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CASE REPORT

HINGE SKULL FRACTURES IN PEDESTRIANS: REVIEW WITH THREE FATALITIES

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ABSTRACT

Hinge fractures typically occur as a result of direct force to the chin, lateral head impacts, or side-to-side compression and are frequently associated with high-velocity collisions involving motorcyclists, commonly referred to as "motorcyclist fractures." This report discusses three cases of hinge fractures identified during the autopsies of pedestrians. In all three cases, the autopsies revealed a hinge fracture extending obliquely through the middle cranial fossa from one lateral side to the other, with no evidence of injuries to the chin. Analyzing the mechanisms underlying these fractures provides valuable insights into the circumstances of the incidents and aids in reconstructing the events leading to the injuries.

Keywords: *Autopsy; pedestrian; road traffic collisions*

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INTRODUCTION

A hinge fracture (HF) is a specific type of skull base fracture characterised by a transverse fracture line, commonly across the middle cranial fossa, involving the temporal and sphenoid bones. The fracture line traverses the pituitary fossa, following the path of least structural resistance. The term "hinge" describes the movement of the separated skull segments, which resembles the motion of a hinge.

In general, skull base fractures are relatively uncommon, occurring only in approximately 4% of all patients with severe head injuries[1]. These fractures are frequently associated with motorcyclists involved in high-velocity collisions. One study revealed that, among victims of motor traffic accidents, only 15% of motorcyclists did not sustain skull base fractures[2]. HF, a unique type of skull base fracture, is often referred to as the "motorcyclist fracture" due to its high incidence among motorcyclists.

Although the HF is defined as a transverse fracture of the skull base, the anatomical pathways of the fracture line can vary significantly. However, no definitive single classification is consistently described in the literature. In the commonly used classification, three types of HFs are described as Types I, II, and III[3]. Type I traverses the middle cranial fossa from one petrous ridge to the contralateral petrous ridge, passing through the sella turcica. Type II extends from the front to the contralateral back through the sella turcica, thus involving the anterior, middle, and posterior cranial fossae. Type III follows the suture lines of the frontal and sphenoid bones in the coronal plane without involving the sella turcica[3]. However, in clinical practice, variations of HFs are encountered that do not fit into any of these categories.

Three different mechanisms have been identified in the causation of HFs. One is side-to-side compression of the skull, as in run-over injuries in road traffic trauma. Here, either side's fracture lines meet at the midline of the skull base. The second mechanism is unilateral force over one temporal bone, in which the force is strong enough to cause a skull base fracture that extends to the contralateral temporal bone. The third mechanism is where force is applied on the mandible (chin), which transmits upward along the mandibular rami or zygomatic arch, entering the skull base through the temporomandibular joint and meeting at the centre. In the latter, there will be evidence to suggest an impact on the chin. The third mechanism has been largely studied using the finite element analysis method and has confirmed the force transmission pathway[4,5].

In common practice, though HFs are considered in motorcycle riders following high-velocity trauma, these fractures can also occur in pedestrians.

CASE HISTORY

Case 01: A 44-year-old female was knocked down by a van from behind, resulting in her hitting her head on the windscreen and then the ground, according to the eyewitness evidence. The autopsy revealed a HF in the middle cranial fossa running obliquely across the sella turcica with additional linear fractures in the anterior and posterior cranial fossae (Fig. 1a)

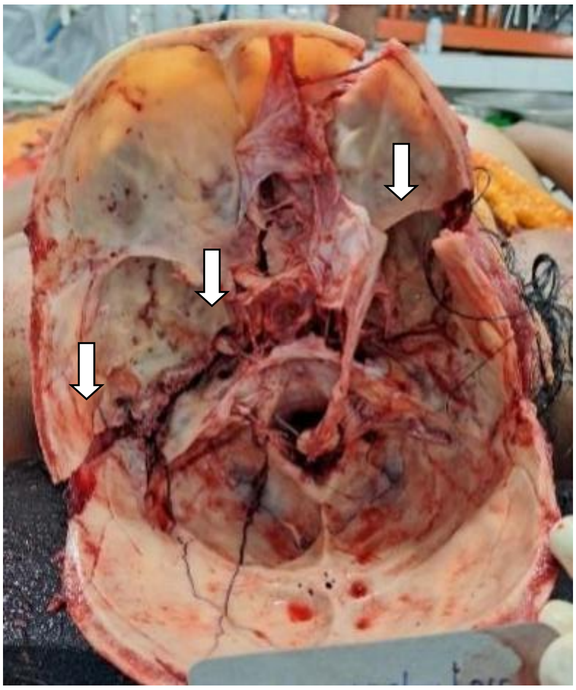
Case 02: A 77-year-old male was hit by a three-wheeler from the front, ejecting him onto the road. CCTV footage was available as circumstantial evidence. The autopsy showed a HF in the middle cranial fossa, which ran obliquely across the sella turcica with a separate linear fracture in the posterior cranial fossa and sagittal suture diastasis. (Fig. 1b)

Case 03: An 80-year-old male was knocked down by a motorcycle. Autopsy findings included a HF in the middle cranial fossa, running obliquely from the right side posterior margin to the left side anterior margin, across the sella turcica, and extending to the left temporal bone of the skull vault (Fig. 1c).

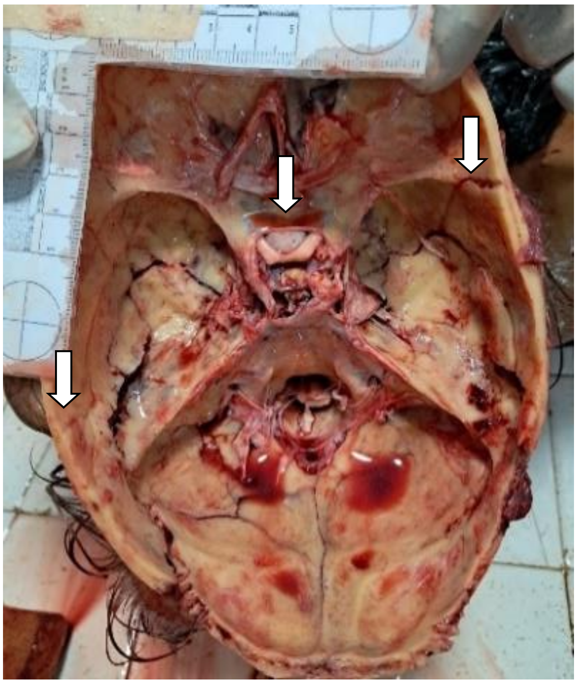
In all three cases, there were no mandibular (chin) injuries or deformation of the head due to side-to-side compression. Lateral impact over the temporal region and mandible, resulting in a transverse fracture of the skull base, is the most plausible mechanism in all three cases. The oblique anatomical pathway of the fracture, rather than a clear transverse line, may provide additional clues regarding the mechanism of injury.

Base of the skull fractures require high-energy impacts. Studies have been conducted to determine the force necessary to cause such fractures, with one study indicating that the artificially induced failure force ranges between 3,000 N and 7,000 N[6].

CASE 1



CASE 2



CASE 3

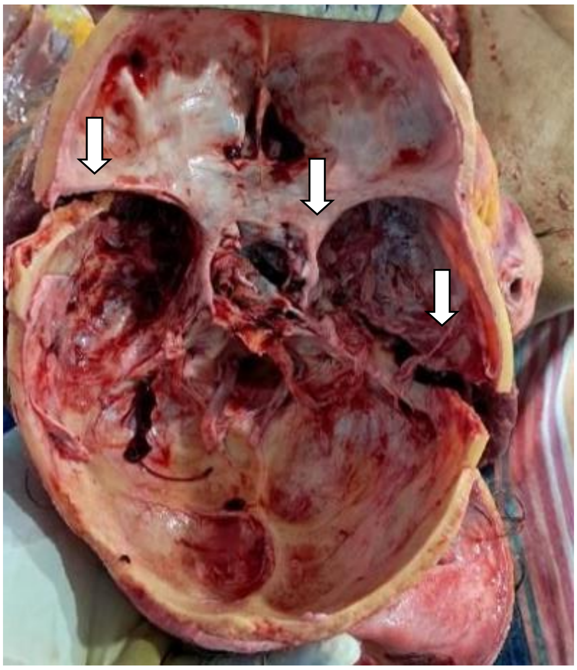


Figure 1: Hinge fractures in each autopsy, running obliquely across the sella turcica, indicated by white arrows

CONCLUSION

Hinge fractures, traditionally associated with motorcyclists and high-velocity trauma, can also occur in pedestrian accidents, as demonstrated by the three cases presented. Understanding these fracture patterns is crucial in forensic and clinical settings, as they can aid in reconstructing the mechanism of injury and distinguishing between different modes of head trauma.

ACKNOWLEDGMENTS
None.

CONFLICTS OF INTEREST
The authors declared no conflicts of interest.

ETHICAL ISSUES
The presented cases were conducted for medico-legal purposes, and the findings were used for academic purposes, according to the institutional guidelines, without divulging the identity of the individuals.

SOURCES OF SUPPORT
None.

AUTHOR CONTRIBUTIONS
JAPTW: Concept designing, acquisition, compiling and analysing of intellectual material, drafting of the manuscript, editing and final agreement of the content to be published. **PP:** Intellectual contribution towards concept, content editing for intellectual input, finalizing the manuscript, and final approval of the version to be published.

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