

Traumatic Acute Brain Herniation through the Ear in a Child

Concealed compound fracture

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انفتاق الدماغ الرضحي الحاد من خلال الأذن في طفل كسر مركب مخفي

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الملخص: فتاة في السابعة من عمرها تعرضت لحادث سيارة، أصيبت على أثره بانصباب السائل النخاعي من الأذن اليمنى، وبعد أسبوع انبثق الدماغ من خلال الأذن اليمنى. أظهر مسح التصوير المقطعي المحوسب للدماغ وجود كسر في السقف الموصل بالقناة السمعية الخارجية. لم يكن هناك أي ضعف في السمع أو العصب الوجهي، وأظهر الفحص بمنظار الأذن سلامة غشاء الطبلة. خضعت الطفلة لإصلاح عبر الجمجمة من قاعدة الحفرة القحفية الوسطى، كشف ذلك عن وجود خلل سحائي وعظمي واسع في السقف مع فتق في الفص الصدغي. أصلح الخلل داخل الجافية بنسيج اصطناعي. وتناقش ندرة هذا النوع من العرض من كسور العظام الصدغية وكيفية علاجها.
مفتاح الكلمات: طب الأطفال، كسر في الجمجمة، قاعدة القحف، قيلة دماغية لاكيسية، تقرير حالة؛ عُمان.

ABSTRACT: A seven-year-old girl presented to Sultan Qaboos University Hospital, Oman, with a history of having been hit by a motor vehicle. After this, she had right-sided cerebrospinal fluid otorrhoea, and a week later, brain matter extruded through the right ear. A computed tomography scan of the brain demonstrated a tegmen fracture communicating with the external auditory canal. There was no hearing or facial nerve impairment and an otoscopic examination showed an intact tympanic membrane. She underwent a transcranial repair of the middle cranial fossa base, which revealed a wide dural and bony defect of the tegmen with herniation of the temporal lobe. Repair was made with an intradural patch of artificial dura. The rarity of this type of presentation of temporal bone fracture and its management are discussed.

Keywords: Pediatric; Skull fracture, Basilar; Encephalocele; Case Report; Oman.

SKULL-BASE FRACTURES ARE RARE IN childhood, with reported frequencies being 5–14% of head injuries but, when they do occur, they are most often located in the temporal bone. Of the temporal bone fractures, only about 8% cause cerebrospinal fluid (CSF) otorrhoea, and most of these cease spontaneously.¹ Endaural brain herniation, though uncommonly seen following mastoid surgery, is a very rare complication following trauma and, when it occurs, has a delayed presentation.^{2,3} Acute herniation of brain matter through the ear following trauma has not been previously reported. We report a child presenting with acute herniation of brain matter through the ear following trauma, and the successful

management of the herniation.

Case Report

A seven-year-old girl who was brought to the Emergency room after being hit by a car while out walking. Her Glasgow coma scale (GCS) score on arrival was 11, with evidence of bleeding from nasal and oral cavities, and the right ear. Her pupils were equal in reaction to light, and she was able to move her limbs equally. There was a scalp swelling in the right temporal region. As she was restless and irritable, she was intubated and taken for an emergency computed tomography (CT) scan.

The CT scan showed a comminuted fracture of

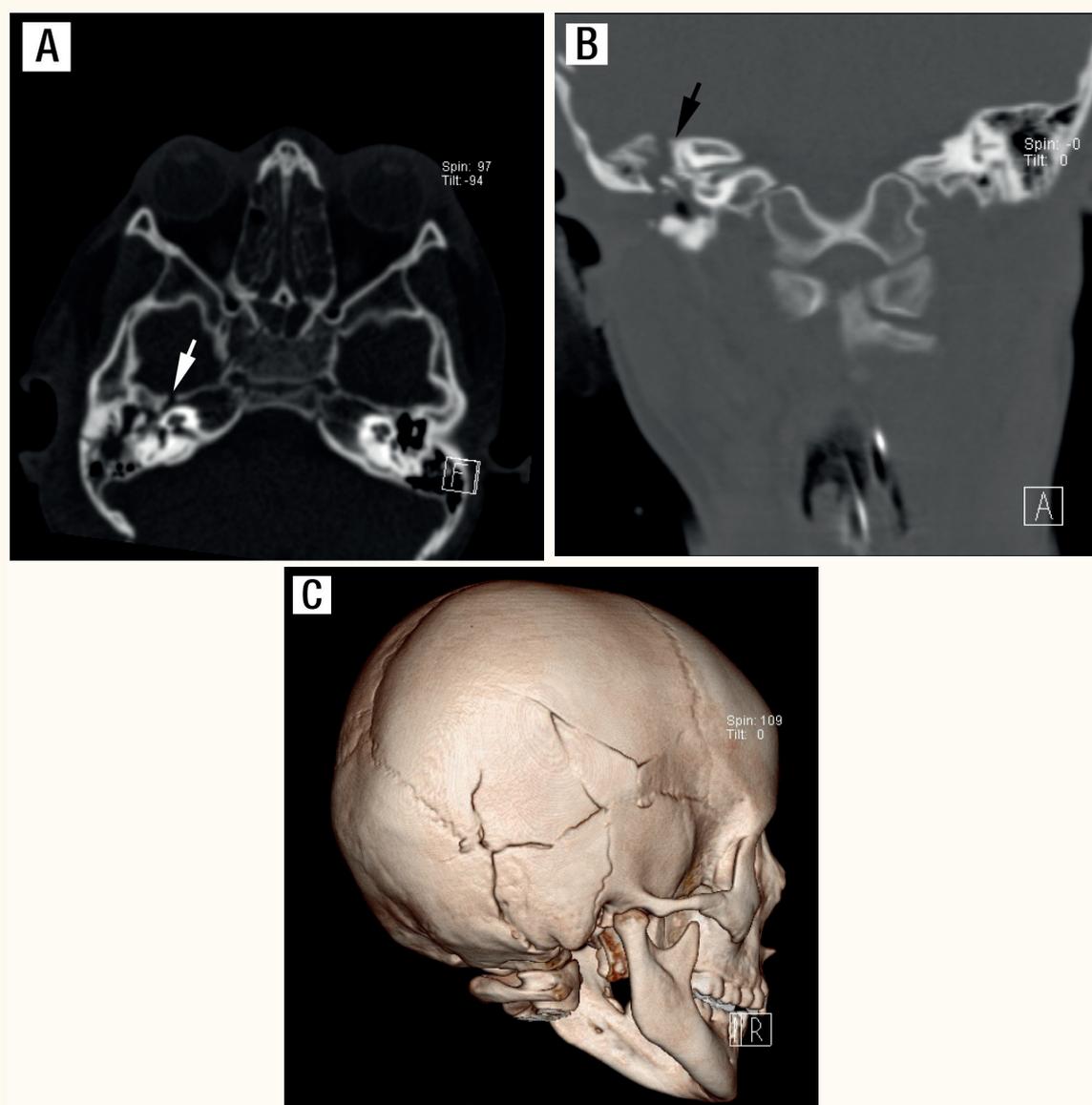


Figure 1: (A) Axial computed tomography scan showing an oblique fracture of the right petrous temporal bone sparing the otic capsule (arrow). (B) Coronal reconstruction of computed tomography scan showing the fracture involving the squamous and petrous temporal bone with wide separation of the fragments and involvement of the external auditory canal (arrow). (C) 3D-reconstruction computed tomography scan showing the fracture line isolating the squamous and mastoid parts of the temporal bone as a single unit.

the right squamous temporal bone extending to the occipital bone, and an oblique fracture of the right petrous temporal bone sparing the otic capsule with wide separation of the margins [Figures 1A and 1B]. In addition, there was fracture of the basisphenoid with blood in the sphenoid and ethmoid sinuses and evidence of pneumocephalus in the frontal region and basal cisterns.

After mechanical ventilation overnight, the level of consciousness improved. A repeat scan showed no new changes and she was extubated. There was no facial nerve palsy. The otorrhoea persisted and examination of the right ear showed blood clots,

which were cleaned. CSF otorrhoea and clots continued to be seen over the next week when it was noticed that there was a whitish substance coming out of the right ear, especially when the child coughed or strained. Closer examination revealed this substance to be brain matter. An otoscopic examination after clearing the canal, revealed an intact tympanum. No discernible defect in the canal could be seen.

The child underwent transcranial surgical repair of the skull base defect. After a right temporal craniotomy, subtemporal exploration extradurally revealed a wide fracture defect in the tegmen with

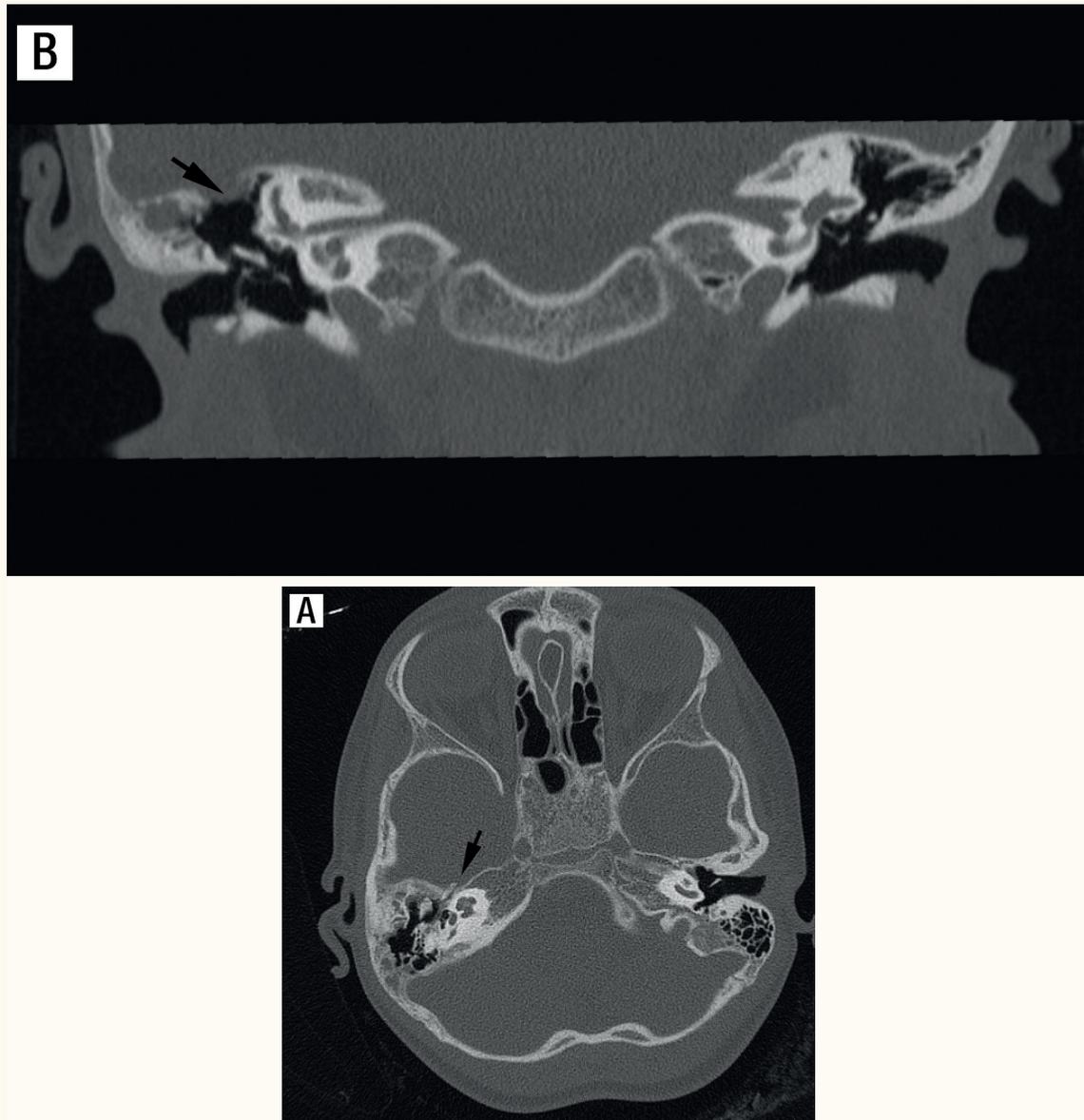


Figure 2: (A) Post operative axial computed tomography (CT) scan after 4 months showing an almost completely healed fracture line (arrow). (B) Post operative coronal reconstruction CT scan after 4 months showing the tegmen defect with no brain herniation into the external auditory canal (arrow).

the dura adherent to the margins. The dura was then opened, revealing brain matter herniating into the bony defect. The herniating brain was transected and an intradural repair was carried out using a patch of artificial dura (Durepair®, Medtronic Neurosurgery, Minneapolis, USA). After wound closure, the external canal was again examined and cleaned, but there was no active CSF leak. A lumbar intrathecal drain was placed at the end of the procedure, which was removed after 3 days. There was no further CSF otorrhoea. On the 5th post-operative day, however, she developed fever along with meningeal signs. Lumbar CSF was turbid and

grew *Acinetobacter baumannii*, which was treated with intravenous antibiotics for 2 weeks. She was then discharged with no further sequelae.

A follow-up after 2 months revealed no neurological deficit. A CT scan after 4 months showed a barely discernible fracture line in the petrous bone with no brain herniation [Figures 2a and 2b].

Discussion

About 4% of patients treated for head trauma have skull fractures, of which around 14–22%

have temporal bone fractures.³ Paediatric skull base fractures are relatively uncommon, with reported incidences between 5 and 14%, of which temporal bone fractures were the most common at about 63.5%.¹ Cadaveric studies have shown that a significant force of lateral impact of up to 1,875 pounds (c. 850 kg) is required to fracture the temporal bone and hence is often associated with other significant intracranial injuries.³

Temporal bone fractures have traditionally been divided into transverse and longitudinal, based on the orientation of the fracture line to the axis of the petrous ridge. However, in practice, fractures often tend to be more random, comminuted and difficult to describe in just two axes alone, and hence the terms oblique and mixed have also been used. Another classification system is based on whether the otic capsule is spared as this directly influences neurological function. Otic capsule involvement has been associated with a higher rate of CSF leak, facial nerve injury, and hearing deficits.^{3,9}

This patient had a comminuted fracture involving the temporal squama and an oblique fracture line passing through the petrous bone anterolateral to the otic capsule, through the tegmen tympani, external auditory canal, middle ear, and the mastoid. The whole segment of the squamous temporal bone along with the lateral part of the petrous bone had become an isolated fragment minimally displaced downwards [Figure 1C]. In spite of the severity of the injury, there was no significant neurological deficit, including of the facial or vestibulocochlear nerves, probably because the fracture spared the otic capsule. Facial injuries have also been reported to be less common in the paediatric age group irrespective of the otic capsule's involvement.⁵

CSF otorrhoea occurs in about 11–45% of temporal bone fractures, with petrous fractures being 10 times more likely to cause a CSF leak.¹⁰ Of these, the otic sparing types are less likely to have a leak.^{3,9} The majority of the leaks subside spontaneously—78% within 7 days and 95% within 14 days.³

Traumatic endaural brain herniation is a rare occurrence. For brain herniation to occur, three pre-requisites have been described: there needs to be a bony defect, a dural defect, and increased intracranial pressure.⁸ Most of the cases described in the literature have been due to a congenital defect, chronic otitis, or surgery. Of the few post-traumatic

cases described, all have presented in the form of a delayed recurrence of CSF leak or meningitis.^{2,4–8}

Temporal fractures usually occur along points of weakness like the skull base foramina, tegmen tympani, and a well-pneumatised mastoid.³ The dura over the skull base is densely adherent to the bone, especially in the paediatric age group.¹ In the event of a fracture with wide separation, as in this patient, it can result in a large dural tear with the margins adherent to this wide bony defect. A significant trauma like this with extensive bone fractures involving the frontal and temporal skull base can also cause associated parenchymal laceration of the basal temporal lobe and cerebral oedema. The fracture line passing through the external auditory canal could have also given rise to a concealed laceration of the roof of the canal. The combination of cortical injury, the wide dural and bony defect, and raised intracranial tension would have contributed to the brain herniation through this laceration like a concealed compound fracture.

The management of acute brain herniation mandates urgent surgical repair to avoid serious infective complications. Repair of CSF otorrhoea and endaural herniation has been done by a transcranial, transmastoid, or combined surgical approach. In neurosurgical literature, where the leak is usually post-traumatic, a middle fossa approach has been favoured.⁷ In the otorhinolaryngological literature, where most herniations follow mastoid surgeries, either a purely transmastoid route, or a combined middle fossa-transmastoid approach, has been advocated, depending on the size of the defect.^{5,6,8} The primary goal of surgery is to disconnect the encephalocele and perform dural repair. Dural repair is preferably done intradurally as the encephalocele is better handled under direct vision and the weight of the temporal lobe would support the graft better.⁶ Extradural repair would also entail more dural elevation and risk additional tears. Various materials have been used for the dural repair including fascia lata, vascularised pericranium, temporalis fascia, lyophilised dura, or a biosorbable polyglycolic acid sheet.^{5–8}

Repair of the bony defect with bone or cartilage has also been described.⁵ However, this is perhaps not always required as removal of the herniated brain and stoppage of CSF flow will in itself enable the fracture edges to heal in a bony or fibrous union [Figures 2a and 2b] and thereby prevent recurrence.

Conclusion

Temporal bone fractures, though less common in childhood, can result in CSF otorrhoea and, rarely, acute brain herniation. Wide fracture lines should alert us to this possibility as the herniation could be occult. Urgent repair is indicated to avoid serious infective complications. A transcranial, intradural repair is the most appropriate procedure, with a wide choice of possible repair materials available.

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References

1. Perheentupa U, Kinnunen I, Grénman R, Aitasalo K, Mäkitie AA. Management and outcome of pediatric skull base fractures. *Int J Pediatr Otorhinolaryngol* 2010; 74:1245–50.
2. Bowes AK, Wiet RJ, Monsell EM, Hahn YS, O'Connor CA. Brain herniation and space-occupying lesions eroding the tegmen tympani. *Laryngoscope* 1987; 97:1172–5.
3. Brodie HA, Thompson TC. Management of complications from 820 temporal bone fractures. *Am J Otol* 1997; 18:188–97.
4. Dedo HH, Sooy FA. Endaural brain hernia (encephalocele): diagnosis and treatment. *Laryngoscope* 1970; 80:1090–9.
5. Feenstra L, Sanna M, Zini C, Gamoletti R, Delogu P. Surgical treatment of brain herniation into the middle ear and mastoid. *Am J Otol* 1985; 6:311–5.
6. Jackson CG, Pappas DG Jr, Manolidis S, Glasscock ME III, Von Doersten PG, Hampf CR, et al. Brain herniation into the middle ear and mastoid: concepts in diagnosis and surgical management. *Am J Otol* 1997; 18:198–206.
7. Nishiike S, Miyao Y, Gouda S, Shimada N, Nagai M, Nakagawa A, et al. Brain herniation into the middle ear following temporal bone fracture. *Acta Otolaryngol* 2005; 125:902–5.
8. Ramsden RT, Latif A, Lye RH, Dutton JEM. Endaural cerebral hernia. *J Laryngol Otol* 1985; 99:643–51.
9. Rafferty MA, Mc Conn Walsh R, Walsh MA. A comparison of temporal bone fracture classification systems. *Clin Otolaryngol* 2006; 31:287–91.
10. Saraiya PV, Aygun N. Temporal bone fractures. *Emerg Radiol* 2009; 16:255–65.