

From the Eastern Vascular Society

# A 10-year experience of infection following carotid endarterectomy with patch angioplasty

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**Objective:** Although infection following carotid endarterectomy is rare, consequences of this seldom seen complication can be devastating. Polyester, polytetrafluoroethylene (PTFE), and vein patches have all been used by many institutions for patch angioplasty, each with reported cases of infection following surgery. Our institution has preferentially used PTFE for the majority of cases, and here, we report our experience with postoperative infection following endarterectomy over the last decade.

**Methods:** From January 2000 through July 2009, we treated infections following carotid endarterectomy in 25 patients. **Results:** Of the 25 patients undergoing treatment for postoperative infection, 21 had PTFE patches placed during the initial surgery. The remaining four consisted of two polyester patches and two bovine pericardial patches. Twenty-three of the 25 initial endarterectomies were performed at our institution, and the other two were referrals. The majority of cases (56%) were due to gram-positive organisms, with only two cases being polymicrobial. The interval from the original surgery to clinical presentation ranged from 7 days to 85 months, with 20 patients (80%) presenting within 60 days of the first operation. Thirteen patients underwent incision and drainage with antibiotics, and 12 patients underwent definitive surgical treatment. Four received patch excision with vein patch angioplasty, four received patch excision with vein interposition, and four received sternocleidomastoid flaps. The 30-day stroke rate was 8%, and the freedom from recurrent infection was 100% at a mean follow-up of 32 months.

**Conclusion:** Infection following carotid endarterectomy occurs <1% of the time; however, the potential for morbidity is significant. Our results show that most infections following PTFE patch angioplasty occur in the early postoperative period (<60 days) and that simple drainage with antibiotics may be an adequate form of treatment in select cases. (J Vasc Surg 2011;53:1473-7.)

Surgical site infection following any type of vascular operation can carry significant morbidity and mortality. Traditionally, the highest rates of site infections are seen in the groin following infrainguinal reconstructions. Clinical symptoms can range from mild drainage to severe hemorrhaging. These infections often require repeat procedures, lengthy hospital stays, and the possibility of failed reconstructions.

Carotid endarterectomy has a very low incidence of postoperative infection. There have been less than 100 reported cases in the literature, with more recent reviews demonstrating a rate of <1%.<sup>1-6</sup> A recent analysis demonstrated that pseudoaneurysms occur in 0.33% of carotid endarterectomies, with 40% due to infection, which is the most common manifestation of carotid infection.<sup>1</sup> Other presentations can include drainage, cellulitis, abscess, and even hemorrhage.

Herein, we report our experience with surgical site infection following carotid endarterectomy with patch an-

gioplasty over the last 10 years. Our institution has preferentially used polytetrafluoroethylene (PTFE) patches (the Acuseal patch; Gore Medical, Flagstaff, Ariz) for carotid endarterectomies during the study period. We examined the onset and treatment of 25 patients with vascular surgical site infections.

## PATIENTS AND METHODS

This is a retrospective study of all carotid endarterectomies done at Charleston Area Medical Center from January 2000 to July 2009 that required readmission and further treatment for surgical site infection following carotid endarterectomy. Vascular, cardiothoracic, or general surgeons performed carotid endarterectomy procedures during this study period. All readmissions following carotid endarterectomy were evaluated based on hospital coding, and review of all cases that met criteria for surgical site infection were included. All initial operations were performed for atherosclerosis, and endarterectomy with patch angioplasty was performed in a standard fashion. The selection of patch, was predominantly PTFE; however, both Dacron and bovine pericardial patches were used as well, depending on physician preference at the time of the procedure. Unfortunately, our review does not have the exact numbers of each specific patch (ie, PTFE, Dacron) used during the study period. From previous audit, we have estimated that approximately 80% of carotid patches used at our institution were PTFE over this time period.

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**Table I.** Demographics and presentation

<i>Patient</i>	<i>Age (years)</i>	<i>Diabetes (Yes/No)</i>	<i>Time to presentation (days)</i>	<i>Clinical presentation</i>
1	85	No	40	Bleed/purulent drainage
2	50	No	45	Purulent drainage
3	49	No	21	Purulent drainage
4	74	Yes	21	Abscess
5	77	No	21	Abscess
6	65	No	21	Abscess
7	78	No	180	Pseudoaneurysm
8	54	No	720	Pseudoaneurysm
9	72	No	360	Pseudoaneurysm
10	68	Yes	210	Pseudoaneurysm
11	66	Yes	12	Purulent drainage
12	59	Yes	10	Hematoma
13	49	No	42	Purulent drainage
14	81	No	2555	Bleeding sinus tract
15	66	Yes	14	Purulent drainage
16	72	No	17	Purulent drainage
17	62	Yes	26	Purulent drainage
18	76	No	33	Serous drainage
19	47	Yes	36	Serous drainage
20	79	Yes	7	Serous drainage
21	79	Yes	16	Abscess
22	60	Yes	14	Abscess/cellulitis
23	66	No	13	Purulent drainage
24	84	No	8	Purulent drainage
25	54	Yes	21	Hematoma

The clinical presentation (drainage, abscess, cellulitis, etc) and the time interval from the initial carotid endarterectomy to presentation were recorded. Patch infection was diagnosed clinically, and all were confirmed with culture at the time of admission. Antibiotics were started routinely on admission, and continued for an extended period of time, according to the sensitivity of each organism, allowing adjustments to be made in the length and type of the antibiotic regimen utilized.

Two treatment strategies were identified: conservative treatment with patch preservation, which includes: antibiotics with local wound care, bedside incision and drainage in seven patients with Szilagyi II infections; operative room incision and drainage with intravenous antibiotics in six patients; and incision/drainage with muscle flap in four patients. The other strategy was patch excision, which involves patch excision with vein patch angioplasty in four patients and patch excision with interposition vein graft repair in another four patients. Follow-up was recorded for 24 of 25 patients with infected carotid patches and ranged from 1 month to 7 years. Only one patient was lost to extended follow-up.

## RESULTS

During the 10-year study period, approximately 4000 carotid endarterectomies were performed at our institution. Twenty-five of these patients were readmitted for treatment of surgical site infection, resulting in an overall infection rate of <1%. Twenty-three of these patients had their original endarterectomies at Charleston Area Medical

Center, and the other two patients were referrals from outside institutions.

Table I outlines the age, presence or absence of diabetes, time to and clinical presentation. The age ranged between 47 and 85 years, with a mean of 67 years. Diabetes was present in 11 patients (44%). Three of the 25 patients developed infection after redo carotid endarterectomy. The mean time to presentation was 178 days, with average of 7 to 2555 days. Ten patients (40%) presented with purulent drainage, three (12%) with serous drainage from the previous surgical site. Five patients (20%) presented with an abscess, and four patients (16%) presented with a pseudoaneurysm, two of whom presented over a year after the initial surgery. Three patients (12%) presented with bleeding from the surgical site: two with a neck hematoma, and one with a bleeding sinus tract.

Twenty-one of the 25 (84%) patients had PTFE patches placed initially, two patients (8%) received a bovine pericardial patch, and two (8%) received polyester patches. Seventeen patients had patch preservation: 10 patients were taken to the operating room for incision/drainage and culture of perigraft fluid; four of these patients had their PTFE patches covered with a sternocleidomastoid muscle flap. Seven other patients with Szilagyi II infections had bedside incision/drainage with cultures taken and antibiotics used for treatment. Tables II and III outline the types of treatment, the type of patch used, and the bacterial isolate found for each infection, the follow-up length, and any complications encountered. The remaining eight patients had patch excision (Table II). Four of these patients

**Table II.** Patch excision with autologous repair

Patient	Type of patch	Bacterial isolate	Treatment	Follow-up period (months)	Complication(s)
1	PTFE	None	VPA	6 months	Recurrent bleed
2	PTFE	<i>S. epidermidis</i>	VPA	24 months	None
3	PTFE	<i>S. aureus</i>	VPA	6 months	Hoarseness
4	PTFE	None	VPA	12 months	None
5	Polyester	<i>S. aureus</i>	Vein interposition	12 months	None
6	Polyester	None	Vein interposition	12 months	None
7	PTFE	<i>Enterobacter aerogenes</i>	Vein interposition	3 days (perioperative death)	Stroke/death
8	PTFE	<i>Enterobacter aerogenes</i>	Vein interposition	24 months	None

PTFE, Polytetrafluoroethylene; VPA, vein patch angioplasty.

**Table III.** Patch preservation

Patient	OR/ surgeon	Patch	Presentation	Imaging	Szilagyi grade	Bacterial isolate	Treatment	Follow-up (months)
9	CEA/GS	PTFE	Erythema with drainage	None	III	None	Vancomycin IV 6 weeks	60
10	CEA/GS	PTFE	Erythema with drainage	None	III	None	Vancomycin IV 6 weeks	3
11	CEA/GS	PTFE	Erythema with drainage	None	III	MSSA	Rocephin IV 6 weeks	1
12	CEA/GS	PTFE	Erythema with drainage	None	III	MSSA	Vancomycin 6 weeks	1
13	Redo CEA/VS	PTFE	Erythema, purulent drainage	CT(-) US(-)	II	MSSA	Augmentin 2 weeks	72
14	Redo w/ BPG/VS	PTFE	Bleeding from sinus tract	CT(-)	II	MRSE	Doxycycline suppression 2 years	44
15	CEA/VS	PTFE	Erythema, purulent drainage	US(-)	II	Proteus, Serratia	Dapto/Pip IV, then Bactrim 2 weeks	28
16	CEA/repair PA/CTS	PTFE	Erythema, purulent drainage	US(-)	III	<i>E. aerogenes</i>	Rocephin, Bactrim DS 2 weeks	0
17	CEA/VS	PTFE	Purulent drainage	CT(-)	II	MSSA, <i>E. aerogenes</i>	Augmentin 12 days	24
18	CEA/CTS	PTFE	Serous drainage	CT(-)	II	MRSE	Bactrim DS 5 days	62
19	Redo CEA/CTS	PTFE	Erythema, serous drainage	CT(-)	II	MRSE	Vancomycin 7 days, Doxycycline 30 days	16
20	CEA/CTS	PTFE	Serous drainage	None	II	Negative	Cipro 4 days	87
21	CEA/CTS	Bovine	Erythema, swelling, F/C, leukocytosis	CT(+)	III	<i>S. agalactiae</i> (GroupB)	I/D abscess, Rocephin 42 days	24
22	CEA/CTS	Bovine	Pain, swelling, purulent drainage	CT(+)/US(+)	III	<i>S. agalactiae</i> (GroupB)	I/D abscess, Rocephin 28 days	60
23	CEA/CTS	PTFE	Swelling, purulent drainage	US(-)	III	MSSA	I/D abscess, Rocephin 21 days	3
24	CEA/GS	PTFE	Erythema, swelling, purulent drainage	US(-)	III	MRSA	I/D abscess, Vancomycin 14 days	24
25	CEA/CTS	PTFE	Hematoma	CT(+)	III	MRSA	I/D, Bactrim 5 days	45

BPG, Bypass graft; CEA, carotid endarterectomy; CT, computed tomography scan; CTS, cardiothoracic surgeon; DM, diabetes mellitus; GS, general surgeon; I/D, incision and drainage; MRSA, methicillin-resistant *Staphylococcus aureus*; MRSE, methicillin-resistant *Staphylococcus epidermidis*; MSSA, methicillin-sensitive *Staphylococcus aureus*; OR, primary operation; PA, pseudoaneurysm, POD, postoperative day; PTFE, polytetrafluoroethylene; US, ultrasound; VS, vascular surgeon.

Imaging denoted as (+), positive or (-), negative for deep space fluid collection surrounding or extending to the endarterectomy site.

received patch excision with vein patch angioplasty, and the other four patients received patch excision with vein interposition repair.

For each reoperation, the wound cavity was reopened in a standard fashion and drained of all purulent exudate. Any debridement, if needed, was taken to healthy borders of arterial tissue, and the decision as to what type of treatment would be used was made intraoperatively by the attending surgeon, which varied greatly based on surgical

speciality. Thirteen of the 17 patients managed with patch preservation were not managed by vascular surgeons (cardiothoracic or general surgeons), whereas all eight cases with patch excision and vein patch angioplasty or vein interposition were performed by a vascular surgeon.

If vein patch angioplasty was performed, shunting was routinely instituted, followed by patch excision and debridement. If interposition was carried out, excision of the patch and artery was taken to healthy borders, and selective

shunting was performed based on carotid stump pressures. The standard vein used for each reoperation was the greater saphenous vein, which was harvested from the thigh portion of the saphenous vein, except in one patient who had basilic vein harvest. In four patients, a sternocleidomastoid muscle flap was used after incision and drainage. A muscle flap with the sternocleidomastoid was performed to cover the patch in these patients.

**Microbiology results.** Isolated gram-positive organisms were found in 14 out of 25 patients (56%), with the predominant organism being *Staphylococcus aureus*. Only two of these isolates were found to be methicillin-resistant. Of the nonstaphylococcal gram-positive species, *Streptococcus agalactiae* was isolated from two patients and *Staphylococcus epidermidis* grew from four patients. Gram-negative isolates included *Enterobacter aerogenes* in three patients (12%). Polymicrobial infections were seen in two patients (8%), *Proteus* and *Serratia* species in one, and *Staphylococcus aureus* and *Enterobacter aerogenes* in another. Six patients (24%) had negative cultures despite clinical signs of infection. There appeared to be no difference in outcomes of patients based on wound cultures.

Antibiotics were started on admission and included broad-spectrum antibiotics for each patient. After appropriate sensitivities were obtained, the antibiotic regimen was narrowed, and the regimen consisted of treatment from 2 to 4 weeks for the group that did not receive patch removal treatment (Table III).

Follow-up revealed one event for the group treated with patch preservation (Table III), and three postoperative events (37.5%) occurred in the group of patients treated with patch excision (Table II). One patient was found to have a recurrent bleed from the site of re-exploration within 7 days of vein patch angioplasty, which appeared to be a technical error with cultures negative during re-exploration. Additionally, one patient that had patch excision and vein patch angioplasty developed persistent hoarseness.

Two patients suffered postoperative strokes secondary to carotid occlusion. One patient had acute occlusion after interposition vein grafting and returned to the operative room from the recovery room, but suffered a fatal stroke despite reestablishment of flow in the interposition repair. The second patient was readmitted with a hemispheric stroke approximately 30 days after muscle flap repair to the infected carotid patch and did not undergo reexploration.

## DISCUSSION

Infection following carotid surgery is one of the most dreaded complications; fortunately, it occurs very infrequently. Several reports have analyzed the incidence of infection after carotid endarterectomy with Dacron as well as vein patch angioplasty. One of the first large reports, by Rizzo et al, demonstrated that the incidence is quite low but the morbidity can be significant, especially with surgical repair.<sup>2</sup> Dacron patch infections were treated with either saphenous vein patching or grafting along with either oral or intravenous antibiotics. Complications following repair

included cranial nerve injury, stroke, and myocardial infarction.<sup>2</sup>

A systemic review of the literature of Dacron patch infection following carotid endarterectomy by Knight et al analyzed 77 cases of carotid patch infections over the 12 years, and found an overall rate of patch infection of 0.25% to 0.50%. Neck swelling and pseudoaneurysms were found to be the two most common presentations, and time to diagnosis ranged anywhere from the perioperative period to as long as 3 years after the initial operation. The majority of infections were due to gram-positive organisms, which included *Staphylococcus aureus*, (both methicillin-resistant and -sensitive) and *Staphylococcus epidermidis*. Occasionally, other organisms were encountered, such as *Bacteroides fragilis* and *Pseudomonas* species, but these constituted a small minority. The overall rates for perioperative stroke and death were 6% and 5%, respectively. Cranial nerve injury and reinfection carried the highest occurrence rates at 8%.<sup>6</sup>

To the best of our knowledge, our series of 25 patients (21 of whom had PTFE) with surgical site infection following carotid endarterectomy is the largest series to date. Our results show that infections for PTFE patches carry the same variable time to presentation as seen with most series of Dacron patches, an average of 178 days, with most (20/25; 80%) presenting within 60 days of the initial surgery. The majority of patients presented with drainage, and only 16% and 20% of patients presented with a pseudoaneurysm and abscess, respectively, in our series. Fifty-six percent of all infections were due to gram-positive bacteria, which is concordant with most reviews; however, our series had a significant proportion of patients who had negative cultures (24%).

This is also the first large series to evaluate conservative patch preservation treatment (antibiotics with or without simple drainage) versus standard surgical therapy (patch excision) in the treatment of surgical site infections following carotid endarterectomy and their long-term outcomes. All 13 patients that were treated with drainage and/or antibiotic therapy had Szilagyi Class II or III infections, and the decision of treatment repair was made during the initial evaluation.

Carotid surgery at our institution has been a high volume procedure over the past decade. Until 5 years ago, a single vascular surgeon was present, with the other surgeons trained as either general or cardiothoracic surgery. Management strategies can vary with the surgeons' background of training; none of the patch excision surgical procedures were performed by cardiothoracic surgeons, all four of the muscle flaps were performed by general surgeons in our institutions, and all definitive repairs, including patch excision, were performed by vascular surgeons. There were no standard criteria for patch preservation since there was such a heterogeneous group of surgeons treating these patients. Freedom from recurrent infection in our follow-up was 100% at a mean interval of 32 months. It is also important to recognize that one patient treated with patch excision and one with patch preservation had a post-

operative stroke. In addition to stroke, cranial nerve injury is also a well-known complication that can occur with surgical treatment, which was noted in one of the eight patients treated with patch excision in our group.

Of interest, the results with either patch preservation with simple drainage or muscle flap had similar long-term results when compared with patch excision. Based on our single institution experience with this rare problem, we suggest the following treatment algorithm. Infected carotid patch removal is mandatory in cases of pseudoaneurysm or sepsis, especially with gram-negative and anaerobes as a culprit organism. Graft preservation appears reasonable even when infected perigraft fluid is present in patients with PTFE patch or bovine pericardial patch. Only two patients in our series had Dacron patches, both of which were removed; therefore, we cannot make recommendations of conservative treatment based on these limitations.

Our study has many of the limitations seen in a retrospective study. Our cohort also did not define any standard criteria for evaluating patients as candidates for conservative patch preservation versus definitive treatment of patch excision. Secondary to this, no definitive statements can be made when comparing the two treatment groups. There is also the possibility that a patient that developed a carotid patch infection may not have had follow-up at our institution, and that surgical site infection rates may not be accurate. Also, the majority of patients who had carotid endarterectomy were treated with PTFE patches, and there was a low proportion of patients treated with polyester patches. Unfortunately, a more definitive prospective study is not feasible secondary to the extremely low frequency of this complication, and retrospective reviews will continue to assist surgeons in evolving treatment options for these infrequent complications.

## CONCLUSION

Infection following carotid endarterectomy occurs <1% of the time; however, the potential for morbidity is

significant. Our results show that most infections following PTFE patch angioplasty occur in the early postoperative period (<60 days). Patch preservation with and incision/drainage with or without muscle flap and antibiotics may be considered in patients with PTFE infections that are not septic or with pseudoaneurysms.

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## AUTHOR CONTRIBUTIONS

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