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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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) grafts²¹ 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 stylid 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.
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,\cite{16} Klebsiella spp. are one of the major pathogens that cause carotid artery infection.\cite{18} The median time interval from stent placement to neck swelling varied between studies, with reports of 7 days,\cite{29} 20 days,\cite{19} 32 days,\cite{21} 13 months,\cite{7} 20 months,\cite{11} and 24 months.\cite{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%,\cite{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.\cite{7,11,29} A SV graft enables more flow volume than a RA graft, 70–140 mL/min versus 40–70 mL/min, respectively.\cite{26} In addition, the infection cure rate is high and the risk of reinfection is only 0–10%,\cite{12} However, disadvantages including the difficulty in obtaining the graft,\cite{25} kinking,\cite{15} and the existence of valves and varices that can predispose the graft to occlusion with a thrombus during manipulation,\cite{25} have been reported. SV graft aneurysms have also been reported in coronary artery bypass\cite{21} and extracranial-intracranial (EC-IC) bypass procedures.\cite{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.\cite{18} Another group also reported 100% patency of RA grafts in EC-IC bypass cases versus 90% patency of SV grafts.\cite{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.\cite{13} 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 prothetic and venous conduits in their 105 cases, with rates of 99% and 100%, respectively.\cite{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.\cite{9} At present, PTFE and Dacron grafts are used widely for vascular reconstruction.\cite{9,27} Within in vitro models, bacterial strains had a greater affinity for Dacron grafts than PTFE grafts.\cite{27} However, which graft is more suitable for carotid reconstruction is still controversial.\cite{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.\cite{13,24} One case had a bad outcome due to an uncontrollable infection, even with systemic antibiotics.\cite{13} The other case, in which ceramic gentamicin chains were placed near the PTFE graft in conjunction with systemic antibiotics, had a good outcome.\cite{24} For local infection control, the effectiveness of a rifampin-soaked

**Table 1:** Summary of clinical characteristics 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 | Contra lateral STA-RA-ipsilateral MCA bypass | Alive    |
| Matano et al., 2020            | Male   | 86  | 32 days                                     | Iatrogenic intimal arterial wall injury | MRSA | CAS (dual layer stent) | Death    |

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
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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