Covered Stent Application of a Repeatedly Regrowing Iatrogenic Subclavian Artery Pseudoaneurysm at the Origin of the Vertebral Artery

G.F. XU**, D.C. SUH, H.W. PYUN, H. YOO, S.W. LEE, M.O. HUH, T. KWON*, S.J. KIM

Departments of Radiology and Research Institute of Radiology and Division of Vascular Surgery,

*Department of Surgery, University of Ulsan, College of Medicine, Asan Medical Center, Seoul, Korea

**Department of Radiology, Yancheng 1st Hospital, 14 Yuehe Rd, Yancheng 224006, Jiangsu Province, China

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Summary

Formation of an iatrogenic subclavian artery pseudoaneurysm while attempting central venous access through the internal jugular vein is relatively uncommon. However, management of a subclavian artery pseudoaneurysm remains a challenge because of its growing tendency and its relation to the origin of the vertebral artery (VA). We report a strategy for using a covered stent as for the endovascular treatment of a patient with a repeatedly regrowing subclavian artery pseudoaneurysm at the origin of the VA.

Introduction

The use of internal jugular venous catheterization may lead to complications at the access site, one of which is damage to the subclavian artery and a resulting pseudoaneurysm. Endovascular treatment is a minimally invasive treatment modality which has been successfully used in patients with pseudoaneurysm¹⁻⁸. We report a case of a continuously regrowing iatrogenic subclavian artery pseudoaneurysm just distal to the origin of the vertebral artery (VA),

which was successfully treated using a covered stent. We also present an endovascular strategy for VA ostial occlusion, which avoids possible complications such as cerebral thromboembolism.

Case Report

A 33-year-old woman presented with progressive swelling and pain in the right lower neck area; she was transferred to our hospital after failure of hemodialysis catheter insertion into the right internal jugular vein. She was diagnosed as having end-stage renal disease and had been treated with hemodialysis via the left internal jugular vein. Contrast-enhanced CT scan showed a large (4x4x3 cm) saccular pseudoaneurysm in the right supraclavicular fossa with partial thrombus formation in the aneurysmal wall (figure 1A). Digital subtraction angiography of the right subclavian artery showed a large aneurysmal sac in the right subclavian artery (figure 1B). The right VA origin was close to the pseudoaneurysm although it was not directly related to the aneurysm neck. Written informed consent for the therapy was

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Figure 1 A) An enhanced CT scan reveals a large thrombosed pseudoaneurysm (asterisk). B) The right subclavian arteriogram reveals a pseudoaneurysm of the right subclavian artery. The neck of the pseudoaneurysm (arrow) is just distal to the origin of the right VA. C) An angiogram obtained after bare-stent-assisted coiling, shows a large residual pseudoaneurysm lumen. D) A microcatheter was subsequently placed in the right VA through the interstices of the previous stent; meanwhile, another wire was advanced into the right subclavian artery. E) After covered stent placement in conjunction with VA embolization using coils, the pseudoaneurysm was completely obliterated. F) At one-year follow-up Doppler ultrasound examination revealed a good patency of the right subclavian artery without further filling of the pseudoaneurysm. Note echogenic covered stent wall (arrows). Asterisk indicates the common carotid artery.

obtained after the nature of the procedure had been fully explained and this study was retrospectively approved by our institutional review board.

We initially decided to treat the patient with bare-stent-assisted coil embolization because we expected that coil embolization alone would not definitely protect the neck of the aneurysm. A 6F guiding catheter was positioned at the origin of the right subclavian artery using a 6F sheath via the femoral approach. An 8 mm x 3 cm bare stent (Precise, Cordis, Miami, FL) was advanced into the le-

sion in the right subclavian artery. Multiple Tornado coils (Cook) were delivered to the pseudoaneurysmal sac by a microcatheter (Excelsior 1018, Boston Scientific/Target, Fremont, CA) through the interstices of the stent. The final angiogram showed only a small amount of residual sac filling.

After the procedure, the patient experienced a decrease of pain in the neck region, but duplex ultrasonography performed one week postoperatively revealed residual aneurysmal lumen remnants. The lesion gradually enlarged and was accompanied by progressive pain during the one-

month follow-up period. After consultation of the vascular surgeon and the radiologist, the decision was made to treat this pseudoaneurysm (figure 1C) with a covered stent in conjunction with protective VA embolization using coils (endovascular stumpectomy).

The patient was pretreated with Aspirin 100 mg and 75 mg Plavix three days before the procedure. After a 9F sheath was inserted via the right femoral artery, 3000 units of heparin were introduced. We did not perform an occlusion test because the contralateral vertebral arteriograms accurately revealed the size of the left VA as well as the fillings of both posterior communication arteries.

Bilateral subclavian and VA angiograms were also obtained to demonstrate the residual pseudoaneurysm as well as the origin of the anterior spinal artery (ASA). ASA was found on the left vertebral angiogram so that compromise of ASA flow was not a concern of the right VA occlusion attempt. Therefore, we regarded a

stump segment between the right vertebral arterial ostium and C4-5 level of the right VA in which the deep and ascending cervical arteries provide collaterals to the VA as a major concern of possible endoleak into the pseudoaneurysm via the VA11 and potential thromboembolic source¹² due to the flow stasis when the right VA is covered by subclavian stent-graft. Therefore, we attempted to obliterate this stump segment of the right VA at the same time of covered stent deployment in the right subclavian artery (figure 2).

After the microcatheter (Prowler plus, Cordis, Miami, FL) was advanced through the interstices of the previous stent into the proximal segment of the right VA over a 0.014-inch microguidewire (Transend, Boston Scientific/Target, Fremont, CA), a long, stiff, 0.035-inch guidewire (Terumo, Tokyo, Japan) was advanced into the right subclavian artery (figure 1D). A 10 x 5 mm self-expanding nitinol covered stent (NITI-S Stent, TaeWoong Medical

Co., Seoul) was carefully placed over the guidewire to cover the neck of the pseudoaneurysm and the origin of the right VA. After identification of the securely positioned covered stent in the right subclavian artery, we continued stumpectomy of the right VA with coils through the microcatheter already positioned in the right VA. A Matrix 12 x 30 mm, 3D coil (Boston Scientific/Target) was deployed at the C5 level of the right VA via a microcatheter as the first distal protective coil for adequate and safe positioning of the following non-detachable fibered coils.

Six Tornado coils (Cook; a 8 x 4 mm, two 7 x 2 mm and three 6 x 2 mm coils) were then packed into the proximal right VA. The post-procedural angiogram of the right subclavian arteriogram revealed slight filling of the aneurysm. Ten minutes later, a repeat angiogram showed that the pseudoaneurysm was completely disappeared (figure 1E). Her pain was relieved immediately after the procedure. She exhibited no further symptom and was discharged with medications consisting of Aspirin 100 mg and Plavix 75 mg. Her neck mass slowly regressed. She did not experience any neurologic deficit during the one year follow-up period and experienced no further pain or swelling in the neck during this time. At one-year follow-up Doppler ultrasound examination revealed a good patency of the right subclavian artery without further filling of the pseudoaneurysm (figure 1F).

Discussion

Subclavian artery pseudoaneurysm is relatively uncommon and generally arises from penetrating injuries, blunt trauma, and occasionally from interventional procedures as an iatrogenic complication¹. Pseudoaneurysm formation occurs due to injury of various layers of the artery wall and extravasation of blood into a compartment in continuity with the arterial lumen. The purposes of treatment are to prevent embolic or thrombotic complications which would threaten the upper extremities or the brain as well as to reduce pain and the risk for pseudoaneurysm rupture^{2,9}.

Since 1991, when Becker et al³ reported the first endovascular treatment of an accidental subclavian artery injury caused by cannulation of the subclavian vein, many modalities of interventional treatment have been used to treat

subclavian artery pseudoaneurysm¹⁻⁸. Especially in recent years, the use of covered stents has become a promising alternative to other endovascular techniques such as coiling^{1-3,5,6,9}.

In our patient, covered stent placement needed to cover the right VA ostium because the pseudoaneurysm was located very close to the right VA ostium. Therefore, we had to plan how to safely sacrifice the right VA. Three issues must be considered when the VA must be occluded by a covered stent. First, the stump of the proximal right VA remains after ostial occlusion by covered stent alone in the subclavian artery because of C3-4 or C4-5 collaterals into the VA stump through deep cervical or ascending cervical arteries⁸. Endoleak around the covered stent¹¹ or cerebral thromboembolism¹² are potential risks of antegrade or retrograde filling of the pseudoaneurysm or vertebral arterial stump. Endoleak can occur in the gap between the vessel wall and the covered stent due to difference of vessel diameters between the subclavian and brachiocephalic arteries (type I endoleak) associated with retrograde flow from the occluded VA (type II endoleak). Second, the origin of the ASA should be identified because stump obliteration by coiling can cause compromise of the origin of the ASA at the level of the C5 VA leading to serious spinal cord infarction. In our patient, we had identified the ASA by contralateral VA angiography prior to embolization. Third, there must be sufficient collateral filling from the contralateral VA as well as from the the posterior communicating artery into the posterior circulation for occlusion of a VA to be completed. Therefore, thorough hemodynamic evaluation of the collaterals through the circle of Willis and the contralateral VA is mandatory before the planned occlusion of a VA. Therefore, thorough hemodynamic evaluation of the collaterals through the circle of Willis is mandatory before the planned occlusion of the one VA.

Watelet et al reported their experience with a patient with traumatic subclavian artery pseudoaneurysm in whom a failed stent-graft procedure was successfully salvaged with coil embolization via the gap between the stent and the arterial wall¹⁰. In order to avoid such problem, we preferred the catheter or microcatheter used for coil embolization to remain in the VA before deploying the covered stent. The microcatheter was placed in the right VA at the C5 level while another wire was advanced into the

distal right subclavian artery. After covered stent placement in the right subclavian artery, a GDC as a first coil was deployed via micro-catheter into the right VA. Subsequent undetachable fibered coils were packed down to the right VA origin. Such a procedural concept is schematically demonstrated in figure 2.

In summary, endovascular treatment with covered stent deployment in the subclavian artery and occlusion of the proximal vertebral arterial stump with coils, were successful in our patient with continuously regrowing iatrogenic subclavian artery pseudoaneurysm close to the origin of the VA.

References

- 1 Lin PH, Bush RL et Al: Subclavian artery disruption resulting from endovascular intervention: Treatment options. *J Vasc Surg* 32: 607-611, 2000.
- 2 Renger RJ, de Bruijn AJ et Al: Endovascular treatment of a pseudoaneurysm of the subclavian artery. *J Trauma* 55: 969-971, 2003.
- 3 Becker GJ, Benenati JF et Al: Percutaneous placement of a balloon-expandable intraluminal graft for life-threatening subclavian arterial hemorrhage. *J Vasc Interv Radiol* 2: 225-229, 1991.
- 4 Parodi JC, Schonholz C et Al: Endovascular stent-graft treatment of traumatic arterial lesions. *Ann Vasc Surg* 13: 121-129, 1999.
- 5 Assali AR, Sdringola S et Al: Endovascular repair of traumatic pseudoaneurysm by uncovered self-expandable stenting with or without transstent coiling of the aneurysm cavity. *Catheter Cardiovasc Interv* 53: 253-258, 2001.
- 6 Baltacioglu F, Cimsit NC et Al: Endovascular stent-graft applications in iatrogenic vascular injuries. *Cardiovasc Intervent Radiol* 26: 434-439, 2003.
- 7 Phipp LH, Scott DJ et Al: Subclavian stents and stent-grafts: Cause for concern? *J Endovasc Surg* 6: 223-226, 1999.
- 8 Lasjaunias P, Berenstein A et Al: Spinal and spinal cord arteries and veins. *Surgical Neuroangiography* vol I. Springer 74-164, 2001.
- 9 Kim HS, Lee DH et Al: Life-threatening common carotid artery blowout: Rescue treatment with a newly designed self-expanding covered nitinol stent. *Br J Radiol* 79: 226-231, 2006.
- 10 Watelet J, Clavier E et Al: Traumatic subclavian artery pseudoaneurysm: Periprocedural salvage of failed stent-graft exclusion using coil embolization. *J Endovasc Ther* 8: 197-201, 2001.
- 11 Sanada J, Matsui O et Al: Stent-graft repair of a mycotic left subclavian artery pseudoaneurysm. *J Endovasc Ther* 10: 66-70, 2003.
- 12 George B, Laurian C: Vertebro-basilar ischaemia. Its relation to stenosis and occlusion of the vertebral artery. *Acta Neurochir (Wien)* 62: 287-295, 1982.

Dae Chul Suh, M.D.
Department of Radiology
University of Ulsan, College of Medicine
Asan Medical Center
388-1 Pungnap2-dong, Songpa-gu, Seoul
138-736, Korea
E-mail: dcsuh@amc.seoul.kr