Infected False Aneurysms of the Carotid Arteries After Carotid Endarterectomy

Spero Raptis and Stephen R. Baker

Department of Vascular Surgery, Royal Adelaide Hospital, University of Adelaide, South Australia

Objective: To determine the incidence and management of infected false aneurysms following carotid endarterectomy.

Design: Case notes of patients undergoing carotid endarterectomy (CEA) between the years of 1980 and 1993 at two major teaching hospitals, or those patients who represented with complications were reviewed.

Results: Eight patients were identified with infected false aneurysms, an incidence of 0.625%, in five the CEA had been performed at one of the teaching hospitals, whilst in three other cases the primary operation had been done elsewhere. Presentation was a median 19 days following CEA. In five cases the original arteriotomy was closed by direct suture whilst in three a saphenous vein patch was used. Staphylococcal organisms were cultured in all cases. Antibiotics had not been administered at the original operation. Repair with saphenous vein graft from the common to the internal carotid artery had the least complications.

Conclusion: Infected false aneurysms are a rare complication following CEA, resection of the false aneurysm and reconstruction with autologous saphenous vein is recommended. Ligation alone is associated with a high incidence of stroke.

Key Words: Carotid Arteries; False Aneurysm; Infection.

Introduction

Development of infection and false aneurysm is a rare but dangerous complication to carotid endarterectomy (CEA). Only 74 cases of carotid aneurysm formation after surgery are reported in the literature, of these 16 were infected. This report documents our experience with eight such patients.

Postoperative carotid false aneurysm involves the arteriotomy, which has been closed either by direct suture or patch angioplasty. Patch angioplasty is thought to reduce the morbidity from early and late thrombosis of the internal carotid artery (ICA) and to minimise restenosis. False aneurysms occur after both patch angioplasty and direct suture. Some authors claim it to be more common after patch angioplasty, whilst others claim no significant difference.

Methods

A retrospective review was carried out of patients who underwent carotid artery surgery between 1980 and 1993 at the Royal Adelaide Hospital (RAH) and the Queen Elizabeth Hospital (QEH), two South Australian teaching hospitals, or who presented with complications following carotid artery surgery done elsewhere, to identify the presence of a false aneurysm.

Prophylactic antibiotics were not administered. Heparin (Delta West, Bentley, Western Australia) 5000 units was given by i.v. injection (i.v.i.) just prior to cross clamping the carotid arteries. Postoperative heparin was not used. Redivac suction drains were routinely inserted alongside the endarterectomised vessels and removed 24–48 h postoperatively.

If there was danger of narrowing the artery by direct suture a saphenous patch from the ankle was inserted.

Results

Eight cases of false aneurysm of the carotid arteries after CEA were identified. In five cases the original CEA was done at one of the teaching hospitals, whilst in the remaining three cases the CEA had been done...
elsewhere in a non teaching Hospital and readmitted later either to QEH or RAH. From 1980 to 1993 a total of approximately 800 carotid endarterectomies were done at the two teaching hospitals. The incidence of infected false aneurysm was 0.625%. All operations were performed by a Consultant Vascular Surgeon or a Vascular Fellow under supervision.

All eight patients were males, median age 65.5 years (range 60–75 years). The indication for CEA, in all cases, was a transient ischaemic attack or amaurosis fugax associated with a stenosis of greater than 80% at the origin of the internal carotid artery, shown on arteriography. In five cases the arteriotomy was closed by direct suture with 6/0 polypropylene, and in three cases a saphenous vein patch sutured with 6/0 polypropylene was used. A shunt was used in four of the eight cases. Six patients recovered from CEA with no neurological deficit. However, one (in whom a shunt was not used) had aphasia and hemiparesis for several hours postoperatively but made a full recovery, and another (in whom a shunt was used) had a mild stroke with monoparesis of the arm, from which he also made a good recovery.

The false aneurysms presented a median 19 days (range 7–33 days) after the initial operation. All patients developed a pyrexia following discharge from hospital after CEA, and re-presented as an emergency to the Casualty Department with a purulent serosanguinous discharge in six, or a profuse haemorrhage in two, and a painful, tender mass in a dehiscing wound. In five cases blood flow from the lumen of the carotid arteries into the cavity of the false aneurysm was demonstrated by radiological investigation (four angiograms, one Duplex scan). In the two cases presenting with haemorrhage, and in one other case the cavity and the wall of the false aneurysm were confirmed at operation.

All the false aneurysms were repaired under general anaesthesia. Insertion of the endotracheal tube was hazardous due to oedema and extrinsic compression of the larynx. In the two cases of haemorrhage this was further complicated by unco-operative, semi-conscious patients who were hypotensive and in whom the haemorrhage could only be halted by applying direct pressure to the wound.

In all cases Sodium Cephalothin (Ely Lily, Australia) 2g i.v. was given after induction and heparin 5000 units i.v. was given prior to application of the arterial clamps.

The wounds were thickened and indurated, with a dense fibrous tissue reaction. Removal of the fresh thrombus was followed by profuse haemorrhage due to disintegration of the endarterectomised arterial wall. Identification of the arteries and their mobilisation, so that clamps could be applied, was complicated by the lack of any anatomical planes and the intense inflammatory reaction. Cranial nerves could not be identified and were at high risk of damage.

Shunts were not used because of the emergency presentation, and the difficulty in mobilisation of the vessels. Furthermore the harvested vein would have to have a diameter large enough to allow it to be threaded over the shunt to carry out proximal and distal anastomoses.

The methods used to repair the false aneurysm were classified into three groups: (i) ligation, (ii) local repair, and (iii) excision and arterial reconstruction. Two cases, that originally haemorrhaged at home presented to casualty with hypovolaemic shock and all the carotid arteries were ligated as a life saving measure without arterial reconstruction. Two patients in whom the arteriotomy had been closed directly had a local repair. In one the arteriotomy was simply resutured, but this was complicated by recurrence of the false aneurysm and a further haemorrhage. A further repair with an interposition vein graft was then necessary. In another, where infection was not obvious, the arteriotomy was closed with polytetrafluoroethylene (PTFE) patch. Cultures at the time later grew Staphylococcus aureus and subsequently the PTFE patch became infected, re-haemorrhaged, was removed and replaced with an interposition vein graft. In four patients the false aneurysm was excised and an arterial reconstruction was done. In three the repair was a reversed saphenous vein graft from the common to the internal carotid artery. The anastomoses between the artery and vein were done well away from the margins of the aneurysm and were end to end with 6/0 polypropylene. The external carotid artery was ligated. In one case arterial reconstruction was done with a reversed saphenous vein graft from the subclavian artery to the superficial temporal artery, followed by anastomosis of a branch of the superficial temporal artery to the middle cerebral artery, following which the false aneurysm was excised and the carotid arteries were all ligated. No further operations were needed after arterial reconstruction.

Wound swabs were taken for microbial culture and antibiotics sensitivity from the cavity of the false aneurysm at the time of repair in all cases. S. aureus was cultured in six cases and Staphylococcus epidermidis in two cases.

Four of the eight patients made a complete recovery from the false aneurysm repair with no neurological deficit, but four developed severe deficits. Both patients in whom all the carotid arteries were ligated had dense strokes (one later died). One patient who...
haemorrhaged after repeated local repair (PTFE patch) had a stroke, and one patient who had an interposition vein graft from the common carotid artery to the internal carotid artery also had a stroke. The results are summarised in Table 1.

Discussion

False aneurysms occur infrequently; those associated with infection are extremely rare and reports in the literature involve solitary or small numbers of cases. We found sixteen cases in the English language literature, and have added eight further cases (Table 2).

Our incidence of 0.625% of infected false aneurysm compares with a previously reported overall incidence of 0.3%, of which 0.33% was for arteries closed by a patch against 0.25% for those closed directly. A higher incidence of false aneurysms associated with patches is also quoted by Ehrenfeld and Hays. This series differs from ours in the use of a jugular vein or a synthetic patch. A higher incidence of false aneurysm following patch angioplasty in contrast to direct closure is also reported elsewhere.

Pathogenesis

False aneurysms of the carotid arteries following CEA may develop either after direct suture of the arteriotomy or patch angioplasty using vein or prosthetic materials. Mechanical factors and infection both have a role in pathogenesis; mechanical factors are thought to be important when haemorrhage occurs early due to rupture of the vein patch while infection is thought to be important when haemorrhage occurs later.

Infection

Organisms were cultured in all eight cases of false aneurysm in this series. *S. aureus* was found in six cases and *S. epidermidis* in two. Organisms have been identified in sixteen other cases in the English language literature. *S. aureus, Staphylococcus albus, S. epidermidis, Staphylococcus pseudomonas, Streptococcus viridans and Enterobacter aerogenes* were cultured in this series.

The presentation of the false aneurysms soon after CEA suggests colonisation of the suture line either at the time of surgery or via the drain. Prophylaxis with a broad spectrum antibiotic active against staphylococcus given at induction of the anaesthetic has been recommended to be of benefit in peripheral vascular surgery but not been tested specifically for carotid surgery. Four doses of a first generation cephalosporin (Sodium Cephalothin) over 24 h is a suitable regime, as it is active against methacillin resistant *S. aureus* and is relatively broad spectrum as opposed to flucloxacillin.

Table 1. Summary of clinical features of the eight cases of infected false aneurysm of the carotid arteries found on review of carotid surgery in two South Australian teaching hospitals from 1980-1993

<table>
<thead>
<tr>
<th>Case number</th>
<th>Arterial closure</th>
<th>Reconstruction</th>
<th>Stroke</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Direct suture</td>
<td>Saphenous vein graft</td>
<td>No</td>
</tr>
<tr>
<td>2</td>
<td>Direct suture</td>
<td>1. Direct</td>
<td>No</td>
</tr>
<tr>
<td>3</td>
<td>Direct suture</td>
<td>Saphenous vein graft</td>
<td>No</td>
</tr>
<tr>
<td>4</td>
<td>Direct suture</td>
<td>1. Goretx patch</td>
<td>Yes</td>
</tr>
<tr>
<td>5</td>
<td>Direct suture</td>
<td>2. Saphenous vein graft</td>
<td>Yes</td>
</tr>
<tr>
<td>6</td>
<td>Vein patch</td>
<td>Saphenous vein graft</td>
<td>Yes</td>
</tr>
<tr>
<td>7</td>
<td>Vein patch</td>
<td>Saphenous vein graft</td>
<td>No</td>
</tr>
<tr>
<td>8</td>
<td>Vein patch</td>
<td>Ligation all vessels</td>
<td>Yes</td>
</tr>
</tbody>
</table>

* 3 cases had primary operation elsewhere.

Table 2. Clinical summary of cases of infected false aneurysm of the carotid arteries

<table>
<thead>
<tr>
<th>Author and reference</th>
<th>No. cases</th>
<th>Direct closure</th>
<th>Patch closure</th>
<th>Patch type</th>
<th>Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Debnery et al</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>Dacron</td>
<td>1</td>
</tr>
<tr>
<td>Ehrenfeld and Hays</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>Vein</td>
<td>2</td>
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<tr>
<td>Branch and Courtland</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>Vein</td>
<td>2</td>
</tr>
<tr>
<td>Graver and Mulcare</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Dacron</td>
<td>1</td>
</tr>
<tr>
<td>Martinez</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>Dacron</td>
<td>1</td>
</tr>
<tr>
<td>Rhodes et al</td>
<td>3</td>
<td>Not known</td>
<td>Not known</td>
<td>Not known</td>
<td>2</td>
</tr>
<tr>
<td>Blackford and McLaughlin</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>No patch</td>
<td>1</td>
</tr>
<tr>
<td>Raskind and Doria</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1 Teflon 1 Velour</td>
<td>1</td>
</tr>
<tr>
<td>Krupinski et al</td>
<td>10</td>
<td>6</td>
<td>4</td>
<td>Vein</td>
<td>5</td>
</tr>
<tr>
<td>Price</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>No patch</td>
<td>1</td>
</tr>
<tr>
<td>Noble et al</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>Dacron</td>
<td>1</td>
</tr>
<tr>
<td>Raptis and Baker</td>
<td>8</td>
<td>5</td>
<td>3</td>
<td>Vein</td>
<td>8</td>
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</tbody>
</table>

*Referred to in Branch and Courtland.*
When a false aneurysm of the carotid arteries presents a therapeutic course of i.v. antibiotic active against staphylococcus should be commenced. The diagnosis should be clarified urgently to avoid haemorrhage. The prognosis is poor if profuse haemorrhage occurs from the neck wound itself. It happened twice in this series. Both patients suffered dense strokes and one died. Corrective surgery should also proceed without delay. Any prosthetic material used at the original operations should be removed, and arterial reconstruction should be done with an autologous conduit. The wound should be swabbed for culture and antibiotic sensitivities of all organisms present as a guide to further antibiotic treatment. Long term (6–8 weeks) oral antibiotics should be used whenever an organism is cultured, as bacteria of low virulence (S. epidermidis and Streptococcus viridans) have been implicated in pathogenesis.

Synthetic patches

Use of synthetic patches, Dacron (Du Pont, Wilmington, U.S.A.) or PTFE (Gore-Tex; W.L. Gore, Flagstaff, Arizona, U.S.A.) to close the arteriotomy after CEA is well described.17 Although wound infection is uncommon after CEA, the incidence is increased by use of foreign material.12 Infection may contribute to rupture of synthetic patches and false aneurysm formation. Late development of an infected false aneurysm of the carotid arteries is a unique feature of synthetic patch angioplasty, (not reported after direct suture or use of a vein patch to close the arteriotomy). It is probably due to haematogenous seeding of the prosthesis by bacteria or alternatively the bacteria are thought to lay dormant for extended periods in the wound and only become manifest late in the patients course.19 Sterile false aneurysms presenting late, result from suture line dehiscence causing the patch to come away from the arterial wall.

Investigation

The diagnosis of a false aneurysm should be confirmed prior to operation, although uncontrolled haemorrhage may sometimes preclude or abort investigation. B-mode ultrasonography can display the aneurysm and its relationship to the carotid arteries, while colour Duplex can show blood flowing in the cavity of the aneurysm sac. This examination may be limited by tenderness of the neck, discharge from the wound or the distressed state of the patient. In these cases computer axial tomography, magnetic resonance imaging or intra-arterial digital subtraction angiography with selective catheterisation of the affected carotid artery can display the lesion. A normal angiogram does not exclude a false aneurysm as the sac may be full of thrombus, furthermore this may result in cerebral embolisation of the thrombus.

Operative management

The initial surgical objective is to obtain control of the carotid arteries proximal and distal to the false aneurysm. Krupski et al. recommended resection of the aneurysm and restoration of blood flow with the use of autogenous material being mandatory in the presence of infection.12 Damage to the cranial nerves due to distortion of the anatomy or incorporation with adjacent structures in scar tissues is a hazard.7,14

(i) Ligation

Ligation of all three carotid arteries arrests the haemorrhage. It was done intentionally in difficult circumstances twice in this series, however, dense hemiplegia followed. Ligation is not recommended, arterial reconstruction is preferred as a high morbidity and mortality is described with ligation.5,9,20 Branch and Courtland5 reviewed eight cases, four of whom sustained cerebral infarcts and two later died whilst Ehrenfeld et al.20 warns of the danger of thrombosis of the internal carotid artery with distal extension of thrombus into the middle cerebral artery.

(ii) Local arterial repair

Local repair (by direct suture and patch angioplasty) was not successful in this series due to persistent infection of the suture line which predisposes the patient to recurrent haemorrhage and is therefore not recommended. Prosthetic material present should be removed and further use should be avoided.

(iii) Arterial reconstruction

Arterial reconstruction with a saphenous vein interposition graft was the most successful method of repair. Four patients in this series had this procedure as the preferred method of repair and only one had a stroke. Two other patients had an interposition graft after unsuccessful attempts at local repair, of which one (with preoperative haemorrhage from a disrupted, infected PTFE patch) had a stroke. None required further surgery.
The preferred reconstruction is an interposition bypass with autologous material preferably reversed saphenous vein from the common carotid artery to the internal carotid artery.\(^3\) In addition Ehrenfeld and Hays\(^3\) advocates the use of autologous external iliac artery. The external carotid artery is ligated and the common and internal carotid arteries are trimmed back to healthy tissue. The aneurysm is resected removing all infected material. Use of a shunt is recommended.\(^9\) This is theoretically desirable but rarely practical. Long saphenous vein, preferably from the groin, is harvested for a bypass graft. All suture material should be monofilament to reduce the incidence of re-infection.

**Conclusion**

This study confirms that infected false aneurysms are a rare but dangerous complication following CEA. The preferred treatment of choice is resection and reconstruction with an autologous saphenous vein interposition graft. Prophylactic antibiotics might be useful in reducing the incidence of infection.

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**References**


