CASE REPORT

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Iatrogenic Vertebral Artery Injury During Anterior Cervical Spine Surgery : Report of Two Cases

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The incidence of vertebral artery injury during the anterior approach to the cervical spine is rare, but potentially lethal. The authors describe two cases of vertebral artery injury during anterior cervical decompression surgery. In the first case, infection was the cause of the vertebral artery injury. During aggressive irrigation and pus drainage, massive bleeding was encountered, and intraoperative direct packing with hemostatic agents provided effective control of hemorrhage. Ten days after surgery, sudden neck swelling and mental deterioration occurred because of rebleeding from a pseudoaneurysm. In the second case, the vertebral artery was injured during decompression of cervical spondylosis while drilling the neural foramen. After intraoperative control of bleeding, the patient was referred to our hospital, and a pseudoaneurysm was detected by angiography four days after surgery. Both pseudoaneurysms were successfully occluded by an endovascular technique without any neurological sequelae. Urgent vertebral angiography, following intraoperative control of bleeding by hemostatic compression in cases of vertebral artery injury during anterior cervical decompression, should be performed to avoid life-threatening complications. Prompt recognition of pseudoaneurysm is mandatory, and endovascular treatment can be life saving.

KEY WORDS : Anterior cervical approach · Endovascular · Pseudoaneurysm · Vertebral artery.

Introduction

The anterior approach to the cervical spine allows direct decompression of the spinal cord with an excellent success rate. It is widely used for cervical spondylotic myelopathy or radiculopathy, trauma, tumor and infection[1,13]. Although anterior approach to the cervical spine is generally considered to be safe and effective, the vertebral artery is at risk during the procedure because of its anatomical relationship adjacent to the neural foramen[9]. The vertebral artery may be injured while micro-surgically removing a cervical disc or drilling spurs narrowing the neural foramen. Vertebral artery injury(VAI) is a serious complication; this is due to difficulty in controlling hemorrhage which can result in severe hypotension and cardiac arrest, and uncertain neurological consequences. If intraoperative profuse bleeding occurs, immediate control of hemorrhage is urgent and usually obtained by means of compressive tamponade only. However, life-threatening bleeding may occur at variable intervals, including several days up to years after surgery[5,7]. We report two cases of iatrogenic injury to the vertebral artery at C5-C6 and C7-T1 during an anterior surgical approach; both were successfully treated by endovascular embolization achieving aneurysm obliteration.

Case Report

Case 1

A 62-year-old man suffering from neck pain and swallowing difficulty was brought to our hospital. Five months prior to admission, he underwent anterior and posterior cervical fusion at a local hospital for a C5-6 dislocation caused by a fall. Plain radiographs of the cervical spine demonstrated a loosened screw and pseudoarthrosis (Fig. 1). Removal of the plate and screw and anterior bone fusion were performed by a right anterior approach. One month later, a wound infection with abscess formation occurred, and aggressive irrigation and pus drainage were performed. He underwent left anterior cervical spine surgery. During soft tissue retraction, massive arterial bleeding was encountered from the left vertebral artery, which was likely eroded and weakened by infection. Hemorrhage was successfully controlled by compressive packing with surgicel. The postoperative course was uneventful, and the patient

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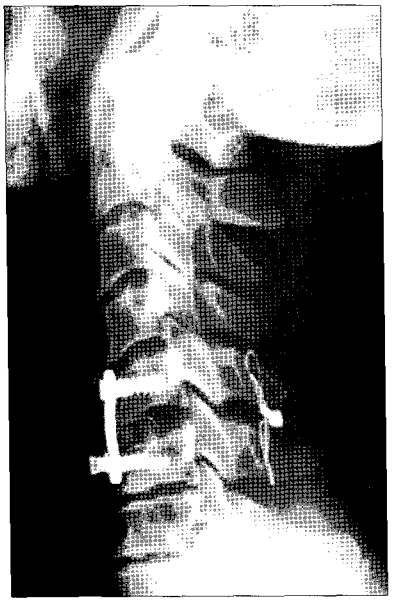

Fig. 1. Case 1. Plain film in lateral projection on admission, revealing a loosened screw from the C6 body and lack of bony consolidation between C5–6. Nonunion is suspected.

did not show any neurological deficit. Ten days later, the patient developed a sudden neck swelling, and rapidly deteriorated with hypotension (70/50mmHg), requiring urgent intubation and volume replacement. After stabilization of the patient's vital signs, an emergency angiogram was performed. The vertebral angiogram revealed a pseudoaneurysm and extravasation of contrast media in the left vertebral artery at the level of C7-T1 (Fig. 2A). Because of the sufficient collateral circulation from right vertebral artery, it was decided to occlude the left vertebral artery. A Pursil guiding wire system was positioned via a transfemoral approach distal to the site of the pseudoaneurysm of the left vertebral artery. A 7mm × 10.5mm sized Golden valve (GVB 19) was positioned at the level of the C4-5 disc, using a Nycomed coaxial microcatheter, and the stabilization was achieved through ballooning system. After suitable ballooning, a left vertebral angiogram showed no blood flow distal to the balloon. Similarly, a 8.5mm × 11.5mm sized Golden valve (GVB 17) was deployed at the level of T1-2 disc. The final angiogram demonstrated successful occlusion of the left vertebral artery with the pseudoaneurysm (Fig. 2B, C). The patient remained clinically stable and continued to do well at a 1 year follow-up.

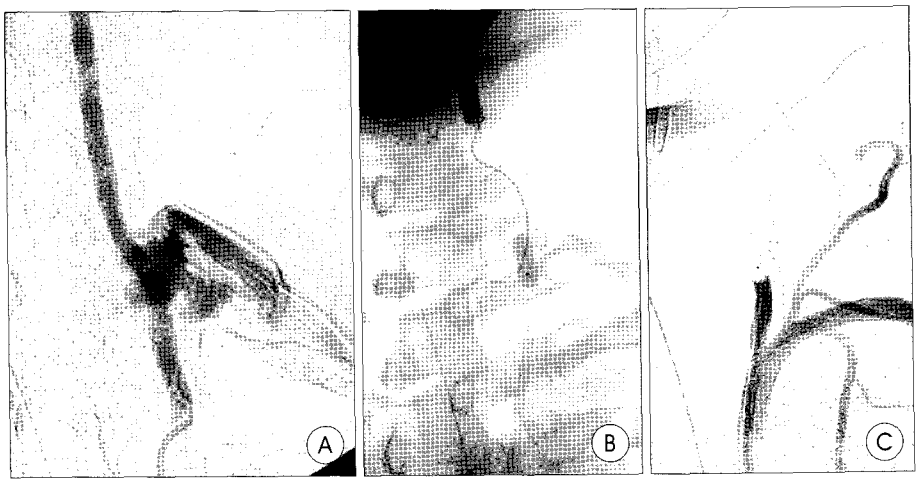

Fig. 2. Case 1. A : Angiogram of the left vertebral artery in case 1 showing a pseudoaneurysm and extravasation of contrast media at the level of C7–T1 B : Angiogram of the left vertebral artery after deployment of the first Golden valve at the level of C4–5 disc showing no blood flow distal to the balloon. C : The final angiogram demonstrated successful occlusion of the left vertebral artery with a pseudoaneurysm.

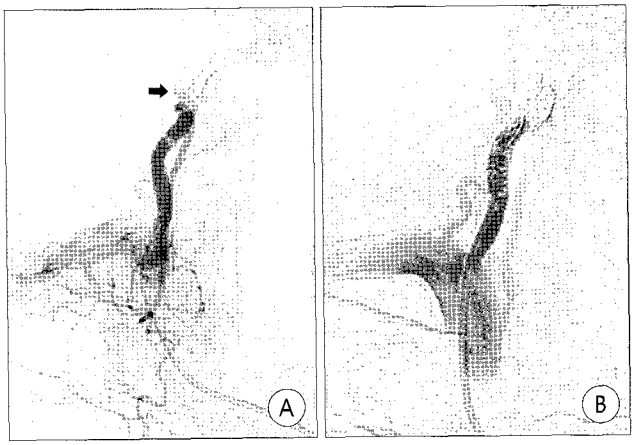

Fig. 3. Case 2. A : Angiogram of the right vertebral artery in Case 2 showing an abrupt cut off at the V2 portion of the right vertebral artery, and a focal contrast filling lesion, suggesting a pseudoaneurysm. B : Post-embolization angiogram shows complete occlusion of right vertebral artery with coils.

Case 2

A 55-year-old woman was transferred to our hospital for evaluation of the vertebral artery. Four days prior to admission, she underwent left anterior cervical spine surgery because of radicular pain at another institution. Diagnostic workup disclosed a cervical spondylosis at the level of C5-6. While drilling the right neural foramen, profuse hemorrhage occurred. The initial control of hemorrhage was achieved by packing with surgicel, followed by anterior interbody fusion with a PCB cervical plate (SCIENT'X, Paris, France) and autologous bone graft. A vertebral angiogram demonstrated an abrupt cut off at the right cervical vertebral artery and a focal contrast filling lesion, considered to be a pseudoaneurysm (Fig. 3A).

Because of retrograde filling of the right vertebral artery from the left vertebral artery, the right vertebral artery, including the pseudoaneurysm was occluded with 4 embolization coils and 4 microcoils. The post-embolization angiogram showed complete occlusion of the right vertebral artery (Fig. 3B). The clinical course was uneventful without any neurological deficit.

Discussion

The anterior surgical approach for decompression of the cervical cord and nerve roots is widely used for patients with herniated disc, spondylosis, trauma, tumor and infection. Despite the low incidence of neurological complications, many vital structures encountered during the anterior surgical approach are at a risk[1,9]. The reported complications include : vocal cord paralysis, dysphasia, carotid artery injury, Horner's syndrome, esophageal perforation, and respiratory obstruction resulting from acute retropharyngeal edema or hematoma[1,19]. If it occurs, iatrogenic injury of the vertebral artery during anterior cervical surgery can be lethal. Possible complications after VAI include : pseudoaneurysm, arteriovenous fistula, late-onset hemorrhages and thrombosis with embolic incidents[5]. Cases of iatrogenic VAI are rare in the literature, and the true incidence of VAI, during cervical surgery, probably remains underreported[2,3,6,9,10,16,17,19,20]. Smith et al.[19] reported an incidence of VAI of 0.5% (10 of 1195 operation), and emphasized three common causes : 1) off of the midline of motorized dissection, 2) excessive width of bone and disc removal, 3) abnormal softening of the lateral bone resulting from tumor or infection. They managed bleeding by hemostatic packing in three cases and ligation of the artery after direct exposure in seven cases. The outcome reported was three brainstem infarcts from the ligated group, and one reversible cardiac arrest due to hemorrhage. Golfinos et al.[10] reported an incidence of 0.3% (4 of 1215 operation); Three arteries were repaired primarily during the surgery and one artery was ligated without ischemic event. Burke et al.[10,19] reviewed their 7-year experience and reported an incidence of 0.3% (6 of 1976 surgeries); They controlled bleeding by direct repair in two cases, arterial ligation in one case, and tamponade in three cases. The result was no sequelae in 4 cases, one intraoperative death and one posterior inferior cerebellar artery infarct from the tamponade group. Interestingly, laceration of the vertebral artery, contralateral to the approach site occurred in 5 out of 6 patients; this was similar to our cases.

Prevention seems to be the best treatment for iatrogenic VAI. There are several ways to prevent intraoperative VAI. First, a dilated or tortuous vertebral artery should be detected preoperatively by careful evaluation of the axial view of computed tomographic scanning(CT) or magnetic resonance imaging (MRI). A tortuous course of the vertebral artery has been well described as an erosion of the pedicle or a widening of the intervertebral foramen in plain radiographs. The foramen of the transverse process exists outside the vertebral body, and its medial margin is situated lateral to a line drawn on the edge of the spinal canal. Its deformation and enlargement, in the axial view of an MRI, suggests a dilated or tortuous vertebral artery[15]. Curylo et al.[4] reported the incidence of a tortuous vertebral artery to be 2.7% in the cadaveric investigation. Despite the low incidence of an anomalous vertebral artery, failure to recognize an aberrant vertebral artery during preoperative planning can result in catastrophic consequences; even when lateral decompression is achieved within generally accepted safe limits. Preoperative MR angiography or conventional angiography should be considered in case of a displaced, tortuous or dilated artery. Preoperative recognition and appropriate modification of decompression can avoid severe complications. Second, VAI has been attributed to several factors : an extensive lateral procedure such as decompression of the uncovertebral joints, drilling for decompression of the neural foramen, lateral disc removal, posterolateral corpectomy, lateral placement of instruments, bone pathologically softened by tumor, infection or irradiation, and intraoperative loss of a midline landmark. Constant intraoperative attention to identification of the anatomic midline, and other anatomic landmarks is mandatory[4,5,10]. Several anatomic clues can be used to maintain the midline : the curvature of the vertebral body and thecal sac, the location of the epidural vein and fat, visualization of the nerve roots, and palpation of the pedicle. Medial uncovertebral joint may be a useful landmark as the lateral extent of any dissection or drilling. The vertebra can be eggshelled out with the drill, leaving only a thin bony cortex to be avulsed with a curette or Kerrison rongeur[1]. Dissection and drilling of the pathologically softened bones from tumor or infection should be performed carefully. In cases of persistent doubt, fluoroscopy may also be helpful to confirm the anatomical midline in operating rooms. Intraoperative CT or image guidance techniques might be another adjunct in difficult cases to assess surgical decompression and midline orientation. Third, the vertebral artery originates from the subclavian or innominate artery at the level of T1, passes by the transverse process of C7 anteriorly and laterally. Despite the existence of the transverse foramen of C7, it usually enters the foramen at the sixth cervical transverse process and passes through the upper six cervical vertebrae[8,15]. Therefore, the potential site for a VAI is down to the C6-7 level, where the vertebral artery runs between the transverse process of C 7 and longus colli muscle. To minimize the risk of injury, the longus colli muscle should be retracted at the level of the C6 transverse process[12]. Wide extension of lateral bone-disc removal should be avoided at the C7 level. A safe approach should be ensured near the vertebral artery with small rongeurs and curettes, rather than with a high speed burr.

Management of VAI is based on the following principles : 1) controlling hemorrhage locally, 2) preventing immediate vertebrobasilar ischemia, and 3) preventing cerebrovascular embolic complications[10]. Intraoperative surgical repair of VAI

include hemostatic tamponade/compression, microvascular repair of the injured artery, ligation of the vertebral artery, and endovascular management using coil or stents. Most authors favor microvascular primary repair, which restores normal blood flow and minimizes the risk of immediate or delayed ischemic complications[5,6,10,16,19]. However, it requires a skillful technique and expert experience. Ligation of the vertebral artery is associated with significant morbidity and mortality. Central nervous system complications, such as Wallenberg's syndrome, cerebellar infarction, isolated cranial nerve paresis, quadriparesis and hemiplegia have been reported after ligation of the vertebral artery[11,18,19]. The anatomy of the vertebral artery in the general population should be considered. The left vertebral artery is hypoplastic in 5.7% and absent entirely in 1.8% of the cases. The right vertebral artery is hypoplastic in 8.8% and absent in 3.1%[10]. An attempted unilateral ligation of the vertebral artery has a reported mortality rate of 12%[18]. Smith et al.[19] reported three vertebrovascular ischemic events after vertebral artery ligation in seven patients. Furthermore, blind placement of sutures, in an attempt to control the hemorrhage, can cause inadvertent damage to cervical nerve roots[19]. Control of bleeding by direct hemostatic tamponade/compression can be an effective and easy method. However, several cases of delayed hemorrhage and fistula formation from packing the injured arteries have been reported in the literature[3,6,19]. In the first case presented here, no angiography was performed because the patient was well following surgery, and delayed hemorrhage was unexpected. However, 10 days later the patient was in critical condition because of rebleeding from a pseudoaneurysm. In the second presented case, we detected the growing pseudoaneurysm prior to rebleeding by angiography 4 days after surgery, and treated it using an endovascular technique in a stable clinical situation. With respect to the present cases, one should keep in mind that there remains a risk of delayed hemorrhage in a patient where hemorrhage was controlled by hemostatic packing[3,6]. Angiography should be performed immediately after surgery to rule out vascular complications, and confirm adequate collateral circulation to the brain. Although postoperative surgical treatments such as ligation, trapping, clipping, and revascularization have been used widely, they are technically demanding, invasive and have a relatively high morbidity rate[9]. Recently, endovascular management such as coil embolization, stent-assist coil embolization and the use of stent grafts or covered stents as a postoperative adjuncts have been introduced[1,3,5,9,14]. With the advances of these new techniques, endovascular management is a good alternative and plays an important role in the treatment of VAI. Moreover, as vertebral angiography and endovascular treatment can be performed in the same setting, prompt detection and management of vascular complications are possible. Although there are no long term outcome studies on endovascular treatment, our two cases suggest a good outcome from this approach.

The status of the vertebral artery anatomy is unlikely to be known preoperatively. Without intraoperative angiography, one cannot easily determine in advance the risk of ischemic events following ligation of the vertebral artery, and outcome is dependent on adequate perfusion of the contralateral vertebral artery. Therefore, when intraoperative angiography and an endovascular team are readily available, this could be an ideal adjunct for the treatment of VAI. Intraoperative angiography will help the urgent evaluation of the injury site, and identify the contralateral vertebral artery status. Direct occlusion of an injured vertebral artery by embolization is only justified if the patient has a patent contralateral vertebral artery or a sufficient collateral posterior circulation[5]. Alternatively, temporary occlusion of the artery could be tried with intraoperative neurophysiological monitoring. If the patient tolerates the procedure, direct occlusion of the artery can be performed by the surgeon or the endovascular team. If the contralateral vertebral artery is hypoplastic, vessel repair ,with patency of the artery, would be the preferred management by microvascular repair or placing a stent into the vertebral artery across the injury.

Conclusion

Although the vertebral artery is rarely injured during anterior cervical spine surgery, one should be prepared for this catastrophic complication. If intraoperative profuse bleeding occurs, initial control can be obtained by hemostatic packing. However, due to a risk of delayed bleeding from pseudoaneurysm in such cases, postoperative vertebral angiography should be performed. Considering the high risk of formation of a pseudoaneurysm, prompt recognition is mandatory and endovascular treatment is an important strategy to avoid life-threatening bleeding.

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