reinforces the established forensic principle that manual strangulation exerts greater direct pressure on the hyoid and laryngeal skeleton, making fracture a key diagnostic indicator.

Table 7. Correlation Between Type of Strangulation and Hyoid Fracture

Type of Strangulation	Fracture Present (n = 36)	Fracture Absent (n = 36)	Total	p-value
Manual	26	6	32	0.001*
Ligature	10	30	40	
Total	36	36	72	
*Significant at $p < 0.05$				

Overall, the study demonstrates that hyoid fracture is more likely in older, male individuals and in cases involving manual strangulation. The fracture commonly affects the greater horns, particularly when ossification and fusion are complete. These results highlight the diagnostic importance of meticulous hyoid examination in all suspected strangulation deaths.

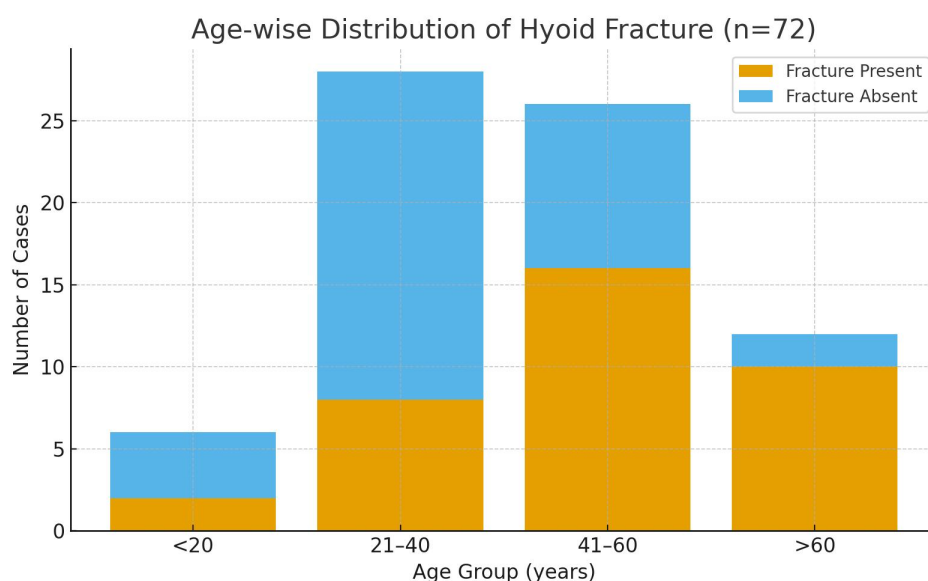


Figure 1: bar graph illustrating the **age-wise distribution of hyoid fractures** among the 72 cases. It clearly shows that the incidence of fracture rises markedly with age particularly in individuals over 40 years aligning with the finding that ossified, less flexible hyoid bones are more prone to fracture under compressive force.

DISCUSSION

The anatomy of the hyoid bone plays a crucial role in understanding mechanical asphyxia, particularly in strangulation deaths. In this study, fractures of the hyoid bone were detected in half of the examined cases, showing a clear relationship between age, degree of ossification, and type of strangulation. These findings carry significant forensic value in differentiating between manual and ligature strangulation, as well as in confirming the vitality of neck injuries.

The present analysis revealed a higher frequency of hyoid fracture among males and in the older age groups, particularly those above 40 years. This pattern corresponds with the findings of studies, who observed that ossified, less flexible bones in older individuals are more prone to fracture when subjected to compression forces [9-12]. In contrast, younger bones, which retain more cartilaginous elements, often remain intact even in fatal compression of the neck. This may reflect the biomechanical transition of the hyoid bone with age from a pliable structure in youth to a brittle, calcified bone in later life [13-15].

The U-shaped morphology predominated in this study, accounting for more than two-thirds of cases, which aligns with studies reported U-shaped hyoids as the most common variant. The predominance of the U-shape may influence fracture susceptibility since the greater cornua of a U-shaped hyoid are more laterally extended and thus more exposed to mechanical forces during manual strangulation [16].

The current findings demonstrated that fractures occurred most frequently at the greater horns, followed by the body of the hyoid. This distribution pattern agrees with the observations of Knight and Saukko (2016), who described the greater cornua as the weakest points due to their thin cortical structure and direct exposure to pressure applied by fingers or a ligature. The statistically significant correlation ($p = 0.012$) between fusion status and fracture incidence indicates that complete ossification increases rigidity, predisposing the bone to break under compressive load. Similar conclusions were drawn by Aggarwal et al. (2020), emphasizing that fusion is a critical factor when interpreting post-mortem hyoid fractures.

The type of strangulation showed a clear association with fracture presence. Fractures were significantly more common in manual strangulation than in ligature cases ($p = 0.001$). This observation is consistent with study who reported that manual throttling produces direct localized pressure on the hyoid, while ligature strangulation often applies force over a broader area, leading to fewer fractures [17]. This difference is of considerable forensic importance, as the presence and nature of hyoid fracture can help distinguish between these mechanisms of asphyxia.

The study also found soft tissue hemorrhage and peri-hyoid muscle injury in over sixty percent of cases. These findings reinforce the fact that fractures accompanied by hemorrhage represent antemortem events, as opposed to postmortem artifacts. Histological confirmation of hemorrhage in 66.7% of cases further supports this interpretation. Similar microscopic evidence of vital reactions around hyoid fractures was described by studies validating its diagnostic reliability [18, 19].

Reflecting on the findings, this study highlights that the presence or absence of a hyoid fracture cannot alone confirm strangulation, but when considered alongside soft tissue and histological evidence, it becomes a highly persuasive indicator. The combination of age, bone fusion status, fracture pattern, and associated hemorrhage provides a comprehensive forensic framework for establishing cause and manner of death. This integrated anatomical-forensic approach reinforces the importance of meticulous neck dissection and hyoid examination during autopsy [20].

CONCLUSION

The analysis of 72 autopsy cases over one year established that hyoid bone examination is a vital component in the investigation of suspected strangulation deaths. Fractures were predominantly found in older, ossified bones and were significantly associated with manual strangulation. The greater horns were the most common sites of injury, and the coexistence of soft tissue hemorrhage strengthened the interpretation of antemortem trauma.

The findings support the established view that while the presence of a hyoid fracture strongly suggests compressive neck injury, its absence does not exclude strangulation, particularly in younger victims where ossification is incomplete. This study emphasizes the forensic value of correlating anatomical and histological evidence to determine the mechanism and manner of death. The results contribute to the growing body of literature affirming that the hyoid bone, though small, holds immense diagnostic significance in forensic pathology.

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