Management of Innominate Artery True Aneurysms: A Single Centre Experience

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Abstract

Introduction: True aneurysms of the innominate artery are rare and continued controversy exists in literature regarding the best management of these aneurysms.

Patients and Methods: The present study reviewed a 5-year experience of managing IA true aneurysms between 2010 and 2015. There were two patients aged 63 and 77 years who were treated successfully by a selective open debranching technique for the exclusion of the aneurysms. The mean follow-up was 2 years. Preoperative information was derived from spiral computed tomography (CT) scanning, magnetic resonance imaging, and color Doppler imaging (CDI).

Results: One male and one female were treated successfully. The most common indication for intervention was transient ischemic attack (100%). The 30-day surgical mortality was zero. Graft patency at 6 months as confirmed by CDI was 100%. One patient had graft-related complication at 6 months and subsequently at 24 months which was revised successfully.

Conclusion: Exclusion bypass is a satisfactory treatment of these proximal aneurysms and durable. The proximity to the aortic arch makes endovascular treatment challenging and would depend on the dimensions of the arch and ascending aorta. De-branching simplifies the treatment pathway. The natural history of these isolated aneurysms is unknown.

Key Words: Complications, innominate artery aneurysm, open repair

Introduction

True aneurysms of the innominate artery (IA) are rare. Aneurysms of IA account for 3% of all arterial and 3% of supra-aortic vessel aneurysms.[1,2] The majority of IA aneurysms are atherosclerotic in etiology; however, other causes are syphilis, tuberculosis, Kawasaki’s disease, Takayasu’s arteritis, Behçet’s disease, connective tissue disorders, and angiosarcoma.[3-5]

An IA aneurysm is usually detected as an asymptomatic mass on chest X-ray or computed tomography (CT) scan. Patients may present with neurologic symptoms from emboli or mediastinal compression due to aneurysmal enlargement.[6-9]

The latter is unusual with earlier detection. The natural history of pure innominate aneurysm is still uncertain. The more common scenario is the presence of aneurysmal ascending aorta or arch aneurysms associated with innominate aneurysms. The treatment paradigms will be influenced by the extent of aneurysm distribution.

Surgery is indicated due to the propensity for these aneurysms to enlarge, rupture, thrombose, or embolize.[10,11] The risk of rupture is, however, more likely following trauma or in patients with underlying connective tissue disease. Early repair using open surgery or endovascular therapy is, therefore, advocated in patients with symptomatic disease, associated aortic arch aneurysms, saccular aneurysms, or isolated asymptomatic aneurysms of >3 cm diameter.[12,13]

Larger aneurysms of the innominate artery in isolation or in association with arch pathology will need extensive surgery. However, smaller aneurysms presenting with embolization can be treated by exclusion bypass. Ongoing expansion of the aneurysm still remains a concern but should be weighed against elderly patients with significant co-morbidities.

We present two patients with IA aneurysms who presented with neurologic sequelae following embolic showers into the cerebral circulation.

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Patients and Methods

Case 1

A 63-year-old Maori female was referred to our vascular outpatient clinic for the management of transient ischemic attacks (TIAs). She had 5 episodes of TIAs (3 episodes involving her right upper limb, 2 episodes involving her left upper limb, and associated with speech disturbance. She had a past medical history of Stage 3 ovarian cancer (T3N2M3), a 50 pack year smoking history, chronic obstructive Airways disease, and dyslipidemia. She was undergoing chemotherapy with cisplatin while awaiting a laparotomy for resection of the ovarian cancer deposits in the peritoneum. She had a family history of Marfan's syndrome with her grandson passing away suddenly at 18 years after repeated cardiac surgery. Her sister was diagnosed with neurofibromatosis recently.

On examination, she was afebrile and hemodynamically stable with a full complement of pulses and in sinus rhythm. Her neurological examination was unremarkable. She was referred for an outpatient color Doppler imaging (CDI) of her carotid arteries. She was commenced on single antiplatelet therapy with aspirin 100 mg daily.

CDI did not show any significant disease of her carotid arteries. Subsequently, she underwent a CT scan of her aorta which showed a dilated aortic root measuring 38 mm and a saccular aneurysm of the IA (Type B) involving both common carotid arteries. A significant amount of thrombus was seen in the aneurysm which was thought to be the cause for her symptoms [Figure 1].

Her imaging was discussed at a multidisciplinary meeting, and it was decided to offer her a reverse debranching procedure to exclude the aneurysm and embolic shower to the brain.

A left subclavian to left and right common carotid bypass was performed using a Dacron graft prepared on bench as shown in diagram (Figure 2). Both carotid arteries were ligated proximal to the anastomoses. The graft was tunnelled in a pre-tracheal fashion.

Case 2

A 77-year-old male was referred to our institution from a peripheral hospital after an episode of collapse and left lower limb weakness that got resolved within 24 hours. He had a similar episode four years prior requiring admission to hospital. He was an ex-smoker with well-controlled hypertension.

CDI showed no significant stenosis in the carotid arteries. The right vertebral showed bidirectional flow with flow velocities suggestive of up to 50% stenosis in the proximal subclavian artery. A CT scan of the Circle of Willis showed 33.8 mm aneurysm of the IA (Type A) just at the bifurcation of the right subclavian and the right common carotid arteries [Figure 3]. There was a significant thrombus within the aneurysm causing up to 88% stenosis based on diameter measurements performed on CT scan [Figure 4].
A left common carotid to right carotid and subclavian bypass was performed using a Dacron graft. The right carotid and subclavian arteries were ligated proximal to the anastomoses. The graft was tunnelled in a pre-tracheal fashion [Figure 5].

**Results**

Both patients had a successful outcome. The most common indication for intervention was TIA (100%). The 30-day surgical mortality was zero. Short-term graft patency (<30 days) as confirmed by CDI was 100%. Long-term graft patency (>30 days) as confirmed by CDI was 100%. One patient had graft-related complication at 6 months and subsequently at 30 months which was dealt with successfully using a vein graft. Mean follow-up time 24 months.

**Discussion**

With the advent of latest imaging technologies, the discovery of small true IAs has become common, especially during workups for the diagnosis of other medical conditions. Operative indications include ruptured and symptomatic aneurysms. Kieffer et al. mentioned that patients with isolated asymptomatic aneurysms who are at high surgical risk should undergo surgery when the aneurysms are saccular or when their maximum transverse diameter is more than 3 cm.

In literature, three types of IA aneurysms (IAA) have been described. Type A, Type B, and Type C [Figure 6]. Treatment of the aneurysm itself depend on the extent of involvement [Figure 1].

Group A aneurysms (no involvement of the origin of the IA) are easy to treat but rare. After distal revascularization using bypass grafting from the ascending aorta, the aneurysm can be excluded using ligation at the origin.

Group B aneurysms (involvement of the origin of the IA) are the most common. Surgical treatment requires aortic clamping. Side-clamping may be possible if lateral suture of the aorta is sufficient. Cross-clamping is required in many cases, including for patch angioplasty. If the left common carotid and subclavian arteries are patent, only minimal cerebral protection, such as the moderate administration of heparin (1 mg/kg) and the stabilization of arterial pressure, is required. If the aneurysmal process includes the left common carotid artery, especially in patients with a common trunk for the IA and left common carotid artery, the best technique consists of sequential revascularization from the ascending aorta to the left common carotid artery and IA.

Group C aneurysms (involvement of the origin of the IA and aorta) require cardiopulmonary bypass for aortic replacement.

In literature, various surgical approaches have been devised for the treatment of the IA aneurysm including ligation alone, patch angioplasty, resection with end-to-end anastomosis, and bypass with either saphenous vein or prosthetic grafts.

Surgical treatment for IA aneurysms has made great strides in the last two decades. Souttar as early as 1934 described surgical repair of an IA aneurysm by ligation using a kangaroo tendon ligature and applying digital pressure to the arteries under local anesthesia.

Cormier in 1957 stated midline sternotomy as the exposure technique of choice to repair IA aneurysms. The most frequently documented approach for IA pathology uses a median sternotomy.

Axial reconstruction is believed to provide optimal long-term patency and has commonly been performed using a combined cervical and transthoracic approach that allows optimal control and exposure for aneurysmection and placement of a prosthetic graft.

Today, the most common surgical approaches to IAs include median hemisternotomy combined with the right anterior thoracotomy in the 3rd intercostal space and the right
supraclavicular fossa, median sternotomy with extension along the medial border the right sternocleidomastoid muscle.\(^{[10,22,23]}\)

Over the recent years, there has been an increase in the number of reports of endovascular innominate aneurysm repairs, however, the majority of cases are still treated using an open surgical technique via median sternotomy with or without extension to the right neck.\(^{[7,23]}\)

Although employed less frequently than open surgical repair, endovascular, minimal access, or hemisternotomy techniques have more recently been associated with fewer short-term complications, shorter hospital stay, comparable graft patency, and similar short and long-term mortality to open surgery. However, despite these potential benefits, careful patient selection is needed, and long-term outcome data remains lacking.\(^{[11,23]}\)

Endovascular treatments can also be challenging in cases of bovine arch morphology, where the aneurysmal neck is inadequate for attachment of the graft or when the distal IA is involved. Furthermore, covered endovascular stents may require long-term antiplatelet therapy and a closed approach presents diagnostic difficulty in ruling out any malignant processes underlying aneurysm formation.\(^{[24-27]}\)

Axial reconstruction is believed to provide optimal long-term patency and has commonly been performed using a combined cervical and transthoracic approach with minimal morbidity.\(^{[21]}\)

In our study, we used a cervical approach to debranch the involved arch vessels and exclude the IA aneurysm, thereby reducing embolic shower into the cerebral circulation. While the aneurysms were partially excluded, a theoretical risk of sac pressurization exists. This could easily be managed using a plug or amplatz device at the origin of the IA thereby excluding the aneurysm completely.

Maintenance of cerebral blood flow is important in any type of intervention undertaken to exclude the aneurysm.\(^{[28-31]}\) In our study, we used a left to right crossover vein graft to perfuse the right cerebral circulation when dealing with the potential issue of graft infection requiring a total explant.

**Conclusion**

The authors recommend a staged debranch procedure using a cervical approach for the affected arch vessels together with an occlusive device at the origin of the IA to exclude the aneurysm in high-risk patients.

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**Conflicts of interest**

There are no conflicts of interest.

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