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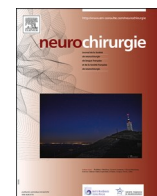
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Case report

Fractured cervical spine, dissected vertebral artery, and life-threatening stroke: A challenging case report and literature review



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ABSTRACT

Introduction: Vertebral artery injury (VAI) following blunt trauma can lead to acute or delayed life-threatening posterior fossa ischemic stroke. Its management raises controversial issues and is still open to debate.

Material & method: We report the case of a 48-year-old male who presented a life-threatening posterior circulation ischemic stroke, secondary to a vertebral artery dissection caused by a cervical spine fracture. This case was successfully managed through intravenous thrombolysis and endovascular thrombectomy followed by antiplatelet therapy and an anterior cervical discectomy and fusion. At the one-year follow-up, the patient had no persisting deficit and was back working as a policeman.

Conclusion: Rapid management of patients with dramatic clinical presentation can lead to full recovery. Implications include a systematic screening of blunt trauma VAI through computed tomography angiography when dealing with high-risk cervical spine fractures; patients harboring both a cervical spine fracture and a VAI must be transferred to a tertiary referral hospital able to deal both with strokes and cervical spine surgery to ensure responsiveness in case of stroke.

1. Introduction

Vertebral artery injury (VAI) can occur in blunt trauma with or without a cervical spine injury. Its incidence varies from 0.1% to 3% of polytrauma patients, and from 30 to 50% of patients harboring a cervical spine fracture [1]. It can lead to acute or delayed posterior fossa ischemic stroke, leading to a life-threatening condition. Its management raises controversial issues and is still open to debate (cf. infra). We report the successful management of a patient presenting brainstem stroke secondary to VAI due to a cervical spine fracture.

This case is interesting for many reasons. First, it illustrates how important neck pain in the context of benign head trauma requires cervical spine injury and vertebral artery injury screening. Second, it demonstrates that patients who harbor cervical spine injury associated with VAI must be transferred to a hospital with both spine surgeons and a neurovascular unit to ensure responsiveness in the event of a stroke. Third, it summarizes recent guidelines and prospective studies done on the management of such cases.

2. Illustrative case

A 48-year-old man with no past medical history presented to a local facility for syncope during a barium swallow study, with loss of consciousness, leading to benign head trauma. Clinical examination revealed left cervical radicular pain. Cervical X-ray was normal. After medical screening, vagal discomfort was suspected, and the patient was discharged with health and diet tips. Later that same day, he consulted again via the ambulance rescue service as clinical findings evolved including new onset ataxia and right-side sensitivity impairment. Medical examination revealed dysarthria and right hemiparesis (4/5 MRC (medical research council scale)) with right-side pyramidal signs.

Cervical contrast-enhanced CT was performed and interpreted as normal. The patient was then addressed to the Neurovascular department of our tertiary referral hospital.

At arrival, his neurological status worsened, reaching a Glasgow Coma Scale (GCS) score of 3 with hypersialorrhea and respiratory discomfort. He was intubated and transferred to the intensive care unit.

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A second look at the cervical CT scan suggested a posterior fossa ischemic stroke.

Brain MRI revealed a terminal basilar artery occlusion extending to both posterior cerebral arteries with left pons and right midbrain signs of acute ischemic stroke (FLAIR hyperintensity, and hypersignal in diffusion-weighted imaging) (Fig. 1). Cerebral Arteriography revealed left vertebral artery dissection with thrombosis (Fig. 2). Hence intravenous thrombolysis and endovascular thrombectomy were performed. The procedure was successful. Postoperative imaging showed complete posterior repermeabilization (Fig. 2).

On postoperative day 1, the patient was fully awoken and extubated. He was transferred to the Neurovascular unit. Antiplatelet therapy with aspirin 160 mg (Acetylsalicylic acid) was introduced. Neurological examination found a binocular vertical diplopia (Fig. 3), right upper limb paresis (3/5 MRC) with persisting left cervical radicular pain. Neurosurgical examination was demanded to further investigate the patient's cervical radicular pain against the backdrop of cerebral stroke. A second look at the cervical CT imaging revealed an unstable left C6 foramen fracture encompassing its articular process, transverse process, and pedicle (Fig. 4) along with the vertebral artery dissection responsible for the occlusion of the basilar artery. This fracture was classified B2 F2 N2 M4 according to the AOSpine subaxial cervical spine injury classification system [2]. Consequently, the patient underwent an anterior cervical discectomy and fusion at C5C6 level under antiplatelet therapy

(Fig. 4), the foramen, which was stenosed by the facet fracture was left untouched. The postoperative course was uneventful, the patient was discharged home at day 6 postoperative. At 3 months postoperative, the patient recovered fully from his right upper limb paresis, his diplopia improved slightly. The Enhanced CT scan showed no residual thrombosis nor stenosis. At one-year postoperative follow-up, the patient recovered fully from his diplopia. One-year postoperative cervical CT scan showed a good bone fusion. To date (13 months later), the patient is still taking aspirin daily.

3. Discussion

In 1961, Carpenter was the first to report the association between cervical spine fracture and VAI [3]. Since then, many cases have been described, mostly secondary to car accidents or chiropractic maneuvers [4]. Blunt trauma VAI mostly involves the second part of the vertebral artery in its course through the vertebral transverse foramina [4,5] (cf. Fig. 5: anatomy of the vertebral artery). That proximity to cervical bones makes it more vulnerable to fractures involving the lateral mass and transverse foramen [6]. According to Giacobetti et al., flexion distraction is the most frequent mechanism followed by flexion compression in fractures causing blunt trauma VAI [7]. It is thought that excessive distraction and stretching of the artery between two adjacent transverse foramina may cause intimal disruption of the artery, acting as a first step

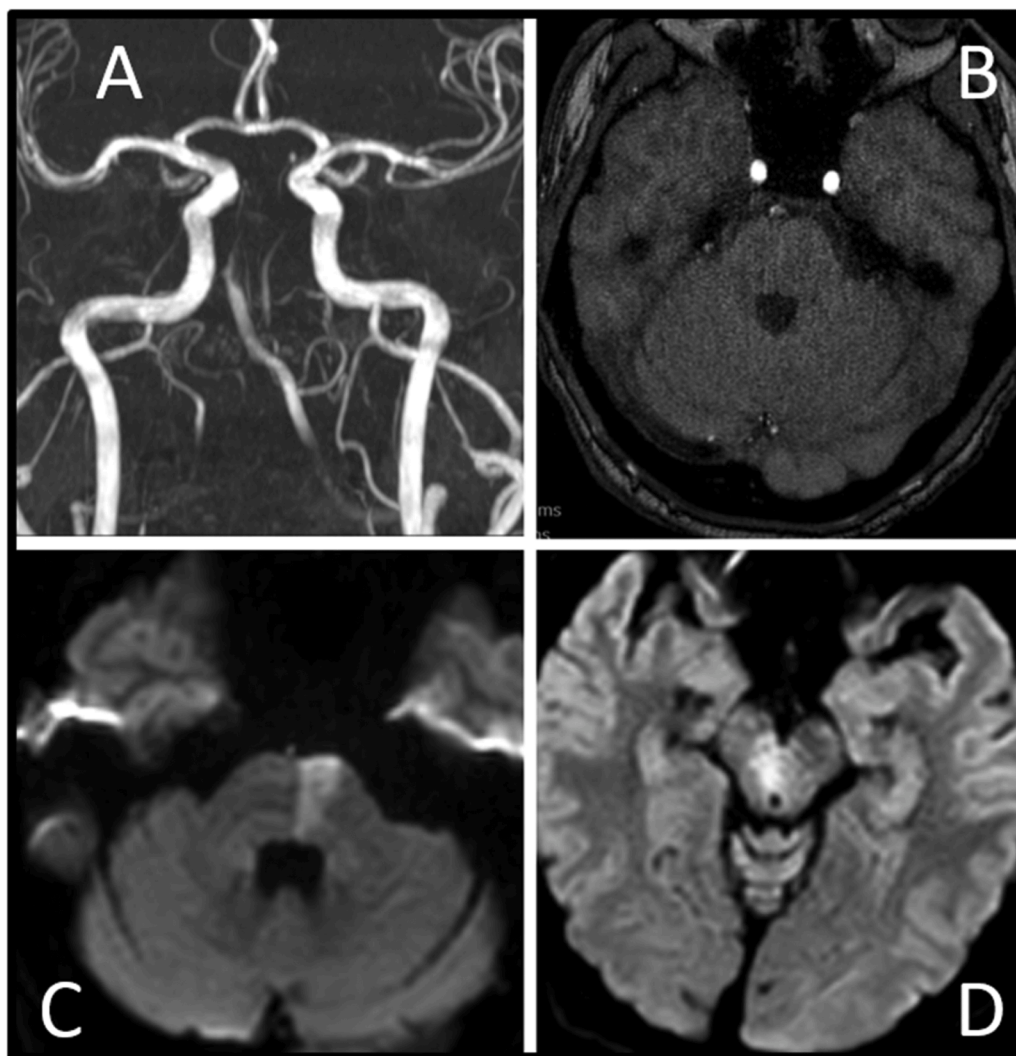


Fig. 1. Brain MRI of the patient performed at neurological worsening. A: 3D Time Of Flight (TOF) frontal view showing basilar artery occlusion. B: 2D axial TOF showing occlusion of the basilar artery. C & D: Axial Diffusion showing ischemic signs of the left pons (C) and the right midbrain (D).



Fig. 2. Arteriography before (A) and after (B) thrombolysis plus endovascular thrombectomy.

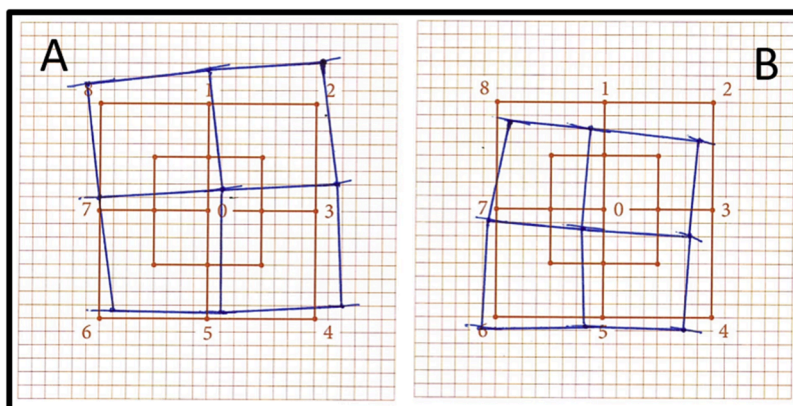


Fig. 3. Hess Lancaster test of the left (A) and right (B) eye.

in VAI [8]. Then, distal extension of the dissection, constitution of a mural thrombus, embolization, or constitution of a pseudoaneurysm can occur. Thus, combined C1–C2 fractures and cervical spine subluxations are also high risk fractures for VAI [6]. It is commonly classified according to the Denver Blunt Cerebrovascular Injury (BCVI) as proposed by Biffi et al. in 1999 [9]. This grading scale has been initially tailored for carotid injuries then extended to vertebral artery injuries (Table 1: Denver BCVI grading scale).

About 0.5% of all blunt polytrauma are associated with VAI in series with systematic screening [10]. Also 30–50% of all cervical spine fractures harbor vertebral artery dissection in prospective angiograph studies [11–13]. Furthermore, 70% of Blunt VAI are associated with cervical spine fracture [5]. VAI screening policy for polytrauma patients and cervical spine injury patients varied during the last two decades among series due to the lack of guidelines [6]. Some aimed for an aggressive screening policy [14,15] while others like Lockwood et al. questioned the cost effectiveness of such a policy and ask for further studies narrowing the range of indication for a screening of the VAI [6]. In 2020, the Eastern Association for the Surgery of Trauma (EAST) gathered and published updated practice management guidelines on the management of blunt cerebrovascular injuries [1]. They concluded that benefits of screening protocols outweigh risks as they carry low potential harm in both polytrauma patient and high risks cervical spine injury patients. High risk cervical spine injury include upper cervical spine fractures (C1; C2; C3), fracture passing through the transverse foramen

process, and subluxation at the facet joints [6]. Indeed, up to 8% of C1–C3 fractures have been reported carrying a BCVI while only 2% of C4–C7 fractures do [16]. Conversely, they concluded that low risk cervical spine injury should be screened on a case by case basis [1]. Regarding screening modalities, both the arteriography and the CTA are available options. Even though the arteriography remains the gold standard, CTA carries a sufficient sensitivity and specificity allowing its use as a first line screening tool [17–20]. MRI is not appropriate for BCVI screening [21]. However, MRI may play a role later on in the management. Indeed, according to a study published in 2022 by Hashimoto et al., MRI at two weeks can predicts spontaneous healing of vertebral artery dissection with 91% sensitivity and 82% specificity [22].

Stroke risk is a prime concern in the management of VAI. Stroke rate can reach 40% depending on VAI grade [23]. Posterior circulation stroke can have devastating consequences as locked-in syndrome or death [24,25]. Embolism from thrombus forming at the dissection site is thought to play the major role in stroke pathogenesis [26]. This prospect raises questions about the use of preventive anti thrombotic therapy (ATT). ATT is a term that collectively refers to antiplatelet (AP) and anticoagulant (AC) therapies [21]. ATT is thought to prevent stroke and BCVI progression [27]. The best management strategy is still a matter of debate [1]. Based on five series, the EAST guidelines for treatment suggest that ATT should be systematically considered in face of VAI as it seems to lower both stroke and death risk [1]. However, there is several limitations to this recommendation: it builds on low to very low quality

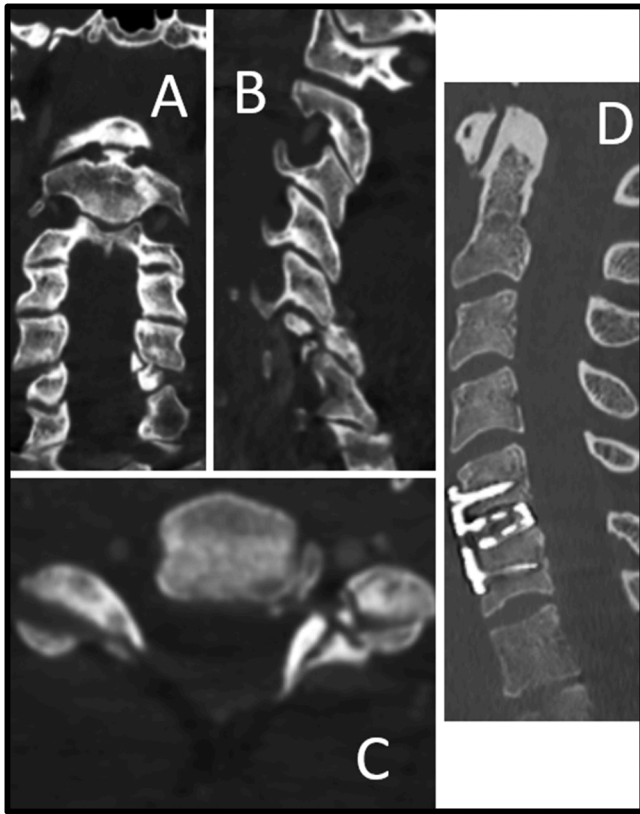


Fig. 4. Coronal (A), sagittal (B), and axial (C) images of the preoperative CT showing a fracture of C6 encompassing its left articular process, transverse process, and pedicle; Postoperative sagittale CT (D) after an anterior discectomy and fusion at C5–C6 level.

of evidence [1], it does not specify which VAI grade would benefit the most from ATT, also most studies refer to BCVI and not only VAI. We believe that decision-making should be based on the VAI grade, surgical indications, and associated internal bleeding. In a study conducted by Shahan et al. focusing on patients harboring both BCVI and traumatic brain injury (TBI), systematic use of ATT significantly decreased stroke rate (4% stroke rate versus 57% in the no therapy group $p < 0.0001$) without exposing patients to higher risks of hemorrhagic worsening (5% versus 6% $p = 0.6$) [28]. Another parameter that is missing in previous studies on blunt traumatic VAI, to the best of our knowledge, is vertebral artery dominance. The left vertebral artery is usually larger than the right one in 50% of people (for 25%, the right side is bigger, and 25% both sides are equal) [29]. This is due to the fact that the left VA emerge directly from the aortic arch while the right one is a tertiary branch originating from the subclavian artery [30]. Some suggest that its size might expose it further to shear force [30]. Is the dominant vertebral artery more affected by blunt VAI? Is dominant VAI more at risk of stroke than non-dominant VAI? Those matters shall have to be cleared out in future studies to best define the treatment strategy. To this day, no high power prospective study has AP and AC is superior in preventing stroke for VAI [1]. However, in the management of cervical artery dissection complicated of stroke, a recent prospective randomized clinical trial including 250 patients (CADISS) found no difference between AC and AP therapies in the recurrence rate of stroke [26]. Finally, the EAST guidelines conclude that systematic preventive stenting for grade II and III dissections is not indicated for blunt trauma BCVI [1].

In our report, the patient presented with a life-threatening posterior circulation stroke (PCS). PCS represents one fifth of all strokes [31]. However, acute management of PCS has received far less attention than anterior circulation stroke (ACS) [31]. A recent review led by Markus and Michel highlights recent advances on the management of PCS and outlines differences with ACS [32]. According to this study, intravenous thrombolysis (IVT) shares same benefits as ACS with lower rates of intracerebral hemorrhage. Thus, IVT seems to be the treatment of choice for distal PCA stroke or minor strokes [32]. A study comparing different

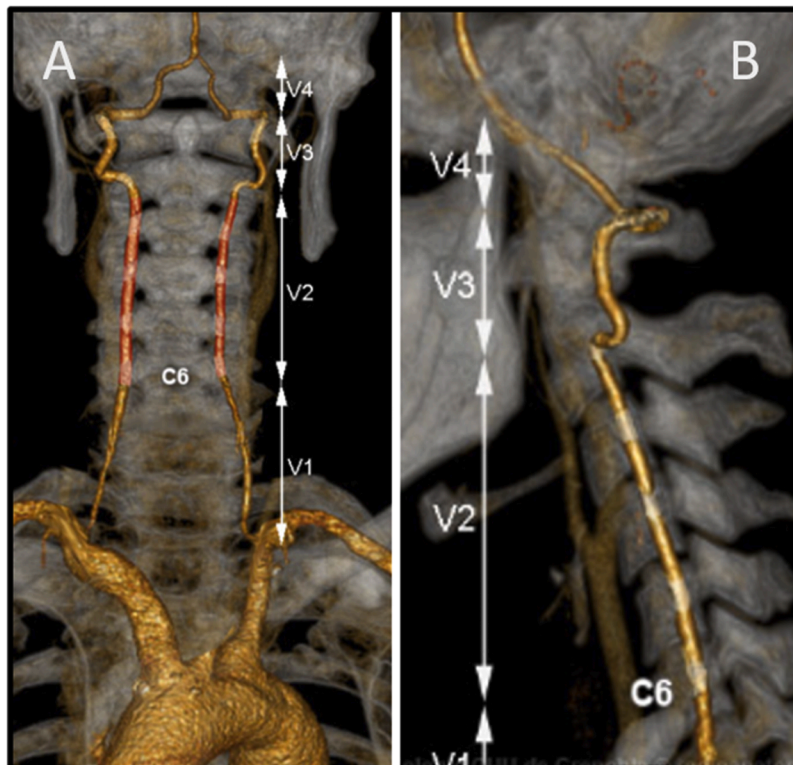


Fig. 5. Anatomy of the vertebral artery [36].

Table 1
Denver grading scale for BCVI applied to VAI.

Grade I
Luminal irregularity
Dissection < 25% luminal narrowing
Intramural hematoma with < 25% luminal narrowing
Grade II
Dissection with > 25% luminal narrowing
Intraluminal hematoma with > 25% luminal narrowing
Intraluminal thrombus
Raised intimal flap
Grade III
Pseudoaneurysm
Grade IV
Occlusion
Grade V
Transection with free extravasation

IVT drug preceding an endovascular thrombectomy (EVT) is currently being done (Post-Eternal: <https://clinicaltrials.gov/ct2/show/NC/T04454788>). More studies have been conducted on EVT for basilar artery occlusion (BAO) than posterior cerebral artery (PCA) or vertebral artery (VA) occlusions. Until recently, benefits of endovascular thrombectomy for BAO was questioned [32]. But two randomized control studies published in 2022 (ATTENTION and BAOCH) confirmed that EVT for BAO carries significant benefits with similar complication rates than in ACS [33,34]. What is more, EVT in BAO is valuable tool up to 24 h after onset [32,34]. More randomized control trials are needed for PCA and VA strokes. Selecting patients that would best benefit from revascularization therapies should build on clinical and radiological criteria. Coma at admission, more than time appears to be an important prognostic factor when dealing with PCS [35]. Several radiological scores exist to better select patients that would benefit most from revascularization therapies. Those mainly assess perfusion and the presence of collateral circulation. Namely, As the «critical area perfusion (CAP)» (seen on CT), «the pons midbrain thalamus (PMT)» (seen on MRI) useful to assess hypoperfusion in BAO [32,35]. The «posterior circulation collateral score (PC-CS)» also used in BAO [32,35]. So far, no prospective randomized studies have been performed assessing posterior cranial decompression against the backdrop of ischemic or hemorrhagic conditions. Posterior decompressive craniectomy is indicated on a case-by-case basis.

4. Conclusion

Neck pain following a benign head trauma require screening for cervical spine fracture and/or a blunt trauma VAI. High risk cervical spine injuries and polytrauma require a systematic screening for VAI through a CTA. Patients harboring a cervical spine fracture and a VAI should be transferred to a hospital that carry both spine surgery unit and a neurovascular unit to ensure responsiveness in the event of a stroke. Preventive ATT (AP or AC) should be systematically considered to lower risk of PCS in case of blunt traumatic VAI. To cope with PCS secondary to a blunt traumatic VAI, decision-making regarding revascularization therapies includes clinical (GCS) and radiological (collateral vascularization) informations. These include IVT and EVT. Further prospective studies are needed to determine the best preventive strategy in case of blunt trauma VAI.

Author contribution

AC: draft, data collection, figures; TB: data collection; MM: surgeon, corrections; HD, KF, SF: corrections, approved the final article; SF: had the idea.

Conflict of interest and disclosure of funding statement

The authors certify that there is no conflict of interest with any financial organization regarding the material discussed in the manuscript. There is no disclosure of funding.

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