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Case Report

Lateral plating of the temporal bone: Hemostatic technique for complex transverse fractures of the petrous temporal bone

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ABSTRACT

Background: Transverse petrous temporal bone fractures are commonly associated with significant intracranial trauma. Diastases of these fractures can lead to issues with hemostasis in the setting of venous sinus or petrous internal carotid artery (ICA) injuries.
Objective: To describe a rare case of a severe displaced transverse petrous temporal bone fracture with impending intra-operative exsanguination, treated with fracture reduction and lateral plating in order to achieve hemostasis.
Methods: We retrospectively reviewed the records of a patient admitted to the neurosurgical department with a hyperacute epidural hematoma (EDH) secondary to a transverse petrous temporal bone fracture with venous sinus and petrous ICA injuries.
Results: A 22 year old male was admitted for a severe traumatic brain injury leading to a left displaced transverse petrous temporal bone fracture and a hyperacute EDH. Given the location of the fractures, injury to the venous sinus (at the area of the transverse-sigmoid junction) and petrous ICA was suspected.
Intra-operatively, significant blood loss from both the venous sinus and petrous ICA was encountered. Given the displaced temporal bone fracture, packing of the areas was impaired.
We performed a manual reduction of the temporal fracture, followed by lateral plating in order to achieve hemostasis from the petrous ICA and aid with packing of the venous sinus injury.
Conclusions: Reduction and lateral plating of displaced transverse petrous temporal bone fractures can aid significantly with intra-

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operative hemostasis in the extreme case of venous sinus and/or petrous ICA injuries.

Introduction

Various patterns of skull base fractures are seen in the setting of severe traumatic brain injury (TBI) [1]. These fractures can lead to cerebrospinal fluid (CSF) leak, meningitis and cranial neuropathies.

Temporal bone fractures are typically secondary to high energy impact, and are classically classified according to the direction of the fracture lines [2,3]: longitudinal, transverse, and mixed. Recently, a newer classification system of temporal bone fractures includes subcategories for petrous region fractures and the degree of involvement of the otic capsule [3].

Fractures of the petrous temporal bone are concerning. The amount of energy required to fracture this segment of the temporal bone is typically transmitted to the brain leading to a variety of intracranial injuries [4]. Up to 78% of the patients have intracranial hematomas, with acute subdural hematomas (SDHs) being the most common [5]. In addition, injuries to the venous sinuses and the petrous portion of the internal carotid artery (ICA) have been described.

Given the incidence of extra-axial compressive lesions with petrous temporal fractures, surgical evacuation may be necessary. If there are associated venous sinus or petrous ICA injuries, hemostasis is paramount in order to prevent exsanguination. In the setting of a severe displaced fracture of the petrous temporal bone, there can be significant difficulties in packing the site of hemorrhage and controlling the bleeding from the petrous ICA.

Within this case we describe a rare displaced petrous temporal bone fracture in the presence of a hyperacute epidural hematoma (EDH), related to a venous sinus and petrous ICA injuries. Intra-operatively, hemostasis was achieved via fracture reduction and fixation with lateral temporal bone plating.

Case presentation

A 22 year old male was presented to the emergency department after being found down on the road. The time from injury to the arrival of first responders was unknown. His Glasgow coma score (GCS) on scene was noted to be 8; with localization of the left arm to central stimulus, incomprehensible vocal sounds, and failure to open his eyes. We stabilized his vital signs, with no signs of hypotension or hypoxia. It was noted that he had significant external trauma to the face and left occiput, with scalp lacerations and arterial bleeding from the left external auditory canal (EAC). He was transferred to the local trauma center for evaluation.

Upon arrival to the emergency department his GCS dropped over a period of 10 min to 4, with extensor posturing of the left side. His left pupil also became fixed and dilated at 8 mm. Mannitol 40 g intravenously (IV) was administered. He was subsequently intubated and sent for computed tomography (CT) of the brain. The non-contrast CT of the brain demonstrated a large left extra-axial hyperacute hematoma, consistent with an EDH, with significant midline shift and uncal herniation (Fig. 1). In addition, the CT scan displayed a severely displaced transversely oriented fracture to the petrous temporal bone (Fig. 2A, B, and C), extending into the carotid canal (Fig. 2D, arrow). Concerns of both injuries to the junction of the transverse-sigmoid sinus and the petrous ICA were raised. Arterial blood continued to drain from the left EAC.

After completion of the CT brain, his examination deteriorated to become bilaterally fixed and dilated. His brainstem reflexes were completely absent at this point, and he was not triggering the ventilator. His pCO_2 was reduced to 25 mm Hg and he was administered 60 g of mannitol, followed by 140 mL of 7.33% saline on his way to the operating room. Given the speed of decline, we were unable to perform CT angiography to confirm suspected venous sinus or petrous ICA injuries.

Under general anesthesia, a large trauma musculocutaneous flap was raised, starting from 1 cm anterior to the tragus and continuing in a “question mark” shape to include the frontal/temporal/parietal regions of the calvarium. This flap was elevated anteriorly until the keyhole was identified. Similarly, the flap was opened inferiorly to expose the entire root of the zygoma.

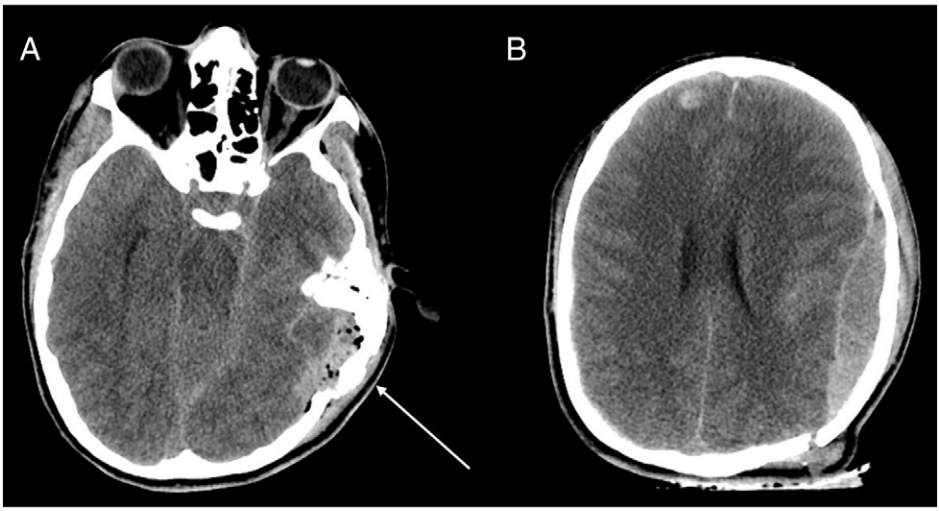

Fig. 1. Pre-operative CT brain. CT = computed tomography. Panel A: Axial CT image at the level of mesencephalon displaying significant bilateral uncal herniation and cerebral edema. The arrow indicates hemorrhage and pneumocephaly near the junction of the left transverse and sigmoid sinuses. Panel B: Axial CT image at the level of the lateral ventricles displaying the left calvarial fracture and hyperacute epidural hematoma.

The temporalis muscle was dissected off from the fractured fragments of the calvarium. At this point a large amount of venous hemorrhage was encountered near the floor of the middle fossa, which was packed with gel foam. The fracture fragments over the lateral cortical surface were removed, and the high speed drill was utilized to complete a large craniectomy, exposing all of the frontal, temporal and parietal lobes of the left hemisphere. A subtemporal decompression was performed with rongeurs.

The EDH was evacuated, revealing a large dural laceration to the cortical surface, measuring 8 cm by 6 cm overlying the peri-Rolandic area. Hemostasis of this cortical injury was obtained with bipolar electrocautery.

Ongoing brisk venous sinus bleeding was seen from the area of the temporal fracture extending into the asterion. The injury was inaccessible for primary repair. Attempts at packing the area failed as the pressure required for packing led to diastases of the transverse petrous fracture and subsequent arterial bleeding from deep within the fracture line. This likely represented the bleeding from the petrous ICA. The lateral portion of the entire temporal bone became free floating from the remainder of the skull base.

The overall blood loss at this point was approximately 4 L from both the venous sinus and petrous ICA injuries. Ongoing transfusion occurred throughout the case, without any episodes of hypotension or hypoxemia.

Given the difficulties with controlling the hemorrhage from these two inaccessible sites, it was elected to perform a manual reduction of the petrous temporal bone fracture, followed by lateral plating, in order to aid with packing of the sinus injury and tamponade of the suspected petrous ICA injury.

Medially directed pressure was applied at the level of the EAC with a gloved open palm, leading the reduction of the fracture diastases in the petrous temporal bone. We were able to completely reduce the fracture fragments, which were initially separated approximately 10–15 mm. Throughout this maneuver we ensured that the medial pressure was as co-axial as possible, so as to prevent any further shear injury to the venous sinus and petrous carotid artery during the reduction attempt. Hemorrhage from both the venous sinus and petrous carotid artery decreased dramatically with this maneuver. Short titanium plates were applied across the fracture lines, both anterior and posterior, and secured with 4 mm screws. Fixation via titanium plates and screws occurred specifically across the spheno–squamousal suture line anterior-inferiorly via two separate plates, and also along the mastoid–occipital suture line posterior-inferiorly utilizing a single plate (Fig. 3). The bleeding at this point decreased significantly, with cessation of the arterial hemorrhage deep within the temporal bone. The plating can be seen in Fig. 3.

The residual bleeding from the venous sinus injury was subsequently packed with gel foam without difficulty.

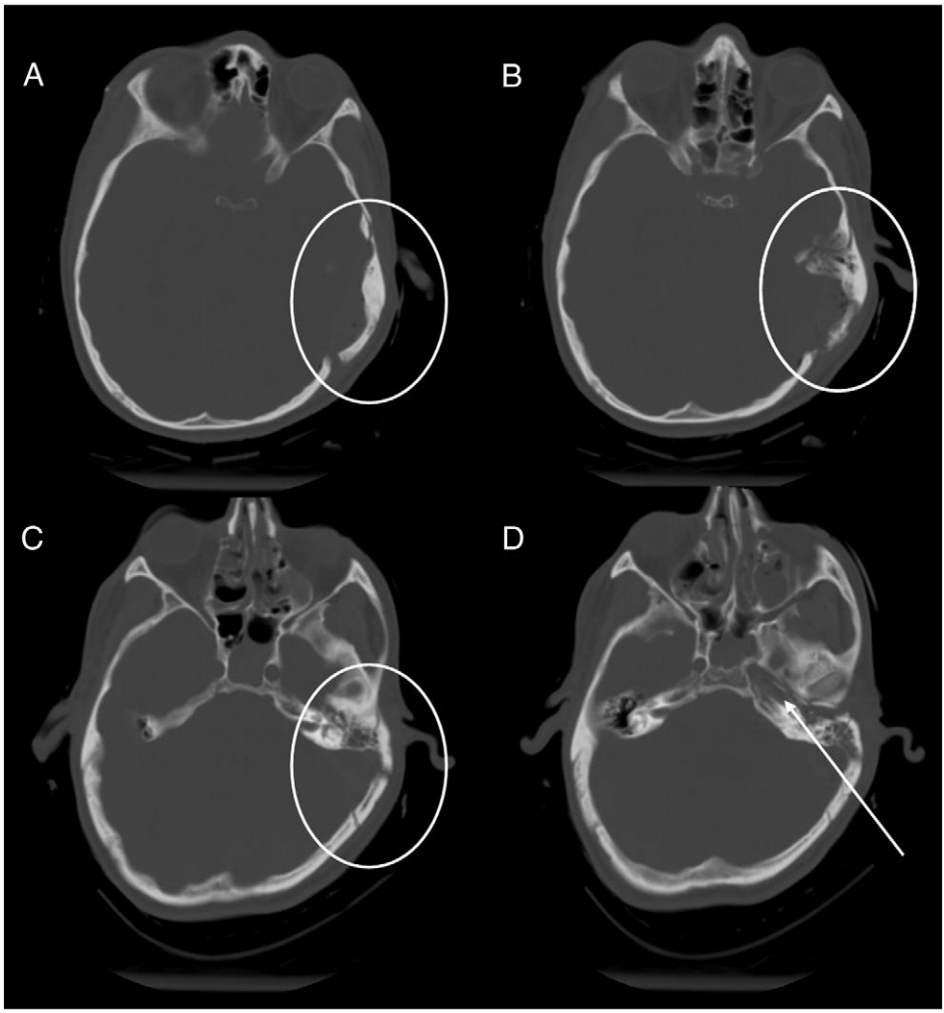

Fig. 2. Pre-operative CT brain displaying bone windows. CT = computed tomography. Panels A, B, and C: Axial CT images at the level of temporal bone displaying a transverse petrous temporal bone fracture with diastases. Panel D: Arrow indicates the fracture of the petrous temporal one extending into the carotid canal compromising the course of the internal carotid artery.

Unfortunately at this point, the entire left hemisphere appeared quite swollen and ischemic (likely from an ICA injury). An intra-parenchymal strain gage intracranial pressure (ICP) monitor was placed and the wound was closed, leaving the bone off. The patient was subsequently transferred to ICU.

Upon arrival in ICU, the ICP was ranging from 40 to 60 mm Hg despite maximal medical therapy. Over the course of the following 6 h the patient developed diabetes insipidus. A CT scan of the brain demonstrated significant left hemispheric ischemia, contralateral hemispheric injuries, and suspected injury to the mesencephalon and pons (Fig. 4). It was elected to withdrawal care. The patient died 6 h after the surgery was completed.

Discussion

Displaced temporal bone fractures, in the setting of venous sinus or petrous carotid injuries, pose significant challenges in achieving hemostasis. Standard techniques in dealing with venous sinus injuries via

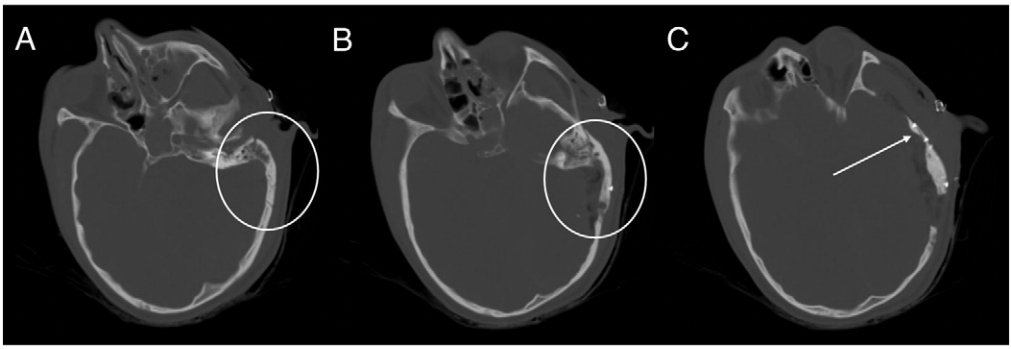

Fig. 3. Post-operative CT brain displaying fracture reduction and plating. CT = computed tomography. Panels A and B: Reduction of previously transverse temporal bone fracture. Panel C: Anterior lateral plating seen (arrow) leading to the fixation and maintenance of fracture reduction.

packing can be impeded. Our case describes a potential surgical technique to aid with hemostasis in these extreme situations.

A few important points can be gleamed from our case. First, fracture reduction is essential. Common orthopedic principles apply even though the injury is in the skull base. Fracture reduction leads to improved hemostasis. This could be seen with simple medially applied pressure directed along the axis of the EAC. Second, fixation of the reduced fracture is paramount. We utilized standard titanium plates and screws for cranial repair. Third, packing of the venous sinus injury in order to achieve hemostasis was impossible with the free floating component of the temporal bone fracture. This had to be secured prior to effective packing. Fourth, the arterial bleeding from deep within the fracture site, suspected to arise from the petrous ICA, was controlled effectively with fracture reduction and fixation. This bleeding would have been extremely difficult to stop otherwise, and packing the fracture line would likely have failed. Finally, this easy to perform technique can potentially be a life saver in the setting of impending exsanguination.

Despite the improved hemostasis with reduction and fixation of the petrous temporal bone fracture in our case, there are some limitations to what can be concluded. First, this is a single extreme case. The majority of temporal bone fractures do not present in this manner with a hyperacute extra-axial hematoma secondary to a venous sinus and ICA injury. Thus, the ability to generalize the principles of this case is limited. Finally, despite adequate hemostasis post-fracture fixation, the patient unfortunately died as a result of significant ischemia and bilateral hemispheric injuries. It should be noted, that despite achieving control of the

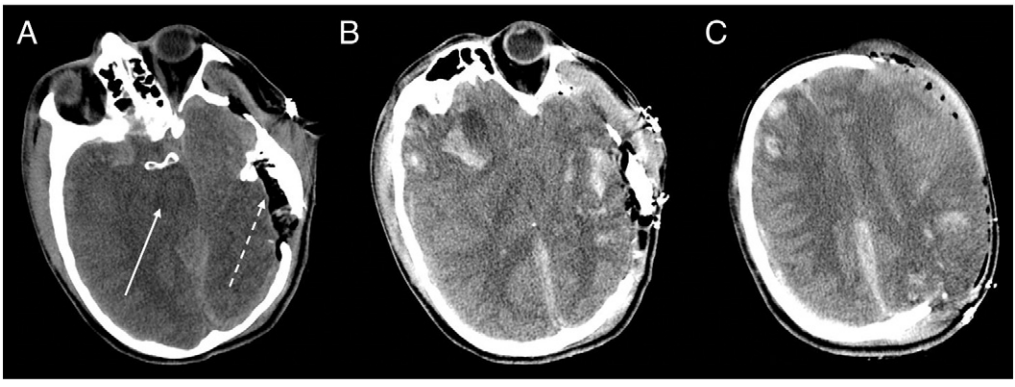

Fig. 4. Post-operative CT brain. CT = computed tomography. Panel A: Axial CT image at the level of the mesencephalon displaying hypoattenuation of the midbrain (solid arrow) and bilateral uncal herniation and edema. The dashed arrow displays the area of the transverse-sigmoid sinus junction that was packed with gel foam. Panels B and C: Axial CT images displaying significant bilateral contusions, interhemispheric subdural hematoma and left hemisphere ischemia.

hemorrhage, we were unable to address the suspected injury to the petrous ICA. It is this injury that likely led to the significant left hemispheric ischemia seen both on intra-operatively and post-operative imaging.

Conclusions

Reduction and lateral plating of displaced transverse petrous temporal bone fractures can aid significantly with intra-operative hemostasis in the extreme case of venous sinus and/or petrous ICA injuries.

Conflict of interest statement

The authors have no conflicts of interest to disclose.

References

[1] D.T. Lin, A.C. Lin, Surgical treatment of traumatic injuries to the cranial base, Otolaryngol. Clin. N. Am. 46 (5) (2013) 749–757.
[2] M.A. Rafferty, R. Mc Conn Walsh, M.A. Walsh, A comparison of temporal bone fracture classification systems, Clin. Otolaryngol. 31 (4) (2006) 287–291.
[3] H.M. Kang, M.G. Kim, S.H. Boo, et al., Comparison of the clinical relevance of traditional and new classification systems of temporal bone fractures, Eur. Arch. Otorhinolaryngol. 269 (8) (2012) 1893–1899.
[4] Z.A. Asha'Ari, R. Ahmad, J. Rahman, N. Kamarudin, L.W. Ishlah, Contrecoup injury in patients with traumatic temporal bone fracture, J. Laryngol. Otol. 125 (8) (2011) 781–785.
[5] Z.A. Asha'ari, R. Ahmad, J. Rahman, R.A. Yusof, N. Kamarudin, Patterns of intracranial hemorrhage in petrous temporal bone fracture, Auris Nasus Larynx 39 (2) (2012) 151–155.