Treatment of a Cervical Carotid Pseudoaneurysm That Occurred Years After Laryngectomy and Irradiation of a Neck Tumor
—Case Report—

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Abstract
A 62-year-old man presented with rupture of a pseudoaneurysm of the left common carotid artery (CCA) that was induced after radiation therapy and neck surgery. The initial treatment was an endovascular procedure to obliterate the aneurysm with coils, and a covered stent was placed in the parent artery. However, the patient presented with subsequent coil migration, wound infection, and left CCA stenosis. Direct surgical procedures were then performed, including resection of the pseudoaneurysm with coils and stent; replacement of the carotid artery with a saphenous vein graft; and operative wound reinforcement with a pedicle flap. Endovascular treatments may be chosen for vascular diseases after irradiation, because of the low risk of wound infection and fragility of the vessels, but the long-term outcomes of intravascular treatments are still unclear. In direct surgery, dissection of the adhesive tissue and adequate wound healing are difficult. Musculocutaneous flaps with vascular pedicles can achieve good results.

Key words: radiation-induced pseudoaneurysm, vein graft, wound infection, pedicle skin flap

Introduction
Radiation therapy for treatment of head and neck carcinomas has been performed with good outcomes. However, adverse effects from radiation therapy include severe fibrosis of the arterial layers and surrounding tissues.2,3,18,19,22) Direct surgery to the irradiated field must consider problems concerning the skin incision line, difficulty in dissection of connective tissue, and poor wound healing.6,12,20,22) We describe a case of rupture of pseudoaneurysm of the left common carotid artery (CCA) that was induced after radiation therapy and neck surgery.

Case Presentation
A 62-year-old man was transferred to our hospital with sudden hemorrhage from a pseudoaneurysm in the left cervical region (Fig. 1). He had a history of radiation therapy for cervical malignant lymphoma at another hospital at age 12 years, and subsequent laryngectomy for radiation-induced necrosis of the irradiation field at age 43 years. The left CCA was injured during laryngectomy, so carotid artery closure using a vein patch was performed. After that surgery, cerebral infarction on the left resulted in persistent weakness of the right extremities, but he was independent in daily life.

On admission, angiography detected a pseudoaneurysm at the bifurcation of the CCA (Fig. 2A). Balloon test occlusion revealed ischemic tolerance for 20 minutes. However, dissection of the adhesive tissue and preservation of the fragile vessels were difficult because of the previous radical surgery and irradiation. Therefore, endovascular treatment was preferred for the initial treatment. The aneurysm was packed with coils (GDC; Boston Scientific, Fremont, California, USA), and a covered stent (Niti-S;
Taewong Medical, Seoul, ROK) was implanted into the true lumen of the parent artery (Fig. 2B, C). The postoperative course was uneventful, and he was discharged from the hospital without complications.

He presented with a fistula and purulent discharge at the region of the bleeding aneurysm 11 months later. Bacterial culture of the purulent discharge identified *Staphylococcus epidermidis*. Intravenous infusion of vancomycin was administered over several days, but the discharge continued. The coils and covered stent behind the fistula were considered to be the main factor of the intractable infection, so removal of the foreign bodies was decided. Moreover, follow-up angiography showed a severe stenotic lesion at the proximal edge of the implanted stent, and stagnant distal flow (Fig. 3). Therefore, the focus of the infection and the severe stenotic lesion at the proximal edge of the stent required treatment. Surgery was planned and performed as follows: the lesion was removed en bloc from the left CCA to the beginning of the left internal carotid artery.

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**Fig. 2** Pre- (A) and postoperative conventional (B), and postoperative computed tomography angiograms (C) of the left common carotid artery showing the pseudoaneurysm treated with Guglielmi detachable coils and a covered stent.

**Fig. 3** Follow-up conventional (A) and computed tomography angiograms (B) of the left common carotid artery showing the stenotic lesion at the proximal edge of the covered stent (arrow).

**Fig. 4** Intraoperative photographs showing (A) the left common carotid artery (CCA), pseudoaneurysm (AN), covered stent, and internal carotid artery (ICA); and (B) interposition with a saphenous vein graft.

**Fig. 5** Photograph of the resected specimen showing the pseudoaneurysm (AN) located at the point where the vein graft was patched (arrows). Adhesion between the skin and surrounding tissue was very hard. CCA: common carotid artery, ICA: internal carotid artery.
carotid artery (ICA) together with the coils and the covered stent, and the left external carotid artery was ligated; blood flow was converted by interposition of a saphenous vein graft between the normal CCA and ICA (Fig. 4); and a pectoralis major myocutaneous island flap covering the thin skin and acceleration of wound healing required for the artificial materials, excision of the vessels was appropriate. The vessel easily collapsed, and interposition with the saphenous vein graft was performed.

Recently, endovascular procedures have greatly improved, and many cases of radiation-induced stenotic and occlusive disease have been reported with favorable outcomes. \cite{6,7,10,11,13-15,24} Coil packing for pseudoaneurysms has occasionally been conducted. However, due to the absence of a true arterial wall, recurrences of pseudoaneurysms presenting with re-expansion or hemorrhage, and coil migration have been observed. \cite{6,7,10} Therefore, stent placement into the parent artery has been widely used to more solidly pack aneurysms with coils or to block inflow toward the aneurysms.

Importantly, these treatments always carry the risk of thrombotic occlusion, thromboembolism, \cite{7,16,27} and in-stent stenosis by neointimal hyperplasia. Long-term patency of stents placed in the carotid artery has not yet been fully established. \cite{12} While endovascular treatment is appropriate for cervical carotid pseudoaneurysms, direct surgical management also remains an important treatment option.

Radiation therapy of a cervical lesion very rarely causes a pseudoaneurysm in the irradiated field. \cite{10,11} Endovascular treatment has been widely used for radiation-induced stenotic and occlusive disease. However, treatment methods are not very well established, and complications (such as in the present case) have been observed. Direct surgery to the irradiated field using pedicle flaps for good wound healing is a treatment of choice.

**Discussion**

The present case of pseudoaneurysm occurred about 20 years after carotid surgery. Pseudoaneurysm rarely develops after carotid artery closure. \cite{3,5} Unfortunately, the present patient had a history of radiation therapy for a neck tumor that may have affected the lesion adversely. Pseudoaneurysm has been recognized as a rare yet lethal complication in patients following irradiation of carcinomas of the head and neck. \cite{7,10,11,13} The mechanism of radiation-induced vascular injury is not fully understood, although chronic changes such as obliteration of the vasa vasorum, premature atherosclerosis, and weakening and necrosis of the arterial wall are possible causes. \cite{10,21,23} Radical neck dissection that exposes the carotid artery is known to injure the adventitia, and can result in insufficient blood supply to the artery wall. \cite{4,21}

In the current case, the pseudoaneurysm might have originated and developed through three factors. First, the vein patch performed for the carotid artery injury during radical neck surgery at 43 years of age was considered a main factor. The hemodynamic effect at the vein patch might promote the formation and growth of the pseudoaneurysm. Second, exposure of the carotid artery during that surgery might have reduced the supply of nutrients to the artery, and accelerated the fragility of the vessels. Third, radiation therapy to the neck region at 12 years of age might have caused this disease, and was another potential factor in the development of the pseudoaneurysm.

The histological changes of the almost totally occlusive lesion located at the proximal edge of the covered stent included degeneration of elastic fibers at the tunica media and fibrous hypertrophy at the tunica intima (Fig. 6). These phenomena were probably caused either by neointimal hyperplasia induced by stent placement or by injury from the continuous self-expanding pressure of the covered stent. Additionally, the previous radiation therapy might have accelerated these changes.

Historically, radiation-induced pseudoaneurysms have been treated with surgical treatment for damage to the vessels and wound infection. \cite{7,22} In the present case, the skin and subcutaneous tissues with neighboring coils were very thin due to the previous neck radiation therapy and radical surgery. Therefore, successful reinforcement of the thin skin and acceleration of wound healing required an adequate blood supply from the pedicle vessels and covering by a musculocutaneous implantation. To overcome the resistant infection associated with the artificial materials, excision of the vessels was appropriate. The vessel easily collapsed, and interposition with the saphenous vein graft was performed.
Surgical Treatment for Radiation-Induced Vascular Disease

References


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