Case Report

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Endovascular Management of Iatrogenic Vertebral Artery Pseudoaneurysm: A Case Report

의인성 척추동맥 가성동맥류에 대한 중재적 치료: 증례 보고

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Iatrogenic injury of the vertebral artery during cervical spine surgery though uncommon is critical. With advances in interventional endovascular techniques, the therapeutic approach for vertebral artery injuries has changed. Nonetheless, an established strategy for their management is lacking. We report a case of pseudoaneurysm due to vertebral artery injury, during cervical spine surgery for a tumor, that was treated successfully with endovascular coiling in a plug-and-patch fashion after triple stenting failed.

Index terms Vertebral Artery; Pseudoaneurysm; Stent; Therapeutic Embolization

INTRODUCTION

Vertebral artery injury during cervical spine surgery is very rare and has been reported to occur in 0.20% to 1.96% of cases (1). Complications of vertebral artery injury are pseudoaneurysm, arteriovenous fistula, delayed hemorrhage, thromboembolism, cerebral ischemia, and death. Although pseudoaneurysms have the potential to resolve spontaneously, ruptures have been reported in 31% to 54% of cases (2). Therefore, prompt diagnosis and treatment of these lesions are critical to minimize the risk of morbidity and mortality. Previously, surgical approaches such as microvascular repair or vessel ligation were the treatment of choice. The recent advances in minimally invasive endovascular techniques have changed the therapeutic approach to vertebral artery injuries. However, there is no established treatment strategy for vertebral artery injury. Moreover, endovascular methods or devices are not always usable

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in emergency situations.

We report a case of pseudoaneurysm caused by a vertebral artery injury during cervical spine surgery for a tumor successfully treated with endovascular coiling in a plug-and-patch manner after triple stenting failed.

CASE REPORT

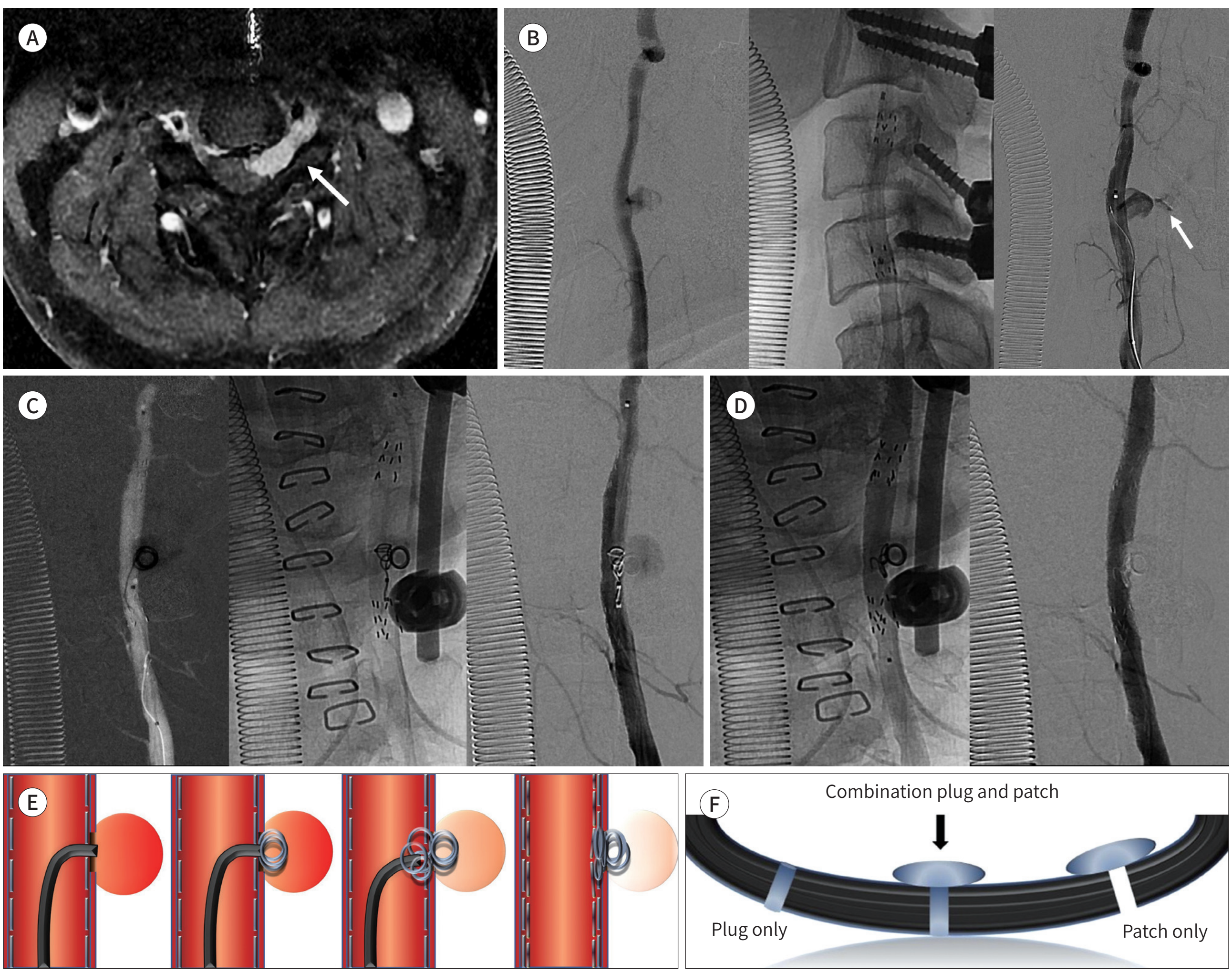
A 63-year-old male with a history of left arm numbness was admitted to our hospital. Preoperative cervical spine magnetic resonance imaging with gadolinium demonstrated a well-defined intradural extramedullary enhancing mass extending through the left C3-4 neural foramen, forming a dumbbell shape (Fig. 1A). The mass slightly compressed the adjacent spinal cord and abutted the left vertebral artery. Tumor resection was performed using the posterior approach. Sudden arterial bleeding was observed during surgery and subsequently controlled with packing and manual compression. After hemostasis was achieved, the patient was transferred to the angiography room under general endotracheal anesthesia.

A left vertebral angiogram showed a 6.7 mm × 5.2 mm pseudoaneurysm of the vessel at the operated level C3-4 (Fig. 1B). The neck of the pseudoaneurysm was not clearly identified. A right vertebral angiogram revealed arterial occlusion. The first decision was to use multiple stents to occlude the pseudoaneurysm and keep the left vertebral artery patent. Three Enterprise stents (4 mm × 30 mm, 4 mm × 23 mm, 4 mm × 23 mm, EP; Codman & Shurtleff, Inc., Miami, FL, USA) were deployed across the injury site in an overlapping manner. Over a period of 20 minutes, the angiogram showed an increase in the size of the pseudoaneurysm and contrast extravasation from the sac (Fig. 1B). Coil embolization was planned as the next treatment option. We attempted to fill and cover the arterial wall defect rather than packing the coil inside the sac. A microcatheter was placed through the stent in the sac. Several loops of the 2 mm × 6 cm coil were deployed in the sac. Pre-deployed loops were used to predict and fill the wall defect (Fig. 1C). The microcatheter was slowly withdrawn while simultaneously deploying a coil to cover the wall defect. A previously inserted stent helped the coil form a mass. A post-coiling angiogram showed slow and reduced contrast filling within the sac (Fig. 1C). An additional 4 mm × 30 mm Neuroform Atlas stent (Stryker Neurovascular, Fremont, CA, USA) was deployed to prevent coil migration and flatten the coil mass against the arterial wall. The final angiogram showed complete occlusion of the pseudoaneurysm (Fig. 1D). A schematic illustration of this procedure is shown in Fig. 1E.

The patients were administered daily doses of aspirin (100 mg) and clopidogrel (75 mg). Six months later, a daily dose of 100 mg aspirin was administered. An angiogram obtained 7 days and 1 year after the procedure showed no recurrence of the vertebral artery pseudoaneurysm). The final histopathological diagnosis was schwannoma. Good clinical outcomes were observed at the 2-year follow-up.

This case report was approved by our Institutional Review Board, and the requirement for written informed consent was waived (IRB No. DAUHIRB-22-140).

Fig. 1. A 63-year-old male with a pseudoaneurysm due to vertebral artery injury during cervical spine surgery.
A. Preoperative axial contrast-enhanced T1-weighted image shows an intradural extramedullary mass (arrow), extending through the left C3-4 neural foramen; the mass abuts the left vertebral artery.
B. Angiogram of the left distal vertebral artery shows a pseudoaneurysm due to vertebral artery injury (left). Unsubtracted (middle) and subtracted (right) angiograms of the left vertebral artery after overlapping triple stenting reveal an enlarged pseudoaneurysm sac with contrast extravasation (arrow).
C. A microcatheter is navigated into the sac through the stents (left), and several loops of a coil are deployed. Coiling is performed to fill and cover the wall defect (middle) with subsequent reduction of blood flow into the sac (right).
D. After additional stent placement, coil mass is flattened against the arterial wall (left). Complete obliteration of the pseudoaneurysm is achieved along with the preservation of the parent artery (right).
E. Several loops of the coil are deployed in the sac. Pre-deployed loops are used to predict and fill the wall defect. Coiling was performed to fill and cover the wall defect using the plug-and-patch technique rather than sac packing. Stents placed before and after coiling help to prevent coil migration and flatten the coil mass against the arterial wall.
F. The combined plug and patch fill the path of the injury, seal the inner surface, and prevent air leakage more effectively than plug or patch seal alone.



DISCUSSION

Although there is no consensus on the optimal treatment strategy for vertebral artery injury in cervical spine surgeries, a systematic management method has been reported (3). In brief, when possible, direct surgical treatment such as microvascular repair or surgical liga-

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tion should be attempted. However, suturing is technically difficult considering the bleeding site and that surgical ligation is required in the presence of posterior circulation collateral flow. Endovascular treatment for vascular injury can be divided into reconstructive and deconstructive techniques with vertebral artery preservation and occlusion, respectively. If sufficient collaterals exist, coil trapping of the vertebral artery is possible. A stent-graft, multiple stents, and a flow-diverting stent can be considered if vessel preservation is necessary (4).

Garcia Alzamora et al. (5) reported a case of iatrogenic vertebral artery pseudoaneurysm successfully treated using the triple stent-in-stent technique. The metal coverage rate of a stent correlates with the flow diversion effect. Multiple overlapping stent placement can increase the metal coverage rate of stents. This method promotes stasis and subsequent thrombosis in the aneurysm by minimizing porosity and decreasing intra-aneurysmal flow (6). However, immediate complete aneurysm obliteration is often not achieved. This method also increases thrombogenicity, thereby necessitating antiplatelet therapy. These may interfere with the healing process and increase the risk of rebleeding of a ruptured case.

In our case, the deconstructive technique with trapping was not considered because the contralateral vessel was occluded. A covered stent was not available in our angiography suite at that time. Utilizing the options available at our hospital, we first attempted to occlude the pseudoaneurysm using multiple overlapping stents across the injury site.

However, our first attempt at using multiple stents failed. Metal coverage of the pseudoaneurysm orifice is an important factor that causes a flow diversion effect. The orientation of the stent interstices could not be adjusted. Theoretically, stent interstices can overlap in the same orientation. In this situation, the porosity of the pseudoaneurysm neck may not be reduced as expected. This may have been the reason for the failure of endovascular management of multiple overlapping stenting. The metal coverage rate of the Enterprise stent is lower than that of braided stents such as low-profile visualized intraluminal support stent and flow-diverting stent (6). This might also cause insufficient metal coverage of the Enterprise stent. In our case, the microcatheter could easily cross the stent interstices into the pseudoaneurysm, supporting this assumption. A possible undesirable effect of insufficient flow diversion can cause flow jets and wall shear stress in the aneurysm sac (7). This might play a leading role in contrast extravasation from the pseudoaneurysm after multiple stents.

We used a coil for the next treatment strategy. Pseudoaneurysms resulting from transmural injury to the vessel wall are covered by a friable layer of connective tissue. Packing the pseudoaneurysm sac with coils exposes the weak connective tissue of the aneurysmal sac to direct manipulation, potentially increasing the risk of rebleeding or rupture (8). In our case, a coil was used to fill and cover the wall defect in a plug-and-patch manner. This type of coil application is analogous to flat tire repair with a commercially available repair plug patch, the mushroom tire plug (9). A tire plug patch to simultaneously seal the tire internally and the injury path can prevent air leak more effectively than a plug or patch alone (Fig. 1F). In clinical practice, this principle has also been used to prevent cerebrospinal fluid leakage using a dural closure technique with a plugged muscle (10). Similarly, we demonstrated successful occlusion of the pseudoaneurysm using "plug-and-patch" coiling in our case.

In plug-and-patch coiling, a stent should be placed before and after coiling. The stent can increase the patch-and-plug effect by preventing coil migration and flattening of the coil mass against the arterial wall. However, as an essential perioperative requirement for stenting, patients should receive dual antiplatelet therapy to prevent thromboembolic complications. Therefore, careful patient selection and observation are recommended.

In conclusion, iatrogenic pseudoaneurysms of the vertebral artery during cervical surgery are uncommon but potentially life-threatening. Endovascular treatment options for iatrogenic vertebral artery injury are limited if there is no contralateral arterial patency or an appropriate instrument in the angiosuite. Our case shows that plug-and-patch coiling, along with stenting, may be a viable option for pseudoaneurysms resulting from the iatrogenic vertebral artery injury.

Author Contributions

Conceptualization, K.S.; investigation, P.J.Y., K.S.; methodology, K.M.; resources, K.M.; supervision, K.S.; writing—original draft, P.J.Y., K.S.; and writing—review & editing, all authors.

Conflicts of Interest

The authors have no potential conflicts of interest to disclose.

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의인성 척추동맥 가성동맥류에 대한 중재적 치료: 증례 보고

박재양 · 김상현* · 강명진

경추 수술 중 발생한 척추 동맥 손상은 드물지만 중요하다. 중재적 혈관내 치료 기술의 발전으로 척추 동맥 손상에 대한 치료 접근 방식이 바뀌었지만 확립된 치료 방침은 아직 없다. 우리는 트리플 스텐트 시술 실패 후 플러그 앤 패치 방식으로 혈관내 코일 시술을 하여 척추 동맥 손상으로 인한 가동맥류를 성공적으로 치료한 사례를 보고하고자 한다.

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