Computed Tomography and Magnetic Resonance Imaging of a Basilar Artery Herniation into the Sphenoid Sinus

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ABSTRACT

We report a rare case of herniation of a basilar artery into the sphenoid sinus after a traumatic skull base fracture. Computed tomographic angiography, magnetic resonance imaging, and cerebral angiogram demonstrated patency of the basilar artery through the fractured clivus at the time of injury, a very rare occurrence. The following day, the patient developed pontine and cerebellar infarcts. In a patient with clival fracture, we advocate fast assessment of vertebrobasilar system with CTA and early anticoagulation treatment in those with vascular entrapment.

KEYWORDS: Basilar artery, herniation, clivus, fracture, CT, MR

Fractures of the clivus are uncommon and usually result from high-impact cranial injury. Of the three subtypes, transverse and oblique fractures are typically associated with multiple cranial nerve and delayed vascular injuries, and longitudinal fractures are associated with injury to the vertebrobasilar system and brain stem. Herniation of the vertebrobasilar vessels is very rare, with only few reported cases. Almost all of these patients died, and autopsy demonstrated occlusion or thrombosis of the trapped vessel.¹ We report a rare case of herniation of a basilar artery into the sphenoid sinus after a traumatic skull base fracture with persistent patency of the artery through the fractured clivus using multiple imaging modalities. This rare event may advocate for early intervention in future cases to avoid potential neurological sequelae, including massive brain stem infarction.

CASE REPORT

History

A previously healthy 55-year-old man was transferred from an outside facility for the evaluation of skull base fractures following a motorcycle accident.

Examination

Initial examination revealed equal and reactive pupils, stable vital signs, and right hemotympanum; his Glasgow Coma Scale score was 8. Complete neurological evaluation was difficult due to patient's sedation. He was intubated for airway prophylaxis.

Imaging Findings

Computed tomography (CT) of the brain demonstrated bilateral temporal and sphenoid bone fractures. Fracture

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Figure 1 Computed tomographic angiography of the brain in sagittal reformatting plane (A) and in axial soft tissue (B) and bone (C) algorithms demonstrates herniation of midbasilar artery into sphenoid sinus.

of the right temporal bone involved squamous, petrous, and tympanic segments with extension to the facial nerve canal and otic capsule and resulting ossicular dislocation. Longitudinal fracture through the foramen magnum extended into the clivus, body, and greater wings of the sphenoid bone and sphenoid sinuses and into carotid canals bilaterally.

Tiny right middle cranial fossa epidural hematoma and scattered subarachnoid blood in the basal cisterns were present, together with intracranial air.

CT angiography (CTA) demonstrated herniation of a small loop of the proximal basilar artery into the sphenoid sinus at the level of fracture site (Fig. 1). Although the vessel was normal and identical in diameter before and after entrapment into the sinus, there was marked stenosis at the level of the posterior wall of the sphenoid sinus. The distal basilar artery and both posterior cerebral arteries were normal in appearance.

Magnetic resonance imaging (MRI) of the brain obtained the following day revealed development of acute right pontine and bilateral cerebellar infarcts in the distribution of posterior inferior cerebellar artery (PICA) (Fig. 2B, C). Although there was herniation of the basilar artery into the sphenoid sinus, there was normal flow void in the distal segment of the vessel as

well as in its branches (Fig. 3). Conventional angiogram was performed on the same day to guide further surgical or conservative therapy (Fig. 2A). The study showed stricture of the proximal basilar artery at the level of herniation into the sphenoid sinus resulting in 90 to 95% stenosis. Bilateral absence of PICA with prominent anterior inferior cerebellar arteries (AICAs), a normal variant, explained cerebellar infarct. Both AICAs originated at the herniation level. In addition, a 5-mm filling defect compatible with a clot was present in the P1 segment of the left posterior cerebral artery resulting in 80 to 90% stenosis. Anterior circulation was normal.

Hospital Course

During subsequent neurological exam, the patient did not open eyes to painful stimuli or follow commands. His pupils were equal and reactive to light, corneal reflexes were diminished on the right, and he had right central facial weakness. Motor exam revealed full strength on the right but no movement on the left.

After the patient was stabilized, he underwent a translabyrinthine facial nerve decompression and cerebrospinal fluid fistula closure. He was transferred to inpatient rehabilitation, and 1 month later was

Figure 2 (A) Cerebral angiogram of the brain shows short segment severe (90 to 95%) stricture of the basilar artery. (B, C) Diffusion-weighted images demonstrate acute infarction in the left cerebellar hemisphere (B) and in the right pons (C).

discharged home with instructions for outpatient follow-up.

DISCUSSION

Fractures of the clivus are uncommon and usually result from high-impact cranial injury. They are divided into three types: longitudinal, transverse, and oblique. Transverse and oblique fractures are associated with multiple cranial nerve and delayed vascular injuries. In particular, cranial nerve VI is frequently involved, and therefore clival fracture should always be suspected in patients with bilateral VI nerve palsy.²⁻⁴ In contrast, longitudinal fractures are associated with 70 to 80% mortality secondary to vertebrobasilar and brain stem injury.^{2,5} Common vascular injuries include dissection, compression, thrombosis, and herniation or entrapment into the fracture line.⁶⁻¹¹

Most cases of longitudinal fractures have typically been diagnosed at autopsy with only few cases diagnosed with CT imaging. Herniation of the vertebrobasilar system vessels is very rare, with only few reported cases. Almost all of these patients died, and autopsy demon-

strated occlusion of the trapped vessel or thrombosis.¹ The proposed mechanism of vascular injury involves inertia of the brain stem and cerebellum carrying the artery into the diastatic fracture. Subsequently, the fracture closes on the artery permanently occluding it and its branches.¹²

To the best of our knowledge, only 11 cases of clival fracture associated with entrapment of basilar artery have been reported. The outcome was very poor: seven patients died, two developed vegetative/locked-in state, one had quadriplegia, and one had mild hemiparesis.⁵ Because of such a high rate of mortality, early diagnosis of clival fracture and its type is crucial. Therefore, angiographic imaging of the intracranial and skull base vessels should be performed in each patient with a longitudinal clival fracture.

Although earlier studies¹³ have suggested early conventional angiography or magnetic resonance angiography to rule out vascular injury associated with clival fracture, we are advocating the use of CTA with three-dimensional reconstruction. This study is typically ordered in radiological evaluation of traumatic skull fractures and may yield more information than conven-

Figure 3 (A–D) Proton density-weighted magnetic resonance imaging demonstrates flow void of the basilar artery before (A), at the level (B), and past the herniation of the vessel into the sphenoid sinus (C, D).

tional angiography and save valuable time with earlier recognition.

Our study is the first to compare three different methods in assessment of vascular integrity in basilar artery entrapment: conventional cerebral angiogram, CTA, and MRI. Although conventional angiogram remains a gold standard, providing superb spatial and temporal resolution, it is an invasive procedure, may not be readily available, and can sometimes be logistically difficult in complex trauma cases. MRA is frequently performed together with MRI of the brain, providing relatively fast and noninvasive evaluation. In addition to several obvious limitations (contraindications, e.g., pacemaker, availability, motion artifacts), three-dimensional time-of-flight MRA is flow dependent, and therefore slow flow may appear as stenosis or even occlusion. In contrast, CTA provides high spatial

resolution, allows evaluation of adjacent soft tissues and bones, is relatively insensitive to motion, and can be obtained at the same time as the rest of the body as a part of trauma series.

At present, only two studies have described entrapment and persistent patency of the basilar artery.^{1,14} Similar to these cases, our patient developed brain stem and cerebellar infarction despite vascular patency, likely resulting from dissection and/or thrombosis. Because surgical intervention is very difficult in this area and frequently contraindicated due to the patient's condition, medical therapy may be the only option. Different forms of anticoagulation have been applied in cases with basilar artery entrapment including aspirin, an antiplatelet agent,¹ and argatroban, a selective antithrombin agent.¹⁵ Some patients deteriorate and develop delayed pontine dysfunction with a lag time of 4 to 6 days,¹⁴ likely due to

progressive thrombus formation. Therefore, this warrants fast diagnosis and strongly suggests that early treatment should be undertaken to prevent devastating outcome.

REFERENCES

1. Bala A, Knuckey N, Wong G, Lee GYF. Longitudinal clivus fracture associated with trapped basilar artery: unusual survival with good neurological recovery. *J Clin Neurosci* 2004;11:660–663
2. Corradino G, Wolf AL, Mirvis S, Joslyn J. Fractures of the clivus: classification and clinical features. *Neurosurgery* 1990;27:592–596
3. Kapila A, Chakeres DW. Clivus fracture: CT demonstration. *J Comput Assist Tomogr* 1985;9:1142–1144
4. Sanders BB, VanderArk GD. Transverse fracture of the clivus. *J Neurosurg* 1973;39:610–614
5. Joslyn JN, Mirvis SE, Markowitz B. Complex fractures of the clivus: diagnosis with CT and clinical outcome in 11 patients. *Radiology* 1988;166:817–821
6. Bank WO, Nelson PB, Drayer BP, Wilkins RH, Rosenbaum AE. Traumatic aneurysm of the basilar artery. *AJR Am J Roentgenol* 1978;130:975–977
7. Guha A, Fazl M, Cooper PW. Isolated basilar artery occlusion associated with a clivus fracture. *Can J Neurol Sci* 1989;16:81–83
8. Lindenberg R. Incarceration of a vertebral artery in the cleft of a longitudinal fracture of the skull. Case report. *J Neurosurg* 1966;24:908–910
9. Nezami AH, Bremer AM. Basilar artery occlusion in multiple trauma: case report. *Neurosurgery* 1980;7:267–270
10. Quintana F, Diez C, Gutierrez A, Diez ML, Austin O, Vazquez A. Traumatic aneurysm of the basilar artery. *AJNR Am J Neuroradiol* 1996;17:283–285
11. Woolsey RM, Chung HD. Fatal basilar artery occlusion following cervical spine injury. *Paraplegia* 1979;17:280–283
12. Sights WP Jr. Incarceration of the basilar artery in a fracture of the clivus. Case report. *J Neurosurg* 1968;28:588–591
13. Khan N, Zumstein B. Transverse clivus fracture: case presentation and significance of clinico-anatomic correlations. *Surg Neurol* 2000;54:171–177
14. Kaakaji R, Russell EJ. Basilar artery herniation into the sphenoid sinus resulting in pontine and cerebellar infarction: demonstration by three-dimensional time-of-flight MR angiography. *AJNR Am J Neuroradiol* 2004;25:1348–1350
15. Taguchi Y, Matsuzawa M, Morishima H, Ono H, Oshima K, Hayakawa M. Incarceration of the basilar artery in a longitudinal fracture of the clivus: case report and literature review. *J Trauma* 2000;48:1148–1152