POST-TRAUMATIC BRACHIOCEPHALIC ARTERY PSEUDOANEURYSM CAUSING TRACHEAL COMPRESSION AND SUCCESSFULLY TREATED VIA ENDOVASCULAR APPROACH

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ABSTRACT

Background: Post-traumatic brachiocephalic artery (BCA) injury is usually due to penetrating injuries that lead to complete vascular dissection of the artery. Nevertheless, isolated BCA injury after blunt thoracic trauma rarely occurs. Most documented cases of isolated BCA injury are due to blunt chest contusion which resulted in complete avulsion of the vessel from the arch of aorta. The majority of those cases also required open thoracotomy and surgical repair.

Materials and method: A case report of post-traumatic BCA pseudoaneurysm due to blunt injury that is a rare condition, with an emerging successful treatment method that improves morbidity and mortality rate. We report a case of a man with post-traumatic isolated brachiocephalic artery pseudoaneurysm. He was involved in a road traffic accident and sustained blunt chest trauma. He was initially asymptomatic then later developed symptoms of tracheal compression due to the enlarging aneurysm. Chest x-ray, Computed Tomography of the Thorax and conventional angiogram of the mediastinal vessels of this subject were retrospectively reviewed on an Osirix workstation (Apple Inc., Cupertino Ca, USA) and imaging findings were documented.

Results: Computed Tomography scan findings identified a pseudoaneurysm of the brachiocephalic artery causing tracheal compression. Conventional angiogram was performed and an endovascular expandable covered stent was deployed to exclude the aneurysm. The BCA pseudoaneurysm was successfully treated, however the outcome was fatal as the patient died due to complications of ruptured pseudoaneurysm and hypovolumic shock.

Conclusion: Endovascular approach is a less invasive method of treatment for brachiocephalic artery pseudoaneurysm with promising outcome.

Keywords: brachiocephalic artery pseudoaneurysm, blunt thoracic trauma, endovascular approach
1.0 Introduction

Aneurysm of the brachiocephalic artery (BCA) is a rare entity. The majority of cases are caused by arteriosclerotic changes, whereby traumatic aetiology is only occasionally encountered. On the other hand, pseudoaneurysms of the brachiocephalic artery are usually due to trauma. Post-traumatic BCA damage is usually due to penetrating injuries that lead to complete vascular dissection of the artery. Nevertheless, isolated BCA injury after blunt thoracic trauma is rare and less than 100 cases of blunt innominate artery injuries have been reported in the literature (1). As a matter of fact, the innominate artery is the second commonest mediastinal vessel to be injured after the aorta. Most documented cases of isolated BCA injury due to blunt chest contusion have usually resulted in complete avulsion of the vessel from the arch of aorta. The majority of those cases also required thoracotomy and surgical repair.

Most patients with brachiocephalic artery injuries have high mortality rate due to exsanguination before arrival at the hospital, and only a few of the patients who actually receive medical attention survive. BCA aneurysms can be difficult to diagnose especially in post-traumatic patients who are unconscious and have more serious injuries. They can be initially asymptomatic and are discovered only on radiological investigation, as the case with our patient.

We report a case of post-traumatic isolated brachiocephalic artery aneurysm in a man involved in a road traffic accident who sustained blunt chest trauma. He was initially asymptomatic then later developed symptoms of tracheal compression. This aneurysm was identified on radiological examination and subsequently was successfully stented using an endovascular approach.

2.0 Material and methods/ case report

A 22-year-old man presented to a district hospital with fracture of the right humerus and Glasgow Coma Scale (GCS) of 8/15 following a motor vehicle accident. At the time of admission, a computed tomography (CT) scan of the brain was done which did not show any intracranial bleed. However, due to low GCS, the patient was intubated and ventilated in the intensive care unit for 10 days. Following that, there was difficulty in weaning him off the ventilator and an elective tracheostomy was performed. During his hospital stay, the patient also underwent open reduction and internal fixation of his fractured right humerus bone. Approximately 2 weeks later, the tracheostomy was removed and patient was discharged home well with full GCS.

Four days later, he developed difficulty in breathing at home and was readmitted to the same hospital. He was subsequently re-ventilated for respiratory distress. Chest radiograph showed left lower lobe collapse. He was treated with intravenous antibiotics for nosocomial pneumonia. However, cultures showed no organism growth. A bronchoscopy which was done 3 days later revealed granulation tissue mass causing tracheal obstruction at the level of the carina. He was subsequently referred to our centre for laser excision of the granulation tissue.

At our centre, the patient was noted to be calm and cooperative. GCS was 10/15 (E4VTM6). Blood pressure on arrival was 107/63mmHg, pulse rate 77 beats/ minute and oxygen saturation 99% on low ventilator settings. On examination, his trachea appeared centrally located, there was a previous tracheostomy scar on his neck and auscultation of his chest revealed occasional
transmitted lung sounds with normal heart sounds. Blood investigations showed hemoglobin level of 10.7g/dL, white blood count of 12.1 x 10^9/L and platelet of 319 x 10^9/L and INR 1.1.

On the second day of his admission to our centre, the patient was referred for CT scan of the neck and thorax as a pre-operative assessment. During scanning, the patient suddenly developed massive bleeding from the mouth and nostrils with an estimated blood loss of approximately 1.5 litres. He was resuscitated immediately with fluids. Upon further blood investigation, his haemoglobin level was noted to have dropped to 10.3g/dL. He was then transfused with 4 units of packed cells, 4 units of platelets, and 4 units of fresh frozen plasma.

3.0 Results and Discussion

The medical diagnostic imaging that were performed for this patient was reviewed on an Osirix workstation (Apple Inc., Cupertino Ca., USA) and imaging findings were documented. Computed Tomography of the Thorax findings identified a pseudoaneurysm of the brachiocephalic artery causing tracheal compression so he was referred to the cardiothoracic team in our centre for further management. Further review of the patient’s plain chest radiograph (Figure 1) revealed an anterior mediastinal mass displacing the trachea to the left. The chest radiograph findings correlated with the CT findings of a BCA aneurysm (Figure 2). The aneurysm measured 3.8 (AP) x 5.8cm (W) x 6.1cm (Ht).

3.1 Conventional angiogram and endovascular approach

On the same day, the patient underwent a conventional angiogram to assess the intra-thoracic aneurysm. The procedure was performed under aseptic technique. Via a right femoral artery puncture, a 7F arterial sheath was inserted and an ascending aortogram was performed. Subsequently, the brachiocephalic trunk was cannulated using a 0.035 Terumo guidewire and a pigtail catheter was positioned in the right common carotid artery (Figure 3). Non-ionic low osmolar contrast media was injected and an aneurysmal dilatation of the brachiocephalic artery was identified. The aneurysm was noted to be in the mid portion of the innominate artery and did not involve the right common carotid artery.

Following that, a right brachial artery puncture was performed and using a 6F JR guiding catheter and contrast media was injected to locate the right common carotid artery and the BCA aneurysm. During the procedure, the patient developed another bout of massive bleeding from the trachea, mouth and nose due to spontaneous rupture of the BCA aneurysm.

His pre-procedure blood pressure of 85/50 mmHg dropped further to 40/20 mmHg. As he became haemodynamically unstable, the anaesthetists performed resuscitation with fluids and blood products. In the meanwhile, urgent deployment of the ADVANTA V12 (12mm x 61mm x 80cm) Balloon Expandable Covered Stent (Atrium Medical Equipment, Hudson, USA) was conducted over the BCA aneurysm. The stent-graft was then angioplastied with a balloon for less than 10 seconds and then deflated rapidly. Subsequently, stent was noted in place going across the full length of the BCA aneurysm (Figure 3).

Post stent placement angiogram showed the BCA aneurysm to be excluded (Figure 4). The proximal tip of the stent was noted to be over the aortic arch. Satisfactory seal of the post-traumatic BCA aneurysm was achieved with good perfusion and patent right CCA and subclavian arteries documented. No abnormal blush was seen in the post stenting angiogram.
run. The bleeding stopped and the patient stabilized haemodynamically. His blood pressure picked up to 110/60 mmHg.

Although the stenting of the BCA aneurysm had been successful, the patient became unstable again later that evening. He developed hypovolaemia secondary to disseminated intravascular coagulation (DIVC) and his blood pressure dropped further. He was started on dopamine and noradrenaline. He was also transfused 6 units of whole blood, 6 units of platelets, 4 units of fresh frozen plasma and 4 units of cryoprecipitate. He was also infused with colloids ie. Gelafundin. Despite this, the patient’s condition deteriorated further. He developed bradycardia and cardiopulmonary resuscitation was started.

He continued bleeding from his nose and mouth. His arterial blood gases showed evidence of metabolic acidosis. He was given intravenous bicarbonate. Nevertheless, patient’s vital signs failed to improve. He became asystole and was proclaimed dead. The cause of death was severe hypovolaemia due to DIVC secondary to ruptured BCA aneurysm.

**Figure 1:** Plain chest radiograph showed a radio-opaque anterior mediastinal mass (white arrow) that had displaced the endotracheal tube (black arrow) to the left.
**Figure 2:** A) Coronal view multiplanar reformatted (MPR) CT scan image in soft tissue window showed the BCA aneurysm (straight arrow) with the trachea deviated to the left. B) A coronal view volume rendering technique (VRT) showing the origin of the brachiocephalic artery (straight arrow) from the arch of aorta and the BCA aneurysm from the posterior view (curved arrow).

![Figure 2: A) Coronal view multiplanar reformatted (MPR) CT scan image in soft tissue window showed the BCA aneurysm (straight arrow) with the trachea deviated to the left. B) A coronal view volume rendering technique (VRT) showing the origin of the brachiocephalic artery (straight arrow) from the arch of aorta and the BCA aneurysm from the posterior view (curved arrow).](image1)

**Figure 3:** A) Ascending aortogram demonstrated the BCA pseudoaneurysm (curved arrow). Contrast media was injected via a pigtail catheter (straight arrow) that was positioned with its tip in the arch of aorta. B) Right brachiocephalic artery approach angiogram delineating the BCA pseudoaneurysm (white arrow) as the endovascular covered stent was deployed. Note that the right common carotid artery was well perfused and not involved by the aneurysm (black arrow).

![Figure 3: A) Ascending aortogram demonstrated the BCA pseudoaneurysm (curved arrow). Contrast media was injected via a pigtail catheter (straight arrow) that was positioned with its tip in the arch of aorta. B) Right brachiocephalic artery approach angiogram delineating the BCA pseudoaneurysm (white arrow) as the endovascular covered stent was deployed. Note that the right common carotid artery was well perfused and not involved by the aneurysm (black arrow).](image2)
Figure 4: The brachiocephalic artery pseudoaneurysm has been successfully excluded following deployment of the covered stent (white arrow).

4.0 Discussion

Pseudoaneurysms of the brachiocephalic artery are rare. The commonest aetiologial factors include blunt chest trauma e.g. post road traffic accident; infection, or iatrogenic injury. Although intra-thoracic vascular injury from blunt trauma most commonly occurs at the aortic isthmus, about 10% of these occur in the brachiocephalic artery (2) BCA pseudoaneurysms are known to occur due to blunt (3) or stabbing injuries and medically introduced trauma, such as intravenous cannulation, catheterization, and stenting. Non-traumatic causes include infection post cardiothoracic surgery or after insertion of artificial grafts that become foci of mediastinitis which leads to mycotic pseudoaneurysm of adjacent intra-thoracic arteries (4).

Clinical symptoms of blunt BCA trauma include decreased peripheral pulse, superior vena cava syndrome, dysphagia, bruits, and pulsatile suprasternal masses (1). In certain cases, the pseudoaneurysm is not detected until much later until its enlarging size causes a mass effect. Only then when its aneurysmal dilatation causes compression on adjacent structures such as the trachea or the bronchi, does the patient become symptomatic.

Complications of BCA pseudoaneurysms include spontaneous bleeding. Generally, free bleeding is prevented by the adventitia and mediastinal pleura and by fibrotic reaction. A pseudoaneurysm may eventually rupture due to weak adventitia layer (2). In the worst case scenario, if left untreated for too long, these aneurysms can rupture and can lead to fatality as in our patient.
In a patient with history of chest trauma, possible injury to mediastinal structures needs to be considered, sometimes even months or years after the injury has occurred. Our patient presented nearly 2 months after his accident with progressive difficulty in breathing and history of chest infection. BCA pseudoaneurysms have also been reported to cause tracheal compression and chronic pneumonia due to impairment of cough reflex (5). We suspect our patient had progressive enlarging BCA pseudoaneurysm that was causing mass effect onto his trachea. A review of his chest radiograph would have given a high index of suspicion as he has an anterior mediastinal mass displacing his trachea to the left.

Diagnosis of intra-thoracic pseudoaneurysms can be further aided by CT Thorax or CT angiography, as was the case of incidental finding in our patient. The precise anatomical location of brachiocephalic / innominate artery injury can be delineated. Details of adjacent carotid artery involvement and distal perfusion can also be visualised as it is important in a pre-operative planning. CT angiography is able to detect presence of intraluminal clot in the aneurysm, distinguish between true and false lumens in dissections, and detect local effects of the hematoma or aneurysm against the adjacent structures (2).

Once diagnosed, early treatment is recommended as it carries a better prognosis. Endovascular covered stent is the treatment of choice compared to surgical repair with is considered highly invasive, long operative time and shorter recovery time (3, 6). Traditionally, open thoracotomy was the widely used method for the access to repair BCA aneurysms. Previously, pseudoaneurysms of the innominate artery were approached through a median sternotomy, with extension into the right neck if necessary. Repair can be attained with simple suture, patch closure, transection and end-to-end anastomosis, or resection and graft interposition (7). In certain cases, where the pseudoaneurysm was adherent to adjacent structures or involved the right common carotid artery, cardiopulmonary bypass and circulatory arrest were needed prior to resection of the aneurysmal lesion (5).

The overall 5 and 10 year survival rate in patients with brachiocephalic aneurysms is reported to be 80.8% and 61.4%, respectively (6). The majority of brachiocephalic aneurysms presents with life- or limb-threatening complications and are associated with a high mortality when patients undergo emergency or concomitant repair. Early elective isolated surgical repair is the optimal therapy. Alternatively, as of late, endovascular surgery has been gaining popularity as the treatment of choice for repair of traumatic pseudoaneurysms (1). The introduction of covered, expandable, metallic stents has led to the successful treatment of patients with brachiocephalic artery aneurysms without having to resort to major cardiothoracic surgery.

Although there are only a few case reports of endovascular intervention for a traumatic false aneurysm of the brachiocephalic trunk, our cardiology team attempted this approach with success. Axisa et al. had used carotid arteriotomy to deliver the covered stent (1) but in our case a right brachial artery access was gained to introduce the stent. Unfortunately, our patient expired within a few hours of stent placement as his case was already complicated by spontaneous rupture and he was haemodynamically unstable.

A learning point in this case is that post-traumatic pseudoaneurysms require early detection as their associated complications carry a high mortality risk. Early intervention preferably by endovascular approach can significantly improve patient prognosis (6).
5.0 Conclusion and Recommendation

In summary, we report a unique case of post-traumatic pseudoaneurysm arising from the brachiocephalic artery, presenting 2 months after a blunt chest injury with symptoms of tracheal compression. It was managed by emergency endovascular covered stent placement with good occlusion of the brachiocephalic artery pseudoaneurysm. Previously, the majority of post-traumatic brachiocephalic artery pseudoaneurysms needed to be surgically corrected, to prevent rupture, thrombosis, embolism, and enlargement causing compression on vital structures such as the trachea and superior vena cava. Endovascular approach is a less invasive method of treatment with promising outcome. Nevertheless, more experience and research is needed to document its long term success rates.

Acknowledgement

Ethical approval was waived, as this is a retrospective case report. No grants or sponsorship were made available for this report. We acknowledge University Malaya Medical Centre, Malaysia for permission to access the materials required for this report.

Declaration

Author(s) declare that there is no conflict of interest in the preparation of this article and for publication in this journal.

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