Original Article

Autopsy-Based Cross-Sectional Observational Study on Carotid Artery Injury in Non-Penetrative Neck Trauma

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Abstract

Background: Non-penetrative neck trauma poses a significant risk of carotid artery injury, which can lead to severe consequences. Diagnosis of carotid artery injury in non-penetrative trauma remains challenging due to delayed clinical presentation. Research on non-penetrative mechanisms of injury is relatively less common compared to penetrating trauma. This study aims to analyse patterns of vascular injuries in compression injuries to the neck, focusing on non-penetrative trauma.

Materials and Methods: A cross-sectional study was conducted in a Forensic Medicine Department of Government Stanley medical college, Chennai, over a one-year period, analysing 150 cases of non-penetrative neck trauma. Post-mortem data, including gross and histopathological findings, were collected and analysed.

Results & Discussion: Among the 150 cases studied, hanging was the most prevalent cause of blunt cervical trauma. The majority of cases affected individuals were between the age group 21 and 40 years, with male preponderance. Gross examination revealed intimal tears in a proportion of cases, with histopathological examination identifying a higher prevalence of injuries. Posterior knot ligatures were predominant in both complete and partial hanging cases, correlating with a higher incidence of carotid body haemorrhage. The association between posterior knot position and carotid body haemorrhage emphasizes specific vulnerabilities in hanging cases.

Conclusion: The findings of the study emphasize the importance of forensic investigations in identifying vascular injuries, guiding injury prevention strategies, and informing medicolegal proceedings. Further research is needed to enhance diagnostic and management approaches in clinical and forensic practice.

Keywords: Non penetrative trauma, Carotid artery injury, Carotid body haemorrhage, Autopsy-based study

Introduction

Non-penetrative neck trauma, although less frequent than penetrating trauma, poses a significant risk of carotid artery injury (CAI), which can lead to devastating consequences such as stroke, vascular compromise, and even death. Diagnosing carotid artery injury (CAI) in non-penetrative trauma can

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be difficult due to its potential for delayed clinical presentation and subtle or nonspecific symptoms.

Non-penetrative neck trauma encompasses a diverse array of incidents, such as motor vehicle accidents, sports-related injuries, fall from heights, strangulation, and blunt assaults. These events can lead to various forms of trauma to the neck structures through blunt force impact, compression, and hyperextension. The carotid arteries, vital conduits supplying blood to the brain, are susceptible to stretching, compression, or tearing during traumatic events, especially those involving rapid deceleration or blunt force impact.

Existing literature suggests that certain demographic factors such as age, gender, and underlying medical conditions may influence the susceptibility to carotid artery injury following non-penetrative neck trauma. Moreover, the mechanism and severity of trauma, including the direction and magnitude of force, may impact the probability and extent of carotid artery injury. Furthermore, anatomical variations, such as tortuosity or aberrant branching patterns of the carotid arteries, may predispose individuals to injury. Despite advancements in diagnostic imaging and clinical evaluation, carotid artery injury in non-penetrative neck trauma remains underexplored, particularly from a post-mortem perspective.

Autopsy-based studies present a distinctive opportunity to systematically evaluate carotid artery injury in non-penetrative neck traumaenabling the detection of subtle injuries, characterization of injury patterns, and correlation with clinical findings. An autopsy-based cross-sectional observational study was conducted with the aim to advance understanding of carotid artery injury in non-penetrative neck trauma, elucidating the epidemiology and associated factors underlying this condition. The incidence of carotid artery injury was assessed by both gross and histopathological examination.

Materials and Methods

The present study was conducted as an autopsy based cross sectional study to analyse the pattern of vascular injuries in compression injuries to the neck in the Department of Forensic Medicine & Toxicology, Government Stanley Medical College between May 2021 and April 2022. Ethical clearance was obtained from the Institutional Ethical Committee [Certificate No. FM201420101002 dated 24/03/2021] before commencement of the study150 cases of deaths due to non-penetrative injury to the neck such as hanging, strangulation, road traffic accidents, railway accidents, workplace accidents and fall from height subjected to postmortem examination in Government Stanley Medical College Mortuary on receiving requisition from the concerned investigating officer was included for the study. Data was collected from the post mortem records, inquest reports and histopathological examination. In case of death due to hanging, details like position of knot, completeness of hanging (partial or complete) were also obtained. Based on the position of knot, deaths due to hanging were divided into anterior, posterior, left and right represented as I, II, III and IV respectively. Also, cases of hanging were further categorised based on completeness of hanging as complete hanging (A) and incomplete hanging (B). The possibility of association between the position of knot in hanging, the completeness of the victim's body suspension and vascular injury was explored.

In all the cases of non-penetrative trauma to neck, layer by layer bloodless dissection of neck was done. After removing the neck organs, gross examination of the both right and left carotid arteries was done by making longitudinal cuts with the blunt arm of scissors to visualize its intimal layer. Both right and left carotid arteries were subjected to histopathological examination.

Observations:

(a) Among 150 cases of blunt cervical trauma, hanging cases were 91, strangulation 8 cases, fall from height 13 cases, road traffic accidents 28 cases, railway accidents 5 and workplace accident were 5. Out of the 150 cases, 113 were male and 37 were female.

(b) The primary age group affected in both genders fell within the range of 21– 40 years, comprising 52.67% (n = 79) of cases. The least affected age group consisted of individuals over 80 years old, with only 2 cases (n = 02).

(c) Out of 91 instances of hanging, gross examination revealed an intimal tear in 22 cases, with 21 cases exhibiting unilateral tear, 1 case demonstrating bilateral tear in the carotid artery and artery dissection was observed in 2 cases (Fig. No.1,2). Among the 8 cases of strangulation and 5 railway accident cases, no vessel wall injury was detected upon gross examination. In road traffic accidents, 2 cases displayed unilateral intimal tear. For falls from height and workplace accidents, one case each showed unilateral intimal tear upon gross examination, while the rest appeared normal.

(d) Out of 91 hanging cases, histopathological examination revealed intimal tear in 32 cases, with 30 cases showing unilateral tear, 2 cases with bilateral tears,3 cases with artery dissection (Fig.No.3,4,5). In cases of strangulation and road traffic accidents, histopathological examination revealed unilateral intimal tear in 2 out of 8 cases and 3 out of 28 cases, respectively (Fig.No.6). Unilateral intimal tear was noted in one case each of railway accidents and workplace accidents, and in 2 cases of falls from height.

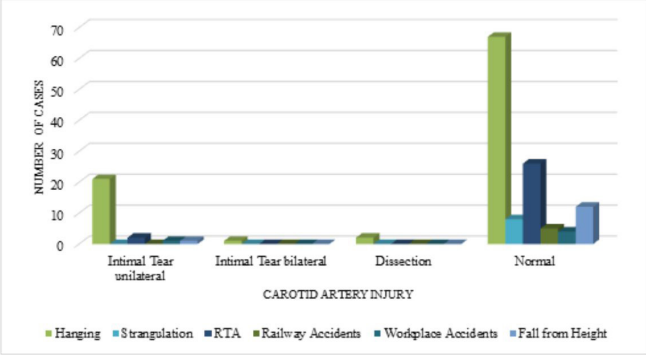

Fig. No. 1: Carotid Artery Injury in Gross Examination and Type of Trauma Associated

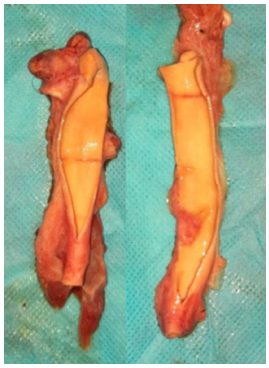

Fig.No.: 2 Bilateral Carotid Artery Intimal Tear in a Case of Hanging - Gross

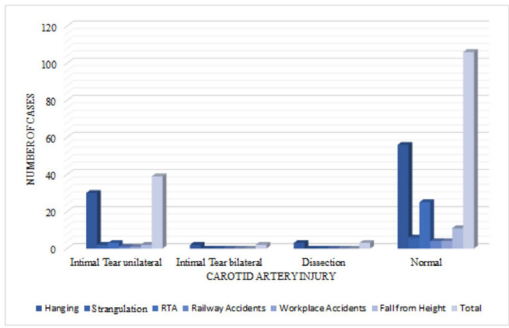

Fig No. 3: Carotid Artery Injury in Histopathological Examination and Type of Trauma Associated

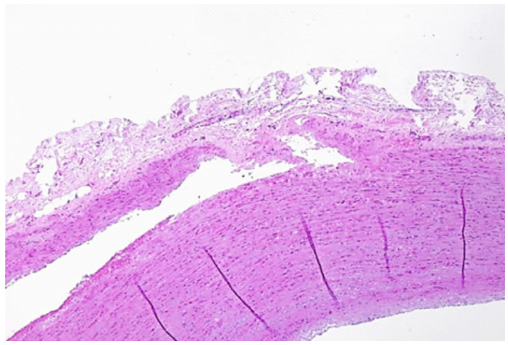

Fig. No. 4: Carotid Artery Intimal Tear – Histopathology

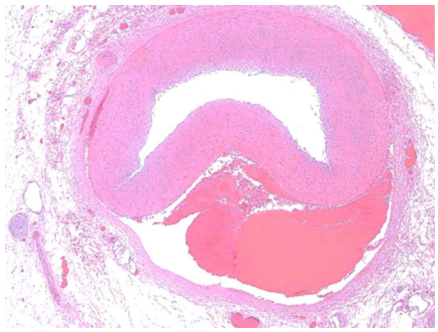

Fig. No. 5. Carotid Artery Dissection - Histopathology

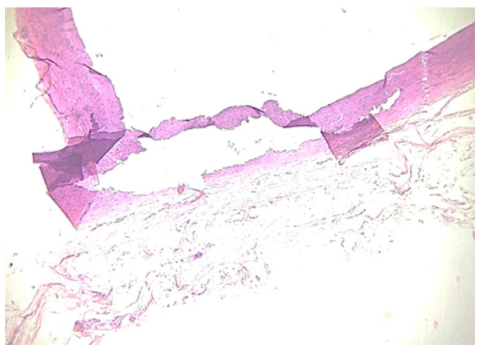

Fig. No.6: Left Carotid Artery Showing Longitudinal Intimal Tear in a Case of Strangulation – Histopathology

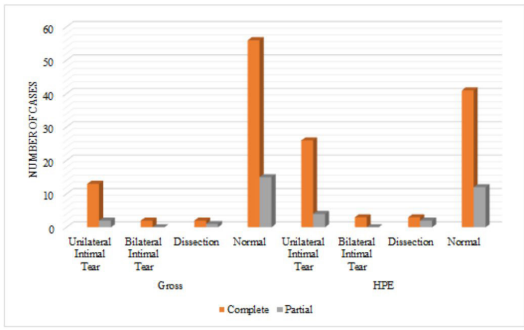

Fig. No. 7: Carotid Artery Injury and Completeness of Hanging

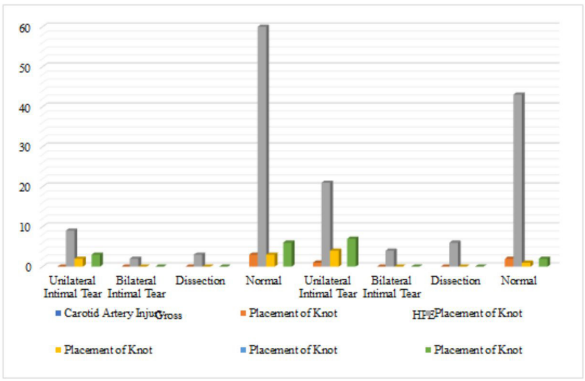

Fig. No. 8: Carotid Artery Injury and Position of Knot

(e) Out of 91 hanging-related deaths, 73 were instances of complete hanging. Among these complete hanging cases, 52 were males and 21 were females. Regarding complete hanging cases in males, an anterior knot was observed in 2 cases (3.85%), a posterior knot in 43 cases (82.69%), a left-side knot in 2 cases (3.85%), and a right-side knot in 5 cases (9.62%). In females with complete hanging cases (21 in total), an anterior knot was observed in 1 case (4.76%), a posterior knot in 17 cases (80.95%), a left-sided knot in 1 case (4.76%), and a right-sided knot in 2 cases (9.52%).

(f) There were 18 instances of partial hanging in total, with 14 involving males and 4 involving females. There were no cases of partial hanging observed with an anterior knot. Among males with partial hanging cases, a posterior knot in 11 cases (78.57%), a left-side knot in1 cases (7.14%), and a right-side knot in 2 cases (14.29%). For females with partial hanging cases (4 in total), a posterior knot in 3 cases (75%), a left-sided knot in 1 case (25%). Female cases of partial hanging with right sided knot were not observed in the study.

(g) In Gross examination of complete hanging cases (73 cases), 13 (17.81%) cases had unilateral intimal tears, 2 (2.74%) cases had bilateral intimal tears and dissection was seen in 2 (2.74%) cases. In Partial Hanging Cases (18 cases), unilateral intimal tear was seen in 2 cases (11.11%) and dissection was seen in 1 case (5.56%). During histopathological examination of 73 cases of complete hanging, unilateral intimal tear was found in 26 cases (35.62%), bilateral intimal tear in 3 cases (4.11%), and dissection was observed in 3 cases (4.11%). In the case of partial hanging (18 cases), unilateral intimal tear was present in 4 cases (22.22%), and dissection was observed in 2 cases (11.11%). (Fig. No.7)

(h) No vessel wall injury was noted in cases with anterior knot ligature upon gross examination. Among cases with a posterior knot ligature (74 cases), gross examination revealed unilateral intimal tear in 9 cases, bilateral intimal tear in 2 cases, and dissection in 3 cases. For cases with a left-side knot, gross examination showed unilateral intimal tear in 2 cases. Among the 9 cases with a right-sided knot, gross examination revealed unilateral intimal tear in 3 cases. (Fig. No.8)

(i) In histopathological examination, one case with anterior knot displayed unilateral intimal tear. Among cases with a posterior knot ligature (74 cases), histopathological examination unveiled unilateral intimal tear in 21 cases, bilateral intimal tear in 4 cases, and dissection in 6 cases. Regarding cases with a left-side knot, histopathological examination identified unilateral intimal tear in 4 cases. Among the 9 cases with a right-sided knot, histopathological examination revealed unilateral intimal tear in 7 cases. (Fig.No.8)

(j) In 14 cases of unilateral intimal tear in gross examination, Amussat's sign was found in 11 (78.57%) cases and rest were longitudinal laceration of intimal layer. Both the cases of bilateral tears seen by gross examination were transverse tear of intima (Amussat's sign). In histopathological Examination, out of 33

unilateral tears, transverse tear was seen in 23 (69.70%) cases and all the 4 (100%) cases of bilateral tears were transverse lacerations.

(k) Carotid Body Hemorrhage was exclusively observed in hanging cases with posterior knot during both gross and histopathological examination. 2 cases in gross examination and 5 case in histopathological examination showed carotid body haemorrhage.

Discussion

In the present study, the distribution of blunt cervical trauma cases across different mechanisms highlights the diverse nature of injuries encountered in forensic settings. Hanging stands out as the primary cause, followed by road traffic accidents. This corresponds with the study done by Ashok Subash Jiwane et al. The demographic distribution of cases reveals a male predominance, consistent with previous studies on traumatic deaths done by Sharija Jayaprakash et al.The peak incidence of blunt cervical trauma in the 21-40 age group, reflecting the active and potentially risky behaviours of this demographic, corresponds with the findings of a study by B.R. Sharma et al.

Analysis of the vascular injuries observed in non-penetrating neck trauma cases reveals a spectrum of findings, including intimal tears, artery dissection, and carotid body hemorrhage. Interestingly, while gross examination identified a substantial proportion of cases with no vessel wall injury, histopathological examination revealed a higher prevalence of intimal tears and dissections, emphasizing the importance of histopathological assessment in identifying vascular injuries that may not be apparent during gross examination.

The incidence of carotid artery injury in hanging cases are consistent with study of Hejna P, Ashok Subhash Jiwane et al.[3,] In the current study, incidence of carotid artery tear was high in cases of complete hanging compared to partial hanging. In anterior hanging cases, only one case had vessel wall injury. A statistically significant association was found between incidence of carotid artery injury and the position of knot which is supported by similar studies conducted by Petr Hejna et al.[6]

The distribution of knot positions in hanging cases provides additional insights into the mechanism of injury. Posterior knot ligatures predominate in both complete (82.19%) and partial hanging (77.78%) cases, aligning with the biomechanics of hanging and the typical orientation of ligature marks. Partial hanging with anterior knot was not seen in the study. This observation corresponds with the study conducted by Vijayakumari et al.

Amussat's sign highlights the significance of this histopathological feature in hanging cases, whichreinforces the understanding that hanging-related vascular injuries result from mechanical stretching or shearing forces as described by Mahmut Asirdizer et al.Additionally, there was increased incidence of transverse lacerations in the intimal layer compared to longitudinal lacerations in the present study.

In cases of strangulation, carotid artery injury was observed only in histopathological examination. In a study conducted by Le Blanc - Louvry I et al it was seen that extra cranialcarotid artery injuries are more common in strangulation than intracranial lesions.In a study by Amadasi et al., carotid artery tears were noted in both gross and histopathological examinations of road traffic accident cases, with more vessel injuries detected histopathologically in gross examination, supporting findings in the present study. Similarly in cases of railway accidents, workplace accidents and fall from height, histopathological examination revealed more vessel wall injury compared to gross examination.

Height of descent, position of body on landing, rate of deceleration, impact surface, clothing etc influences the incidence of injuries associated with fall from height. Skeletal injuries are predominantly found in cases of fall from height. Hence it can be presumed that vascular injuries associated with skeletal injuries may occur. Also, vascular injuries may occur independently due to direct trauma from impact surface. Carotid body haemorrhage was seen in cases of posterior hanging only (2 cases in gross examination and 5 cases in histopathology). This corresponds with the increased incidence of carotid artery injury in this study. The association between posterior knot position and carotid body haemorrhage further substantiates previous research

findings indicating that the posterior aspect of the neck is particularly vulnerable to vascular injury during hanging.

Conclusion

In conclusion, the present autopsy-based cross-sectional study provides critical insights into carotid artery injuries resulting from non-penetrative trauma to the neck in terms of epidemiology, patterns, and associated factors of carotid artery injury. The findings of the study underscore the importance of thorough forensic investigations in cases of blunt neck trauma. We have identified demographic factors, such as age and comorbidities, as well as the mechanism and severity of trauma, as key determinants of carotid artery injury risk. A comparative study of vascular injuries in live patients and autopsy-based study will provide deep insight into mechanism of the injury. MSCT (Multislice computed tomography) angiography can be used to identify vascular lesions better than traditional autopsy methods and histopathological examination. Identifying the vitality of Amussat sign is important to differentiate hanging death from postmortem hanging of the body. In cases where vascular injury is observed in gross or histopathological examination, the brain tissue can also be subjected to histopathological examination to gain knowledge about the effect of vascular injuries on brain tissue. Moving forward, continued research in this field is essential for improving diagnostic accuracy, improving patient outcomes, and advancing forensic science methodologies.

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Ethical Clearance: Government Stanley Medical College & Hospital, Chennai - 0 I, Institutional Ethics Committee - 24/03/2021

Conflicts of interest statement: Nil

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