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Case Report

End-to-End Anastomosis of an Unanticipated Vertebral Artery Injury during C2 Pedicle Screwing

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Vertebral artery (VA) injury is a rare and serious complication of cervical spine surgery; this is due to difficulty in controlling hemorrhage, which can result in severe hypotension and cardiac arrest, and uncertain neurologic consequences. The authors report an extremely rare case of a 56-year-old woman who underwent direct surgical repair by end-to-end anatomosis of an unanticipated VA injury during C2 pedicle screwing. Postoperatively, the patient showed no neurological deterioration and computed tomography angiography of the VA demonstrated normal blood flow. Although direct occlusion of an injured VA by surgical ligation or endovascular embolization has been used for management of an unanticipated VA injury during surgery, these methods may be associated with significant morbidity and mortality. However, despite its technical demand, microvascular primary repair can restore normal blood flow and minimizes the risk of immediate or delayed ischemic complications. Here we report an iatrogenic VA injury during C2 pedicle screwing, which was successfully treated by end-to-end anastomosis.

KEY WORDS : Vertebral artery injury · End-to-end anastomosis · Atlantoaxial complex.

INTRODUCTION

Various methods of fixation have been described and used successfully in treatment of patients with atlantoaxial instability[2,4,5,7]. Although posterior wiring techniques, such as Gallie, Brooks-Jenkins, and the modified Sonntag method have been used in stabilization of the atlantoaxial joint, these technically simple procedures have been associated with high fusion failure rates due to their limited stiffness in rotation and require rigid postoperative immobilization[4,7,11]. For this reason, technically demanding rigid screw fixation techniques, such as C1-2 transarticular screw fixation[11] and the C1 lateral mass screw combined with C2 pedicle screw fixation (C1-2 LMPSF)[2,3,7] have been developed. Both techniques are biomechanically superior to wiring techniques; however, they may carry a risk of iatrogenic injury to the VA[7,15]. Compared with posterior C1-2 transarticular screw fixation, the C1-2 LMPSF has gained popularity due to the following advantages[3,7,10,11]; 1) it does not require preoperative reduction, 2) it allows intraoperative direct reduction, 3) it is unaffected by cervicothoracic kyphosis, and 4) it can be used as temporary internal fixation while preserving C1-2 after removal of hardware.

The true incidence of VA injury during posterior screw fixation of the C1,2 complex will probably remain unknown and under-reported[10,11], and it is suspected that the incidence of VA injury will probably increase with the increasing popularity of the C1-2 LMPSF. If intraoperative profuse bleeding occurs, it is generally agreed that immediate control of hemorrhage is urgent and is usually obtained by means of compressive tamponade only[8-10]. However, because life-threatening massive arterial bleeding from VA injury may be encountered, surgeons should have a thorough knowledge of the complex surgical anatomy of the C1-2 region in order to avoid iatrogenic VA injury during surgery, and should be prepared to manage VA injury. We present here an extremely rare case of iatrogenic VA injury during C2 pedicle screwing, which was successfully treated with direct end-to-end anastomosis. To the best of our knowledge, this is the first report of successful direct surgical repair of a VA injury that occurred during C2 pedicle screw fixation.

CASE REPORT

A 56-year-old woman with neck pain after cervical trauma

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was brought to our hospital. Neurologic examination revealed no deficits and no clinical signs of cervical myelopathy. Cervical spine X-rays, computed tomography (CT), and magnetic resonance (MR) imaging showed atlantoaxial subluxation with an atlantodental interval of 8 mm in flexion, and 4 mm in extension. On preoperative surgical assessment with 3-dimensional CT scan and CT angiography, the width of the C2 isthmus was 5 mm, and there was no vascular abnormality on the planned screw trajectory; therefore, we planned atlantoaxial fusion with C1-2 LMPSF (Fig. 1).

Under the guidance of lateral fluoroscopic imaging, we performed uneventful placement of bilateral C1 lateral mass screws; next, we identified the entry point for the left C2 pedicle screw with delineation of the medial border of the C2 pars interarticularis and C2 isthmus. The entry point for the left C2 pedicle screw was marked with a high-speed drill; a 2.5 mm drill bit was then introduced at approximately 25 degrees medially and at 25 degrees in the cephalad direction, guided directly by the superior and medial surface of the left C2 isthmus. Massive pulsatile arterial bleeding from the drilled hole was suddenly encountered during removal of a 2.5 mm drill bit. With the initial local tamponade achieved by massive packing with cottonoid pledgets for several minutes, we struggled to control bleeding from the injured vessel with bipolar coagulation, compressive packed gelfoam, and large pieces of hemostatic agents, such as oxidized cellulose. However, we were not able to achieve successful control of the bleeding. We suspected direct left VA injury by the drill bit, which was incorrectly introduced more laterally than we initially planned. Because intraoperative angiography was not available due to the prone position of the patient, endovascular embolization of unanticipated VA injury was impossible. Therefore, we made the decision to perform intraoperative direct surgical repair of the injured left VA.

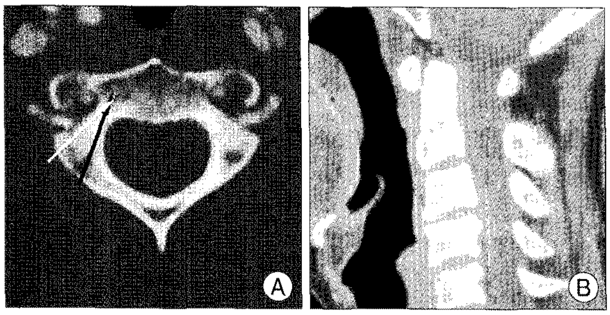

Fig 1. Preoperative computed tomography scan of C2 vertebra. (A) Axial image. Blue arrow indicates initially planned direction of screw and red arrow indicates incorrectly introduced direction of screw. (B) Sagittal image.

Once local tamponade by massive packing with cottonoid pledgets was achieved, we performed rapid exposure of the injured VA by dissection and removal of the bone surrounding the VA using a high speed drill and a Kerrison rongeur. Due to the dominance of the left VA on preoperative CT angiography, there was no information on collateral circulation from the contralateral side; therefore, we could not be convinced of the safety of direct surgical ligation of the in-

Fig 2. Intraoperative photomicrographs. A : Exposed injured vertebral artery. B : Completed vertebral artery repair by means of end-to-end anastomosis.

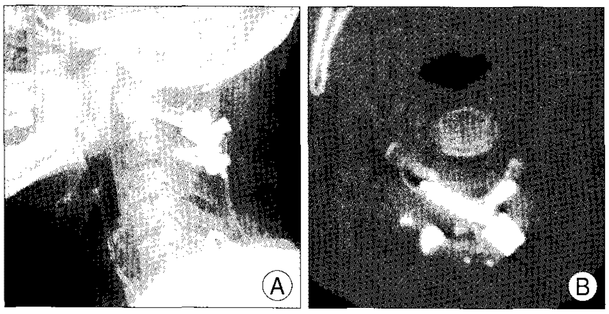

Fig 3. A : Lateral radiograph showing C1-2 stabilization with C1 pedicle screws and C2 translaminar screws. B : Axial computed tomography scan showing the C2 lamina with crossing intralaminar screws.

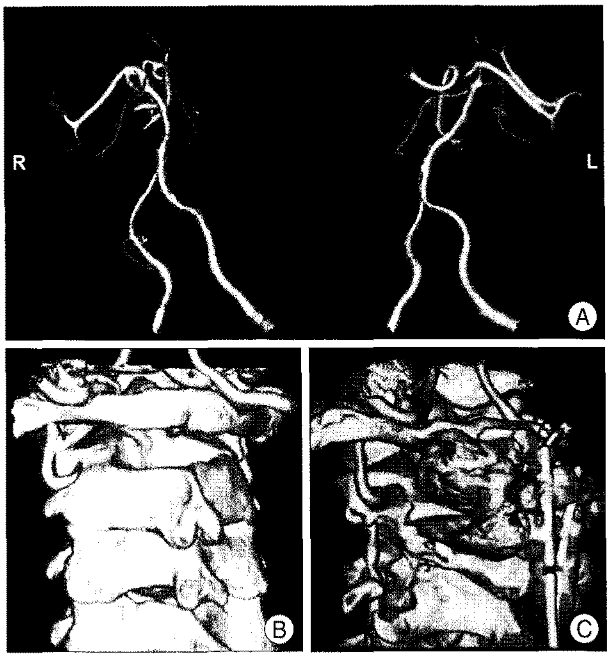

Fig 4. A : Postoperative computed tomographic angiography demonstrating patent flow through the anastomosed vertebral artery. B : Preoperative 3 dimentional reconstruction image of computed tomographic scan of C2 vertebra. C : Postoperative 3 dimentional image of expoopsed left vertebral artery.

jured VA, considering the subsequent risk of ischemic deficits from VA sacrifice. Although copious bleeding from the venous plexus surrounding the VA was controlled using bipolar coagulation and Gelfoam packing, the site of arterial injury was severely torn, with irregular margin; therefore, direct primary suture was not possible. Fortunately, by this time, the patient was hemodynamically stable, with systolic blood pressure over 80 mmHg. Following adequate exposure, temporary aneurismal clips were applied at the proximal and distal portion to the injured arterial site; both ends of the injured VA were then excised. A vascular neurosurgeon (J.P) performed microvascular end-to-end anastomosis using 8-0 Vascufil in an inside-to-outside interrupted fashion (Fig. 2). Good pulsation of the distal artery was noted after removal of the temporary clip. The patient remained hemodynamically stable during a period of about 90 minutes, which was required for exposure and anastomosis of the injured VA. Instead of C2 pedicle screwing, the patient underwent bilateral C2 translaminar screw fixation for stabilization (Fig. 3). Blood loss was estimated at about 800 cc and two units of packed red cells were transfused during surgery. The patient recovered uneventfully from general anesthesia, and showed no symptoms of vertebrobasilar insufficiency during follow up periods. Postoperative CT angiography revealed good blood flow of the VA (Fig. 4). Solid bone fusion of the atlantoaxial joint was confirmed by 3-dimensional CT scan 6 months later.

DISCUSSION

Although VA injury during cervical spine surgery is a rare complication, occurrence of iatrogenic VA injury can be lethal. VA injury during anterior cervical spine surgery has been reported in a few studies, with reported incidences of 0.3-0.5%[9,10]. Considering unrecognized and under-reported cases, the true incidence of VA injury will probably remain unknown and under-estimated, and will increase with the increasing popularity of cervical instrumentation techniques[10,11].

Most cases of VA injury in posterior cervical spine surgery have occurred during the C1-2 transarticular screw fixation procedure. In the study by Wright et al., VA injury during C1-2 transarticular screw fixation was reported in 1-3% of cases, and neurologic deficits are seen in 3% of these patients[13]. Although the recently popularized method of C1-2 LMPSF could achieve a successful outcome for atlantoaxial instability[2,4,7], there also remains a potential risk of VA injury during C2 pedicle screw placement, due to variation in size and angle of the pedicle, and location of the transverse foramen[1,3,18]. Aberrant VA course, thin C2 pars, and incomplete reduction of the atlantoaxial complex may make certain individuals more vulnerable to VA injury during this procedure[6]. Resnick et al.[16] reported that from a strictly anatomic standpoint, C2 pedicle screw fixation is not any safer than transarticular screw fixation.

Consequences of VA injury are often unpredictable, with a wide spectrum of symptoms. Although some patients may remain asymptomatic due to adequate collateral circulation, other patients may sustain devastating vertebrobasilar ischemia or fatal bleeding. Once massive bleeding is encountered intraoperatively by unanticipated hemorrhage from the VA, temporary hemostasis could be achieved by compression of the bleeding point and packing with cottonoids or bone wax. After tamponade for control of bleeding, there are some options for management of iatrogenic VA injury during spine surgery; hemostatic tamponade only, ligation of the VA, and microvascular repair of the injured artery[6,8-10]. Control of hemorrhage by direct hemostatic tamponade can be effective and easy; however, there remains a potential risk of brain stem and cerebellar infarction or delayed sequealae due to pseudoaneurysm or arteriovenous fistula formation. Therefore, in this situation, it is recommended that patients be followed by MR angiography or CT angiography for evaluation of vessel status and to exclude a growing pseudoaneurysm.

Permanent occlusion by surgical ligation is another available option; however, it should only be attempted if the patient has a patent contralateral vertebral artery or sufficient collateral posterior circulation. Attempted unilateral ligation of the VA has a reported mortality rate of 12%[17]. In our case, preoperative CT angiography showed a left dominant VA; however, there was no information on collateral circulation from the contralateral side; therefore, we were not able to attempt surgical ligation due to the risk of severe postoperative sequelae. Some authors have recently reported on successful endovascular management after local control of VA injury by hemostatic tamponade[6,10]. However, significant morbidity and mortality can result from this method, and further follow-up angiography is necessary. Intraoperative angiography and a readily available endovascular team will help in urgent evaluation of the injury site and determination of contralateral VA status. However, in cases like the present one, intraoperative angiography is not practicable, particularly when the patient is in the prone position.

Some surgeons advocate direct primary repair of the injured vessel. Microvascular repair could restore normal blood flow and minimize the risk of hemorrhagic or ischemic complications; therefore, it should be especially considered when injury occurs in the dominant VA[9,14]. Golfinos et al. treated three cases of VA injury that occurred during anterior cervical surgery with primary repair; they recommended primary repair as an optimal management strategy, if it was technically feasible. However, this procedure is technically demanding and may not always be feasible due to the location of the VA within the bony canal and surrounding venous plexus. When bleeding is noted secondary to VA injury, it should be initially controlled by packing. After rapid removal of the bone surrounding the VA, the VA is adequately exposed proximal and distal to the injury site. With temporary occlusion by aneurismal clip, the injured vessel could be carefully repaired. If the VA is lacerated or perforated with good margin, it can be repaired by primary suture. However, in the present case, repair by end-to-end anastomosis was performed because the injured VA was severely torn, with irregular margin.

There is no doubt that prevention of the problem is the best treatment. In the current patient, preoperative CT angiography showed a left dominant VA; however, there was no anatomic variation that could place the VA at risk of injury. We suspected direct VA injury by the drill bit, which was incorrectly introduced more laterally than we initially planned. Surgeons should have a thorough knowledge of the complex surgical anatomy of the C1-2 region and be careful not to induce iatrogenic VA injury during surgery. Proceeding with screw placement or leaving a screw in place after VA injury is not recommended because it may prevent tamponade of the bleeding vessel, and may result in VA erosion with recurrent hemorrhage, distal embolization, or infarction at a later date[13]. And if VA damage is suspected during placement of the first screw, no attempt should be made to place the contralateral screw, as bilateral VA injury may cause fatal brain stem infarction[13]. A new technique for fixation of the atlantoaxial complex, which involves crossing C2 laminar screwing, has recently been devised. When compared with C1-2 transarticular screw fixation and C1-2 LMPSF, this procedure may provide similar stability to the atlantoaxial complex and eliminate the danger to the VA[1,5,7,12]. For stabilization, we performed crossing C2 laminar screwing instead of C2 pedicle screwing.

CONCLUSION

Although occurrence of VA injury during posterior cervical spine surgery is rare, one should be prepared for this devastating complication. Optimal management of iatrogenic VA injury remains controversial. When massive bleeding due to unanticipated hemorrhage from the VA is encountered intraoperatively, initial control can be obtained by hemostatic packing. Permanent occlusion or ligation should not be attempted without knowledge of adequate collateral circulation from the contralateral side. Endovascular treatment is not available due to the prone position of the patient during posterior cervical spine surgery. Therefore, we believe that direct surgical repair by end-to-end anastomosis may be an effective treatment option for VA injury during posterior cervical spine surgery.

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