Case #148

NAME Educational Activities Committee

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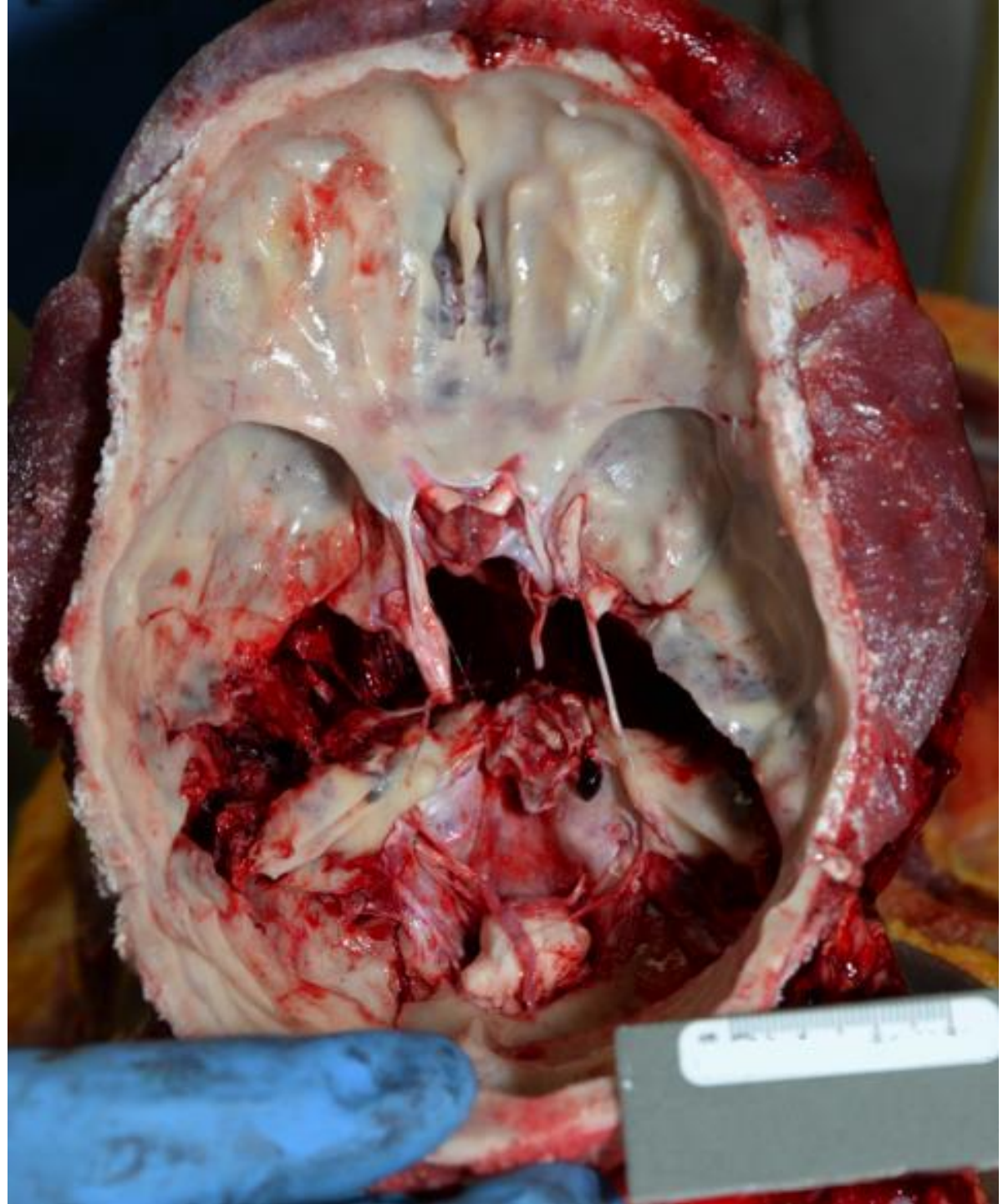


An adult female was found dead beneath bushes along a city sidewalk with initial suspicion of foul play. At autopsy, the finding seen in the photo was identified. Based on the provided image, what is the most likely cause of the observed finding?

A. Blunt force trauma to the temple from a falling air compressor.

B. High-speed motor vehicle collision with severe head–neck hyperflexion/extension

C. High-energy impact to the sacrum

D. Intraoral shotgun wound

Answer...

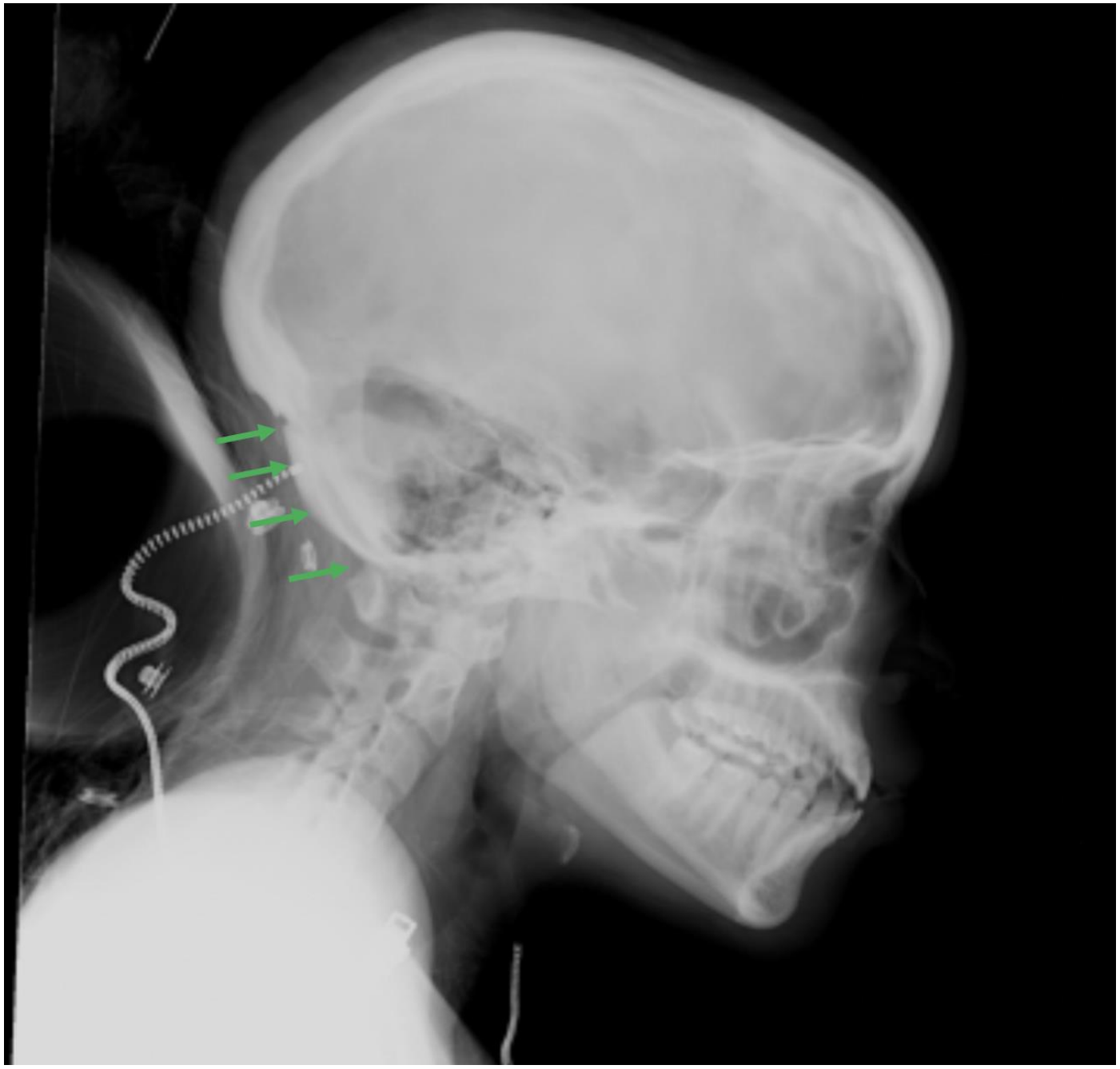
C. Fall from height onto the buttocks (*Correct Answer: 44.5%*)

A ring fracture (foramen magnum ring fracture) is a basilar skull fracture caused by massive axial loading transmitted through the occipital condyles and foramen magnum region. A ring fracture classically occurs after a fall from height with landing on the feet or buttocks, with axial force transmitted upward through the cervical spine. It can also occur after a direct impact to the top of the head, with axial force transmitted downward onto the cervical spine, generally seen in motorcycle accidents. Finally, a ring fracture can develop during pedestrian versus vehicle collisions, if there is a vertical compression of the cervical spine.

High-energy longitudinal loading (such as falling from height onto the buttocks or rapid torso deceleration in pedestrian, vehicle collisions, or crushing/head-first impact) drives the cervical spine and condyles into the skull base, generating the shearing forces needed to separate the bone in this region. All these mechanisms are biomechanically equivalent and produce the same fracture pattern.
These forces are far greater than those produced by simple falls and blunt force injuries seen in assault.

In this case, the deceased was involved in a hit and run event and sustained multiple severe blunt force injuries involving numerous anatomical regions, including a ring fracture identified upon opening the skull.

Correct Answer: C. Fall from height onto the buttocks



The green arrows show a depression deformity of the skull base.

A. Blunt force trauma to the temple from a falling air compressor. (*incorrect: 13.9%*)

Hinge fractures are severe basilar skull fractures in which a transverse break extends across the skull base and may allow the two halves of the skull to move like a hinge. They result from significant force applied to the circumference of the head. Blood in the external auditory canal can signal its presence. Hinge fractures frequently accompany catastrophic brainstem injuries, particularly pontomedullary tears.

B. High-speed motor vehicle collision with severe head–neck hyperflexion/extension (*incorrect: 31.5%*)

Severe head–neck hyperflexion/extension such as in a high-speed motor vehicle collisions does not produce the vertical axial loading required for a ring fracture. Instead, this mechanism disrupts the craniocervical ligaments and is a classic cause of atlanto-occipital dislocation. AOD typically results from violent hyperextension, flexion-distraction, or vertical distraction injuries that tear the stabilizing ligaments between the skull and C1.

Lateral X-ray with AOD

Lateral CT with AOD

CT Reconstruction of AOD

D. Intraoral shotgun wound (*incorrect: 10.1%)*

An intraoral shotgun wound can produce massive destructive trauma to the face and skull base, but it does not generate the biomechanical forces required to produce a true ring (foramen magnum) fracture. A ring fracture forms only when intense axial loading is transmitted upward through the vertebral column into the occipital condyles, causing a circumferential separation of the skull base. In contrast, an intraoral shotgun blast delivers force from inside the mouth and skull, expanding outward and upward rather than transmitting a longitudinal compression force through the spine.

References.

1. Bell C, Prickett TRA, Rutty GN. PMCT images of a motorcycle helmet-associated fracture. Forensic Sci Med Pathol. 2017 Dec;13(4):511-514. doi: 10.1007/s12024-017-9911-4.
2. Gan YC, Charkravarty D, Flint G. Ring fracture of the skull base: case report and review of the literature. Br J Neurosurg. 2002 Jun;16(3):300-3.
3. Jang JH, Kim JS. Pontomedullary laceration, a fatal consequence of skull base ring fracture. J Korean Neurosurg Soc. 2014 Dec;56(6):534-6.
4. Jia M, Li Z, Zhang J, Huang P, Wang J, Zou D, Tao L, Chen Y. Finite element analysis to determine the cause of ring fractures in a motorcyclist's head. Leg Med (Tokyo). 2020 Jul;45:101697.
5. Byard RW, Langlois N, Gilbert JD. Positive "water test"-an external indicator of base of skull hinge-ring fracture. J Forensic Sci. 2010 Mar 1;55(2):519-20.
6. Wijayarathne JAPT, Paranitharan P. Hinge skull fractures in pedestrians: review with three fatalities. Sri Lanka Journal of Forensic Medicine, Science & Law. 2025;16(Special Issue):34-37. (PDF available here: https://sljfmsl.sljol.info/articles/8023/files/6837fcb366f38.pdf)
7. Adams VI. Neck injuries: II. Atlantoaxial dislocation--a pathologic study of 14 traffic fatalities. J Forensic Sci. 1992 Mar;37(2):565-73.
8. Yang SY, Boniello AJ, Poorman CE, Chang AL, Wang S, Passias PG. A review of the diagnosis and treatment of atlantoaxial dislocations. Global Spine J. 2014 Aug;4(3):197-210.
9. Dorado-Fernández E, Andreu-Tena E, Magaña-Loarte C, Ruiz-Tagle Fernández E, Cáceres-Monllor D, Souto López-Mosquera JL, et al. Muertes por arma de fuego y disparo intraoral: etiología medicolegal. Rev Esp Med Legal. 2017;43:70–78