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Case Report

Stent infection and pseudoaneurysm formation after carotid artery stent treated by excision and *in situ* reconstruction with polytetrafluoroethylene graft: A case report

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ABSTRACT

Background: Stent infection after carotid artery stenting (CAS) can be a life-threatening postoperative complication, but there is a paucity of data due to its exceedingly low frequency. We report a case of stent infection with pseudoaneurysm formation after CAS that was treated through replacing the infected stent and pseudoaneurysm with a polytetrafluoroethylene (PTFE) synthetic vessel graft.

Case Description: An 86-year-old man was treated for the right internal carotid artery with CAS in local hospital. One month after stenting, he suffered aspiration pneumonia and septicemia. Three months after stenting, swelling and tenderness of the right side of his neck appeared. His general condition deteriorated due to septicemia and he was unable to ingest anything by mouth as a result of decreasing levels of consciousness. He was transferred to our hospital. Computed tomography and digital subtraction angiography showed the presence of a pseudoaneurysm around the stent. The neck mass enlarged daily and surgical intervention was required to prevent closure of the airway. Stent and pseudoaneurysm resection and *in situ* reconstruction with a PTFE synthetic vessel graft were performed. The patient returned to his local hospital 36 days after surgery and had a modified Rankin Score of 5.

Conclusion: Although the risk of reinfection is high due to the nature of artificial material, stent/pseudoaneurysm resection and *in situ* reconstruction with a PTFE synthetic vessel graft might be one of the best options for patients suffering stent infection after CAS. To the best of our knowledge, this is the first report of treatment using this material.

Keywords: *In situ* reconstruction with polytetrafluoroethylene graft, Pseudoaneurysm formation after carotid artery stent, Stent infection

INTRODUCTION

Stent infection after carotid artery stenting (CAS) is an extremely rare complication and there is no consensus regarding treatment despite high mortality rates. These infections often cause arterial destruction and pseudoaneurysm formation.[4,7,11,19,21,29,30] Treatment through stent removal and aneurysm resection with reconstruction using saphenous vein (SV)[7,11,29] and radial artery (RA) grafts[21] have been reported. We report a case of stent infection with pseudoaneurysm formation

3 months after CAS that was treated by replacing the infected stent and pseudoaneurysm with a polytetrafluoroethylene (PTFE) synthetic vessel graft. To the best of our knowledge, this is the first report of treatment using this material.

CASE PRESENTATION

An 86-year-old man was treated for symptomatic (transient left hemiparesis) right internal carotid artery (ICA) with CAS in his local hospital. One month after stenting, he suffered aspiration pneumonia and septicemia, and *Klebsiella oxytoca* was isolated on blood culture. Three months after stenting, swelling and tenderness of the right side of his neck appeared. His general condition deteriorated due to septicemia and he was unable to ingest anything by mouth because of his decreasing level of consciousness. Five months after stenting, he was transferred to our hospital [Figure 1a]. Doppler ultrasound showed an iso-and high-echoic mass around the stent and multiple arterial fistulas between the right ICA and the mass. Computed tomography angiography (CTA) revealed a pseudoaneurysm around the stent [Figure 1b]. The distal edge of the stent was at the level of the superior aspect of the C2 vertebral body. Balloon test occlusion revealed no tolerance to scarification of the affected right ICA. The neck mass rapidly increased in size, getting larger every day [Figure 1c], and this growth of the neck mass was confirmed with CTA and digital subtraction angiography (DSA) [Figures 1d and e]. Therefore, 15 days after admission, we performed an interposition with a tapered (4–6 mm) type PTFE synthetic vessel graft (ADVANTA VXT: GETINGE group, Gothenburg, Sweden).

The operation was performed under general anesthesia. A skin incision was made over the anterior border of the sternocleidomastoid muscle extending to the root of the zygoma. First, the common carotid artery (CCA) proximal to the stent was secured. Then, the styloid process and mandibular angle distal to the stent and pseudoaneurysm were cut to secure the ICA [Figure 2a]. After securing both sides of the stent and pseudoaneurysm, we attempted to detach the pseudoaneurysm from the surrounding tissue to the greatest extent possible. A massive amount of purulent material emerged during detachment, and *K. oxytoca* was later isolated by bacterial test. The external carotid artery was cut at the distal aspect of the pseudoaneurysm [Figure 2b]. After clamping the proximal CCA and distal ICA [Figure 2c], the pseudoaneurysm was removed and interposition of the PTFE synthetic vessel graft through a continuous suture using CV-5 Gore-Tex suture was performed [Figure 2d]. The wound was thoroughly lavaged and then closed over a subcutaneous drain. The patency of the graft was confirmed at 1 and 35 days after surgery through CTA and DSA, respectively [Figures 3a and b]. The patient returned to his local hospital 36 days after surgery and had a modified Rankin score of 5.

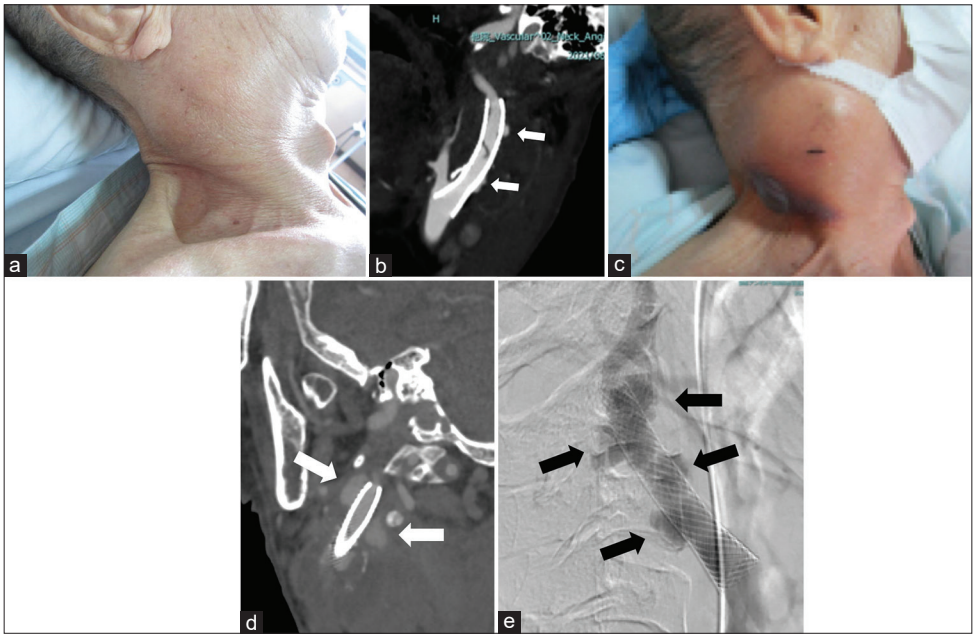

Figure 1: Clinical images before surgery. (a) Picture taken on the day the patient was transferred to our hospital showing swelling of the right side of the neck. (b) CTA taken the day the patient was transferred to our hospital showing the stent placed in the right ICA-CCA and contrast material outside the stent (arrow). (c) Picture taken 2 weeks after admission showing growth of the mass. (d) CTA taken 2 weeks after admission showing an increase in the size of the region that contrast material was flowing into outside the stent (arrow). (e) DSA showing contrast material flowing outside the stent (arrow). CTA: Computed tomography angiography, ICA: Internal carotid artery, CCA: Common carotid artery, DSA: Digital subtraction angiography.

Histopathological investigation showed rupture of the arterial wall and formation of a pseudoaneurysm [Figures 4a and b]. Infiltration of plasma cells, hemosiderin-laden macrophages, and neutrophils was confirmed in the neck of the aneurysm. These results indicated that inflammation around the stent caused the arterial wall to rupture, and then form a pseudoaneurysm [Figures 4c and d].

DISCUSSION

We report a case of stent infection with pseudoaneurysm formation 3 months after CAS that was treated by replacing the infected stent and pseudoaneurysm with a PTFE synthetic vessel graft.

Stent infection after CAS is an extremely rare complication. Lejay *et al*. searched for studies evaluating infection in supra-aortic trunks published between 1997 and 2017 and found only eight cases of stent infection in the carotid artery.[16] During our search, and excluding trauma and cancer blowout cases, we found only six case reports to date [Table 1].[4,7,11,19,21,29] In our case as well as these six cases, all patients were male and relatively older adult, with a median age of 78 (49–88). In general, men are more susceptible to infections caused by viruses, bacteria, parasites, and fungi than women,[14] and individuals become more immunocompromised as they age.[6,31] Thus, careful observation of older adult men after CAS might be necessary.

In the previous reports, authors discussed some potential causes of carotid stent infections.[7,11,19,21,29] Son *et al*. reported that phlebitis of the forearm and septicemia preceded the appearance of neck swelling.[29] Dental surgery and septic teeth in the oral cavity have also preceded neck swelling.[7,19] Matano *et al*. presumed that iatrogenic intimal arterial wall injury during endovascular thrombectomy and CAS followed by septicemia caused bacterial attachment to the injured arterial wall and stent.[21] Kaviani *et al*. placed a CAS for a patient who had undergone radical neck dissection for a carcinoma followed by neck irradiation. Erosion of the metallic stent through the dermis because of the paucity of soft-tissue coverage and the inherent functional abnormality of the irradiated dermis were thought to have caused the stent infection.[11] In the present case, aspiration pneumonia and septicemia preceded neck swelling. *K. oxytoca* was detected both in the blood culture before the neck swelling appeared and in the purulent material within the pseudoaneurysm.

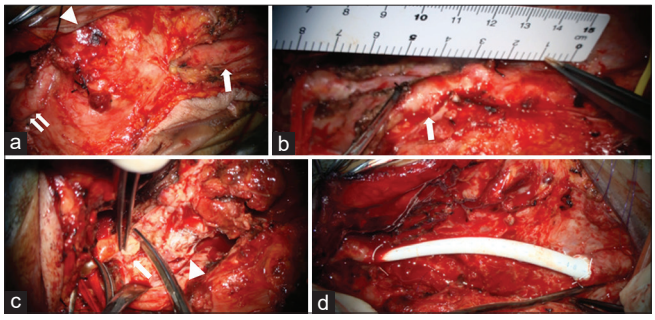

Figure 2: Perioperative pictures. (a) Pseudoaneurysm (arrowhead) and the normal region of the CCA (arrow) and ICA (double arrow). (b) ECA (arrow) was cut at the distal location of the pseudoaneurysm. (c) ICA distal to pseudoaneurysm. Arrow shows normal intima and arrowhead shows the stent inside the ICA. (d) PTFE synthetic vessel graft reconstruction with continuous suture of CV-5 Gore-Tex. CCA: Common carotid artery, ICA: Internal carotid artery, ECA: External carotid artery, PTFE: Polytetrafluoroethylene.

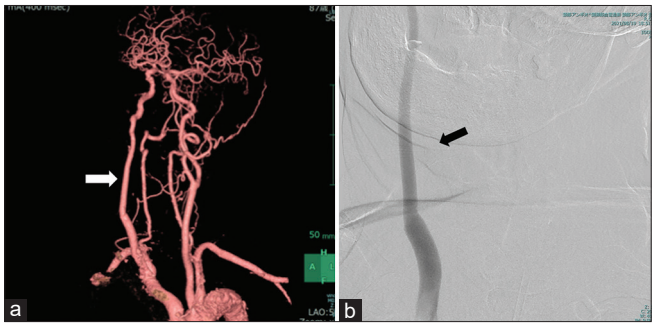

Figure 3: Follow up images after surgery. (a) The reconstructed 3D CTA image taken on the day following surgery showing patency of the graft (arrow). (b) DSA taken 35 days after surgery showing patency of the graft (arrow). CTA: Computed tomography angiography, DSA: Digital subtraction angiography.

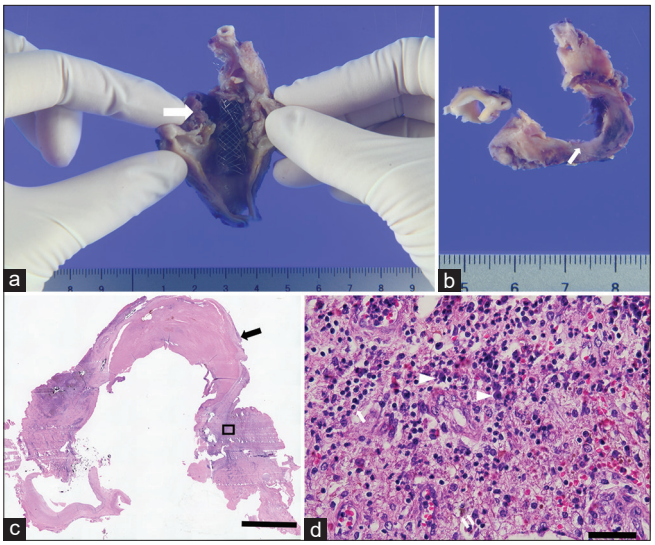

Figure 4: Histopathological images. (a) Overview image of the excised pseudoaneurysm and stent. Arrow shows the cutting level of the axial image. (b) Axial image cut at the level of the arrow in (a) showing rupture of intima (arrow). (c) Hematoxylin-eosin staining. The arrow shows the vessel wall consisting of a clot. The black bar equals 5 mm. (d) Magnified image of the square region in (c). The arrow shows a neutrophil. Arrowheads show plasma cells. Double arrow shows a hemosiderin-laden macrophage. The black bar equals 50 m.

Table 1: Summary of clinical characterics in patients with stent infection and pseudoaneurysm after CAS.

Author and year of publication	Gender	Age	Time interval between CAS and neck swelling	Possible cause	Responsible microorganism	Treatment	Outcome
Present Case	Male	86	3 months	Aspiration pneumonia	*Klebsiella oxytoca*	*In situ* bypass with PTFE graft	Alive
Grazziotin *et al*., 2002	Male	49	13 months	Dental surgery	*Staphylococcus aureus*	*In situ* bypass with SV graft	Alive
Kalvani *et al*., 2006	Male	78	20 months	Stent erosion through dermis due to prior neck surgery and irradiation	MRSA	*In situ* bypass with SV graft	Death
Desai *et al*., 2010	Male	88	24 months	NA	*Streptococcus agalactiae*	Surgical excision	NA
Son *et al*., 2014	Male	68	7 days	Phlebitis of forearm	MRSA	*In situ* bypass with SV graft	Alive
Monzato *et al*., 2020	Male	78	20 days	Ludwig's angina	*Staphylococcus aureus*	CAS (dual layer stent)	Death
Matano *et al*., 2020	Male	86	32 days	Iatrogenic intimal arterial wall injury	MRSA	Contralateral STA-RA-ipsilateral MCA bypass	Alive

All authors except Monzato *et al*. removed stent and pseudoaneurysm. CAS: Carotid artery stenting, PTFE: Polytetrafluoroethylene, SV: Saphenous vein, MRSA: Methicillin-resistant *Staphylococcus aureus*, STA: Superficial temporal artery, RA: Radial artery, MCA: Middle cerebral artery

Thus, we consider it likely that septicemia following aspiration pneumonia caused the stent infection.

Although staphylococci are the most frequently encountered microorganism in cases of stent infections involving supra-aortic trunks, comprising about 60% of cases,[16] *Klebsiella* spp. are one of the major pathogens that cause carotid artery infection.[18] The median time interval from stent placement to neck swelling varied between studies, with reports of 7 days,[29] 20 days,[19] 32 days,[21] 13 months,[7] 20 months,[11] and 24 months.[4] The time interval in our case was 3 months.

The mortality rates when using conservative antibiotic therapy to treat stent infections is high overall (50%) and for non-coronary stents is 14.3%,[2] so surgical intervention may be necessary. The most common treatment for carotid stent infection and pseudoaneurysm is stent/pseudoaneurysm resection and *in situ* reconstruction with SV graft.[7,11,29] A SV graft enables more flow volume than a RA graft, 70–140 mL/min versus 40–70 mL/min, respectively.[28] In addition, the infection cure rate is high and the risk of reinfection is only 0–10%.[12] However, disadvantages including the difficulty in obtaining the graft,[25] kinking,[15] and the existence of valves and varices that can predispose the graft to occlusion with a thrombus during manipulation,[25] have been reported. SV graft aneurysms have also been reported in coronary artery bypass[23] and extracranial-intracranial (EC-IC) bypass procedures.[20] *In situ* reconstruction with a RA graft is another potential treatment option for carotid stent infection and pseudoaneurysm formation. Houkin *et al*. reported 100% RA graft patency in 20 EC-IC bypass cases that were evaluated over more than 5 years.[8] Another group also reported 100% patency of RA grafts in EC-IC bypass cases versus 90% patency of SV grafts.[10,22] However, if an Allen test is positive, a RA graft cannot be used for palmer ischemia. In addition, intimal hyperplasia could cause graft failure.[3] Although *in situ* reconstruction with a synthetic vessel graft might present a high risk of reinfection compared with autologous grafts such as RA and SV grafts, it has some advantages including being less invasive and allowing a shorter operating time by omitting the need to harvest a graft. Ramdon *et al*. reported similar 1-year ICA bypass graft patency rates between prosthetic and venous conduits in their 105 cases, with rates of 99% and 100%, respectively.[26] Illuminati *et al*. also reported similar 10-year graft patency rates between PTFE and SV groups for replacement of degenerative CA aneurysms, 100% and 85%, respectively.[9] At present, PTFE and Dacron grafts are used widely for vascular reconstruction.[9,27] Within *in vitro* models, bacterial strains had a greater affinity for Dacron grafts than PTFE grafts.[27] However, which graft is more suitable for carotid reconstruction is still controversial.[5,33] Only two case reports that describe using a prosthetic graft, both PTFE, to interpose for an infected extracranial carotid aneurysm could be found.[13,24] One case had a bad outcome due to an uncontrollable infection, even with systemic antibiotics.[13] The other case, in which ceramic gentamicin chains were placed near the PTFE graft in conjunction with systemic antibiotics, had a good outcome.[24] For local infection control, the effectiveness of a rifampin-soaked

vascular prosthesis has been reported.[1,17,32] In cases in which synthetic grafts are used, the combination of local and systemic antibiotics might be beneficial.

CONCLUSION

Although the risk of reinfection is high, stent/pseudoaneurysm resection and *in situ* reconstruction with a PTFE synthetic vessel graft might be one of the best options for patients suffering stent infection after CAS, particularly in older individuals in poor condition.

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Declaration of patient consent

Patient's consent not required as patients identity is not disclosed or compromised.

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Conflicts of interest

There are no conflict of Interest.

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