VERTEBRAL ARTERY INJURY IN A PATIENT WITH FRACTURED C4 VERTEBRA*

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SUMMARY – Vertebral artery injuries due to cervical spine trauma, although rarely described in the literature, are relatively common. While most of them will remain asymptomatic, a small percentage of patients may suffer life threatening complications. We report a case of the right vertebral artery injury in a patient with fracture of C4 vertebra, successfully treated with endovascular approach. A 78-year-old male patient was hospitalized for cervical spine injury caused by falling off the tractor. Radiological assessment revealed fracture of C4 vertebra with proximal two-thirds of C4 body dislocated five millimeters dorsally. Significant swelling of soft prevertebral tissues distally of C2 segment was also present. During emergency surgery using standard anterior approach for cervical spine, excessive bleeding started from the injured right vertebral artery. Bleeding was stopped by tamponade with oxidized regenerated cellulose sheet and C4-C5 anterior fixation; then partial reduction of displacement was done. Fifteen days later, after angiography, endovascular repair of the right vertebral artery was performed using percutaneous stent graft. Follow up computed tomography scan angiography showed valid stent patency without contrast extravasation. In cases of cervical spine trauma, surgeon should always be prepared to manage injury of vertebral artery. Bleeding can primarily be stopped by hemostatic packing, and definitive repair can be successfully achieved by endovascular approach using percutaneous stent graft.

Key words: *Cervical spine; Spinal injuries; Vertebral artery – injury; Vertebral artery – surgery; Fracture fixation; Case reports*

Introduction

Vertebral artery is a major neck artery, important for blood supply to the cerebellum and brain stem, as well as the initial part of the spinal cord. The exact incidence of vertebral artery injury in patients with cervical spine injury is not known, and in different studies it ranges from 25% to 88%[1-4], and the consequences of the injury can range from asymptomatic to lethal[5].

The objective of this case report is to present our management of the cervical spine injury complicated with vertebral artery injury.

Case Report

A 78-year-old male patient was hospitalized for cervical spine injury caused by falling off the tractor.

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Fig. 1. Preoperative cervical spine x-ray.

The patient was complaining of neck and chest pain, together with feeling of weakness and numbness in arms and legs. He was able to remember the event and stated that he had not lost consciousness. Physical examination showed elevated tone of cervical paravertebral muscles. Neck movements were limited and painful. Right hand grip was weaker than left hand grip, but both were inadequate. The patient could elevate his lower extremities, but could not keep them in antigravity position. Presternal and nasal hematomas were also visible.

After immobilization and emergency radiological assessment, the patient was admitted to the Intensive Care Unit (ICU). Antiedematous corticosteroid therapy according to the NASCIS III protocol was administered (bolus dose of 30 mg/kg body weight of methylprednisolone over 15 minutes, followed by a 45-minute pause, and then a 23-hour continuous infusion of 5.4 mg/kg/h), together with analgesics and proton pump inhibitor. Plane x-rays of cervical spine showed fracture of C4 vertebra with proximal two-thirds of C4 body dislocated five millimeters dorsally. Significant swelling of soft prevertebral tissues distally of C2 segment was also present. The patient suffered from Bechterew syndrome, so x-ray showed severe spondylosis, spondyloarthrosis and intervertebral osteochondrosis, with almost complete osseous block between C4-C5 and C5-C6 vertebrae (Fig. 1).

Fig. 2. Postoperative cervical spine x-ray.

Emergency surgery was indicated, and the operative plan was to remove intervertebral discs C3-C4 and C4-C5, to perform corporectomy of C4 vertebra, to reduce the displacement, and to fix vertebrae C4- C5 with locking plate and autologous bone graft. Standard anterior approach for cervical spine was used. During the C3-C4 diskectomy, excessive bleeding started, evidently from the injured right vertebral artery. It was stopped by tamponade with oxidized regenerated cellulose sheet (Surgicel®), and C3-C4-C5 anterior fixation was done after subtotal displacement reduction (Fig. 2). During the surgical procedure, the patient received 7 units of packed red blood cells (PRBC), 1000 mL of fresh frozen plasma, 2000 mL of crystalloid, and 500 mL of colloid fluids.

After the surgery, the patient was recovering at the ICU and was stable, on mechanical ventilation. Additional two units of PRBC were administered. On postoperative day 7, tracheostomy was done and endotracheal tube was removed. ENT examination revealed a bump on the posterior soft palate wall and neck computed tomography (CT) scan showed retrotracheal hematoma as a consequence of the right vertebral artery injury. The patient was transferred to the Department of Interventional Radiology, Merkur University Hospital. After angiography, which showed contrast extravasation at the site of arterial rupture (Fig. 3), endovascular repair was performed using percutaneous stent graft (Fig. 4). Follow up CT scan angiography (done 11 days after endovascular treatment) showed a valid stent patency, without contrast extravasation. Anticoagulant therapy (60 mg/d of low molecular weight heparin) was additionally adminis-

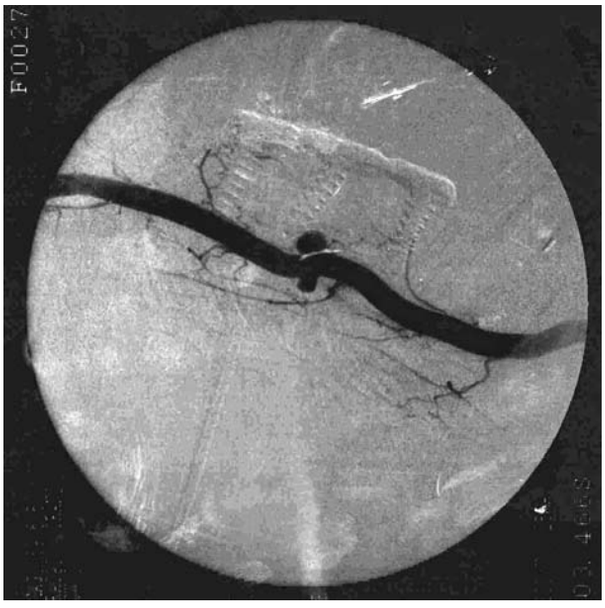

Fig. 3. Angiography of the injured right vertebral artery before endovascular repair, showing contrast extravasation.

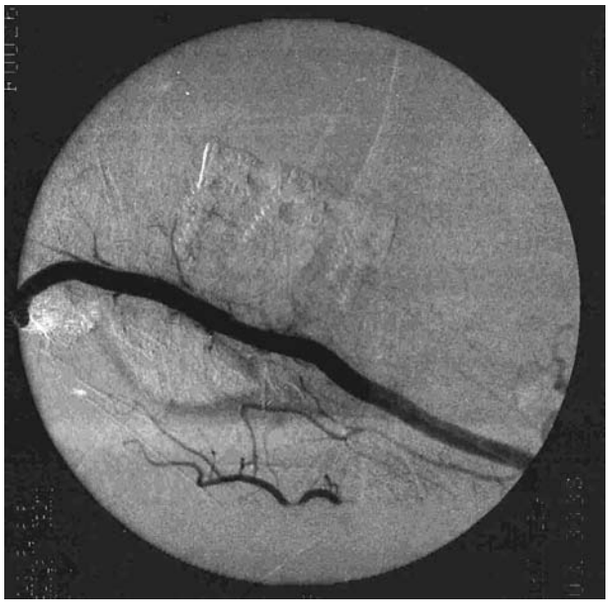

Fig. 4. Angiography of the right vertebral artery after endovascular repair using percutaneous stent graft.

tered for six weeks and was replaced with antiaggregation agents (100 mg/d of acetylsalicylic acid + 75 mg/d of clopidogrel) for the next six months.

On day 32 of the injury, the patient was transferred to the Department of Spine Surgery, University Hospital for Traumatology, Sestre milosrdnice University Hospital Center, where he gradually additionally recovered. Tracheostomy cannula was removed and physical therapy was further implemented. On day 39 of the injury, the patient was relocated to Varaždinske Toplice Special Hospital for Medical Rehabilitation. Two months later, after rehabilitation, the patient was able to walk independently, using just one cane. Follow up x-rays showed good alignment of vertebrae C4-C6, with incipient bone fusion between them, as well as a valid position of allenthesis. During the six months following the surgery, the patient's motor performance further improved and he had no additional consequences of vertebral artery injury.

Discussion

Vertebral artery is extremely important for blood supply to the cerebellum and brain stem, as well as the initial part of the spinal cord. Its course can be divided into 4 segments: extraosseous, which extends from the point of its separation from subclavian artery to transverse process of the sixth cervical vertebra; foraminal, which includes part of vertebral artery that passes through the transverse foramina of vertebrae C1-C6; extraspinal or suboccipital, from transverse foramen of C2 to the foramen magnum; and intradural, which extends from dural penetration along the medulla to the site where it merges with the contralateral vertebral artery to form basilar artery[2,5]. The exact incidence of vertebral artery injury in patients with cervical spine injury is not known, and in different studies it ranges from 25% to 88%[1-4]. According to the literature, vertebral artery injury most often occurs in fractures involving transverse foramina[6-13], in vertebral subluxations[6,7,14-16], and in fractures of the first three cervical vertebrae[6,7,17].

Vertebral artery injury can cause different consequences, ranging from asymptomatic to severe neurologic deficits that can often result in death[18]. These effects may occur immediately or can be delayed, and are caused by the following mechanisms: obstruction of flow in the vertebral artery with subsequent vertebrobasilar insufficiency; obstruction of flow in the anterior spinal artery with subsequent ischemia of the spinal cord; and thrombus formation at the site of arterial injury and distal embolization[6].

So, the question evolving is how to early detect the injury of the vertebral artery and what action to take then to prevent the above mentioned potentially lethal events or, as in our case, severe bleeding from the site of arterial rupture during the surgical procedure that is indicated for concomitant injuries of the spine and spinal cord. The logical solution is screening for vertebral artery injury in patients with cervical spine injury. However, as screening methods are either invasive and associated with complications or time consuming, or are unavailable in many institutions, it is necessary to be limited only to those patients who have the highest risk of vertebral artery injury. The most sensitive test for detecting vertebral artery injury is conventional catheter cerebral angiography[5]. However, it is invasive and has a complication rate of up to 4%[18]. Other solutions are magnetic resonance angiography and computed tomography angiography, which are less invasive, but also have lower sensitivity.

The next question is what to do when a vertebral artery injury is found during surgical procedure. In the first place, it is necessary to achieve hemostasis, which can be done by packing thrombogenic materials in the zone of injury. Hemostasis, if well done, can buy time until final repair. The repair may involve ligation of the vertebral artery, direct surgical repair with sutures, or endovascular procedures. Ligation of vertebral artery is the fastest and simplest method, but is linked to significant morbidity and mortality. Its consequences include cerebellar infarction, cranial nerve palsies, quadriplegia and posterior circulation insufficiency with consequent death, according to some studies in about 12% of patients[19]. Direct surgical repair of injured vertebral artery is a complex procedure that requires careful dissection of the ipsilateral transverse process, with their partial resection, together with the longus colli and intertransverse muscles. Once exposed, the vertebral artery is temporarily clamped, during which time direct suture repair is performed. Unfortunately, direct exposure and repair of injured vertebral artery is not always possible because of profuse bleeding and hemodynamic instability[2]. The alternative are endovascular procedures. In a study on 18 patients with traumatic vertebral artery lesions, Herrera *et al*. have shown that endovascular techniques for occlusion of vertebral artery lesions are safe and effective, without significant complications[20]. The aim of these procedures is to close the laceration on the vessel wall without compromising blood flow. The advantages lie in the approach to the injured vessel from a remote location that is not affected by the injury, thus avoiding difficult dissections and complications related to surgical access[21]. Disadvantages lie primarily in the fact that there is no sufficiently long follow up of patients treated by this method. However, technology and properties of stents, as well as methods of its application continue to evolve on a daily basis, and it can be expected that endovascular techniques, as ever more data are collected, will continue to further develop.

Conclusion

Vertebral artery injury, according to the literature, is more common than usually thought, and can have serious consequences, ranging from asymptomatic to severe neurologic deficits that can often result in death. Therefore, we emphasize the importance of thorough preoperative evaluation and planning in patients with elevated risk of vertebral artery injury: fractures involving transverse foramina, vertebral subluxations, and fractures of the first three cervical vertebrae. We also suggest endovascular stenting as a safe and effective treatment for injured vertebral artery.

References

1. MILLER PR, FABIAN TC, CROCE MA, *et al*. Prospective screening for blunt cerebrovascular injuries: analysis of diagnostic modalities and outcomes. Ann Surg 2002;236:386-95.
2. GANTWERKER BR, BAAJ AA, MAUGHAN PH, McDOUGALL CG, WHITE WL. Vertebral artery injury during cervical discectomy and fusion in a patient with bilateral anomalous arteries in the disc space: case report. Neurosurgery 2010;67(3):E874-5.
3. BIFFL WL, MOORE EE, ELLIOTT JP, *et al*. The devastating potential of blunt vertebral arterial injuries. Ann Surg 2000;231:672-81.
4. WOODRING JH, LEE C, DUNCAN V. Transverse process fractures of the cervical vertebrae: are they insignificant? J Trauma 1993;34:797-802.
5. VACCARO AR, KLEIN GR, FLANDERS AE, *et al*. Long-term evaluation of vertebral artery injuries following cervical spine trauma using magnetic resonance angiography. Spine 1998;23:789-95.

6. FASSETT DR, DAILEY AT, VACCARO AR. Vertebral artery injuries associated with cervical spine injuries: a review of the literature. J Spinal Disord Tech 2008;21(4):252-8.
7. COTHREN CC, MOORE EE, BIFFL WL, *et al*. Cervical spine fracture patterns predictive of blunt vertebral artery injury. J Trauma 2003;55:811-3.
8. KERWIN AJ, BYNOE RP, MURRAY J, *et al*. Liberalized screening for blunt carotid and vertebral artery injuries is justified. J Trauma 2001;51:308-14.
9. KRAL T, SCHALLER C, URBACH H, *et al*. Vertebral artery injury after cervical spine trauma: a prospective study. Zentralbl Neurochir 2002;63:153-8.
10. VERAS LM, PEDRAZA-GUTIERREZ S, CASTELLANOS J, *et al*. Vertebral artery occlusion after acute cervical spine trauma. Spine 2000;25:1171-7.
11. WELLER SJ, ROSSITCH E Jr, MALEK AM. Detection of vertebral artery injury after cervical spine trauma using magnetic resonance angiography. J Trauma 1999;46:660-6.
12. WILLIS BK, GREINER F, ORRISON WW, *et al*. The incidence of vertebral artery injury after midcervical spine fracture or subluxation. Neurosurgery 1994;34:435-42.
13. CARPENTER S. Injury of neck as cause of vertebral artery thrombosis. J Neurosurg 1961;18:849-53.
14. COTHREN CC, MOORE EE. Blunt cerebrovascular injuries. Clinics 2005;60:489-96.
15. COTHREN CC, MOORE EE, RAY CE Jr, *et al*. Screening for blunt cerebrovascular injuries is cost-effective. Am J Surg 2005;190:845-9.
16. SAWLANI V, BEHARI S, SALUNKE P, *et al*. "Stretched loop sign" of the vertebral artery: a predictor of vertebrobasilar insufficiency in atlantoaxial dislocation. Surg Neurol 2006;66:298-304.
17. ROJE-BEDEKOVIĆ M, VARGEK-SOLTER V, BEDEK D, DEMARIN V. Basilar impression as a possible cause of cerebellar stroke: case report. Acta Clin Croat 2011;50(4):577-80.
18. CITRON SJ, WALLACE RC, LEWIS CA, *et al*. Quality improvement guidelines for adult diagnostic neuroangiography: cooperative study between ASITN, ASNR, and SIR. J Vasc Interv Radiol 2003;14:S257-S262.
19. SHINTANI A, ZERVAS NT. Consequences of ligation of the vertebral artery. J Neurosurg 1972;36:447-50.
20. HERRERA DA, VARGAS SA, DUBLIN AB. Endovascular treatment of traumatic injuries of the vertebral artery. AJNR Am J Neuroradiol 2008;29(8):1585-9.
21. PASTORES SM, MARIN ML, VEITH FJ, BAKAL CW, KVETAN V. Endovascular stented graft repair of a pseudoaneurysm of the subclavian artery caused by percutaneous internal jugular vein cannulation: case report. Am J Crit Care 1995;4(6):472-5.

Sažetak

OZLJEDA VERTEBRALNE ARTERIJE U BOLESNIKA S PRIJELOMOM C4 KRALJEŠKA

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Oštećenja vertebralnih arterija, iako se rijetko navode u literaturi, relativno su učestale u bolesnika s ozljedom vratne kralježnice. Iako će većina bolesnika ostati asimptomatska, njihov mali postotak može zadobiti životno ugrožavajuće komplikacije. U ovom članku opisujemo ozljedu desne vertebralne arterije kod bolesnika s prijelomom C4 kralješka, koja je uspješno zbrinuta endovaskularnim pristupom. Muškarac u dobi od 78 godina hospitaliziran je zbog ozljede vratne kralježnice koju je zadobio pri padu s traktora. Radiološkom dijagnostičkom obradom potvrđen je prijelom C4 kralješka s dorzalnom dislokacijom tijela istog kralješka za 5 mm. Pritom je bila vidljiva i značajna oteklina prevertebralnih mekih tkiva distalno od C2 segmenta. Tijekom hitnog operacijskog zahvata u kojem je korišten standardni prednji pristup na vratnu kralježnicu došlo je do masivnog krvarenja iz ozlijeđene desne vertebralne arterije. Krvarenje je zaustavljeno pomoću tamponade vaticom od oksidirane regenerirane celuloze, uz prednju fiksaciju segmenta C4-C5 i parcijalnu repoziciju. Petnaest dana kasnije, nakon angiografije, učinjena je endovaskularna sanacija oštećenja desne vertebralne arterije, uz perkutano umetanje stent grafta. Kontrolno oslikavanje kompjutoriziranom tomografijom pokazalo je dobru prohodnost stenta, bez ekstravazacije kontrasta. Kirurg mora uvijek biti svjestan mogućeg oštećenja vertebralne arterije kod bolesnika s ozljedom vratne kralježnice. Krvarenje se može primarno zaustaviti hemostatskom tamponadom, a konačna se sanacija oštećenja može učiniti endovaskularnim pristupom, korištenjem perkutanog stent grafta.

Ključne riječi: *Kralježnica, cervikalna; Kralježnica, ozljede; Vertebralna arterija – ozljede; Frakture, fiksacija; Prikazi slučaja*