



## Management of Subclavian Artery Pseudoaneurysm: Case Series

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### Abstract

Injuries to the subclavian artery as well as post traumatic pseudoaneurysm of the Subclavian Artery (SCA) are uncommon. We performed retrospective study of ten patients for strategies of management of subclavian artery pseudoaneurysm enrolled in the study from March 2013 to January 2022 at Grant medical college and JJ group of Hospitals, Mumbai (Maharashtra). All patients enrolled in the study were male with age range between 20 to 40 years. Three patients had left sided and seven patients had right sided subclavian artery involvement. Eight of the patients had traumatic history of subclavian artery injury out of which five patients had history of penetrating stab injury, two patients had blunt injury, and one patient had stone chip injury. Two patients had iatrogenic history while central line insertion.

All patients underwent computed tomography angiography preoperatively and postoperative Doppler study. All patients underwent emergency operative procedure after short preoperative workup. Pseudoaneurysm excision with repair of subclavian artery was done in all patients. Primary repair of Subclavian artery done in 4 patients and repair of artery with vein patch in 2 patients. Interposition graft with reverse saphenous vein graft for 2 patient and PTFE in 2 patients. Subclavian vein injury was there in two patients which were managed with primary repair. One patient had brachial plexus injury which was managed by plastic surgeons. On follow-up Doppler study done after 6 month of surgery, normal study was noted. One patient had wound gaping which was treated with dressing and secondary suturing. There were no deaths.

Good results can be achieved by emergent management to prevent complications such as rupture, infection, gangrene. Proximal and distal control of artery is a must for safe excision of any pseudoaneurysm. Stenting of subclavian artery pseudoaneurysm is good option but with the risk of infection and abscess formation in residual Pseudoaneurysm, surgical excision is the best option for large pseudoaneurysm.

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### Introduction

Penetrating Subclavian artery injuries constitute less than 2% of all civilian vascular traumas [1,2]. Pseudoaneurysm develops when there is a lack of integral arterial wall structure, resulting in blood leakage through the wall, and then wrapped by perivascular tissue. Complex local anatomy combined with the difficult surgical exposure of proximal injuries makes these injuries challenging even for experienced surgeons. Most common site of pseudoaneurysm is common femoral artery, followed by radial and brachial artery, pseudoaneurysm of Subclavian Artery (SCA) is rare [3]. We are presenting the results of a retrospective analysis of our strategies for the management and surgical treatment of subclavian artery pseudoaneurysm.

### Patients and Methods

Ten patients with traumatic subclavian artery pseudoaneurysms enrolled in the study from March 2013 to January 2022 at Grant Medical College and JJ Group of Hospitals, Mumbai (Maharashtra). Out of all patients enrolled in the study all were male and age ranges between 20 to 40 years. Eight patients had traumatic history of subclavian artery injury out of which five patients (50%) had history of penetrating stab injury, two patients (20%) had blunt injury, and one patient (10%) had stone chip injury. Two patients (20%) had iatrogenic history while central line insertion. Two patients had chronic kidney disease as comorbidity. Three patients out of ten presented to the hospital with delayed onset of symptoms and sign. All patients underwent computed tomography angiography preoperatively and postoperative Doppler study. Average size of aneurysm was 11 cm

**Table 1:** Demographics, medical history, symptoms of subclavian artery pseudoaneurysm.

| Patient number | Sex  | Age in year | Etiology           | Medical history              | Symptoms  | Physical sign                | Presentation | Location of pseudoaneurysm | Size of pseudoaneurysm in cm |
|----------------|------|-------------|--------------------|------------------------------|---|------------------------------|--------------|----------------------------|------------------------------|
| 1              | Male | 24          | Stab injury        | Nil                          | Right upper limb pain                             | Pulsatile mass               | Early        | Right                      | 12 × 9                       |
| 2              | Male | 32          | HD Catheter injury | Chronic kidney disease (CKD) | Left upper limb pain                              | None                         | Delayed      | Left                       | 9 × 7                        |
| 3              | Male | 38          | Stab injury        | Nil                          | Left upper limb numbness and breathing difficulty | Restricted shoulder movement | Early        | Left                       | 11 × 6                       |
| 4              | Male | 29          | Stab injury        | Nil                          | Left upper limb pain                              | Pulsatile mass               | Early        | Left                       | 8 × 6                        |
| 5              | Male | 28          | HD Catheter injury | Chronic kidney disease (CKD) | Dysphagia and breathing difficulty                | None                         | Early        | Right                      | 11 × 6                       |
| 6              | Male | 38          | Stab injury        | Nil                          | Left upper limb pain                              | Pulsatile mass               | Delayed      | Left                       | 12 × 6                       |
| 7              | Male | 21          | Stone chip injury  | Nil                          | Left upper limb pain                              | None                         | Delayed      | Left                       | 14 × 9                       |
| 8              | Male | 29          | Blunt injury       | Nil                          | Breathing difficulty and right upper limb pain    | None                         | Early        | Right                      | 11 × 7                       |
| 9              | Male | 22          | Stab injury        | Nil                          | Left side upper limb numbness                     | Pulsatile mass               | Early        | Left                       | 10 × 6                       |
| 10             | Male | 35          | Blunt injury       | Nil                          | Left upper limb pain                              | None                         | Early        | Left                       | 12 × 7                       |

**Table 2:** Operative intervention of subclavian artery pseudoaneurysm.

| Patient number | Repair            | Interposition graft | Complications | Brachial plexus injury | Subclavian vein injury | Blood loss in ml | ICD insertion |
|----------------|-------------------|---------------------|---------------|------------------------|------------------------|------------------|---------------|
| 1              | Primary repair    | No                  | No            | No                     | No                     | 350              | No            |
| 2              | Reverse SVG graft | Yes                 | No            | No                     | No                     | 500              | No            |
| 3              | Primary repair    | No                  | No            | Yes                    | Yes                    | 400              | No            |
| 4              | Vein patch        | No                  | No            | No                     | No                     | 500              | No            |
| 5              | Primary repair    | No                  | No            | No                     | No                     | 400              | Yes           |
| 6              | e PTFE graft      | Yes                 | Wound gaping  | No                     | No                     | 500              | No            |
| 7              | ePTFE graft       | Yes                 | No            | No                     | No                     | 300              | No            |
| 8              | Reverse SVG graft | Yes                 | No            | No                     | No                     | 550              | Yes           |
| 9              | Primary repair    | No                  | No            | No                     | No                     | 400              | No            |
| 10             | Vein patch        | No                  | No            | No                     | Yes                    | 350              | No            |

× 7 cm according to the ct angiography study (Figure 1a, 1b). The lesions were located in the right subclavian artery in three cases (30%) and in the left subclavian artery in seven cases (70%) (Table 1).

**Surgical Approach**

All patients underwent computed tomography angiography preoperatively and postoperative Doppler studies (Figures 2a-2d) and underwent emergency operative procedure after short preoperative workup.

Pseudoaneurysm excision with repair of Subclavian artery done in all patients under general anesthesia. Written and informed consent obtained from all patients. Initially for distal vascular control axillary artery exposed and loop in upper arm with separate incision. Considering the CT angiography findings and size of aneurysm, sternotomy or supra clavicular incision took for proximal control of the subclavian artery. After proximal and distal vascular control was secured, the pseudoaneurysm was dissected with blunt and sharp dissection to reach the pseudoaneurysm. Intravenous heparin (100 IU/kg) was administered and after 3 min, the proximally subclavian and distal axillary arteries were clamped. Pseudoaneurysm opened and clots were removed. Separation of pseudoaneurysm followed by excision of the pseudoaneurysm sac done. During dissection of pseudoaneurysm pleura opened accidentally in two patients. Neck of pseudoaneurysm communicating to the subclavian artery was identified. Subclavian arterial wall proximal and distal to the defect were inspected in view of planning for the primary repair of



subclavian artery or interposition grafting. Fogarty catheter passed proximal and distal through the defect to retrieve thrombus. After confirming adequate flow from both sides, decision of primary repair of subclavian artery or need of interposition grafting was made. After achieving hemostasis, Romo Vac drains were placed in the pseudoaneurysm cavity in all the patients and chest drain tube in the pleural cavity kept in two patients. Wound closure done in layer

(Figures 3a-3d).

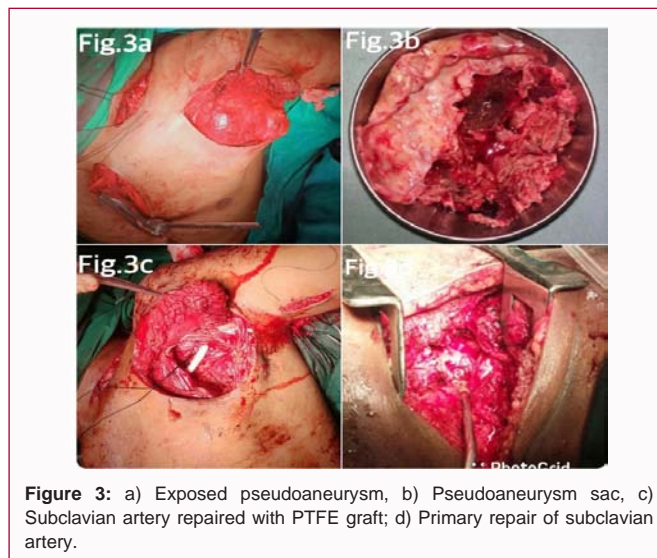
Radial and ulnar artery pulsations were well felt and confirmed with a hand held Doppler. Doppler study done in all the patients postoperatively on the day of discharge. Intercostal drain and Romo Vac drain removed on 3<sup>rd</sup> Postoperative Day (POD) and on the POD 7 patients were discharged in average. Patient advised limb physiotherapy on discharge. Patient to be followed up on 1, 6, 12 months after discharge. Follow up Doppler study at six months were normal in all the patients.

### Results

Pseudoaneurysm excision with repair of subclavian artery done in all patients. Primary repair of Subclavian artery done in four patients and repair of artery with vein patch in two patients. Interposition graft with reverse saphenous vein graft done in two patient and PTFE graft in two patients. Subclavian vein injury was there in two patients which were managed with primary repair. One patient had brachial plexus injury which was operated by plastic surgeon (Table 2). The patients who underwent primary repair were kept on anti platelet Tab. Aspirin 75 mg once daily for 3 months and those who underwent repair with ePTFE were kept on anticoagulation- Tab Warfarin (dosage based on INR 2-3) and anti platelet- Tab Aspirin 75 mg once daily, for a year. Follow-up Doppler study done after 6 month of surgery was normal in all patients. One patient had wound gaping which was treated with dressing and secondary suturing. There were no deaths. Average duration of surgery was 3 h. Average blood loss was 425 ml. Average blood transfusion required was 1.5 pints. Average duration of ICU stay was 1, 2 days. Total average duration of hospital stay was 6.6 days (Table 3).

### Discussion

The iatrogenic most common cause for a post-traumatic pseudoaneurysm is post AV fistula dialysis needle puncture or invasive procedures such as percutaneous coronary interventions. Accidental arterial puncture occurs in around 1% and 2.7% of jugular and subclavian approaches, respectively [4,5]. Penetrating stab injuries involving subclavian arteries are particularly devastating because mortality prior to hospitalization is about 75% and long-term morbidity is due to brachial plexus injuries [6,7]. Symptoms of subclavian artery aneurysm are determined by the aneurysm site and



**Figure 3:** a) Exposed pseudoaneurysm, b) Pseudoaneurysm sac, c) Subclavian artery repaired with PTFE graft; d) Primary repair of subclavian artery.

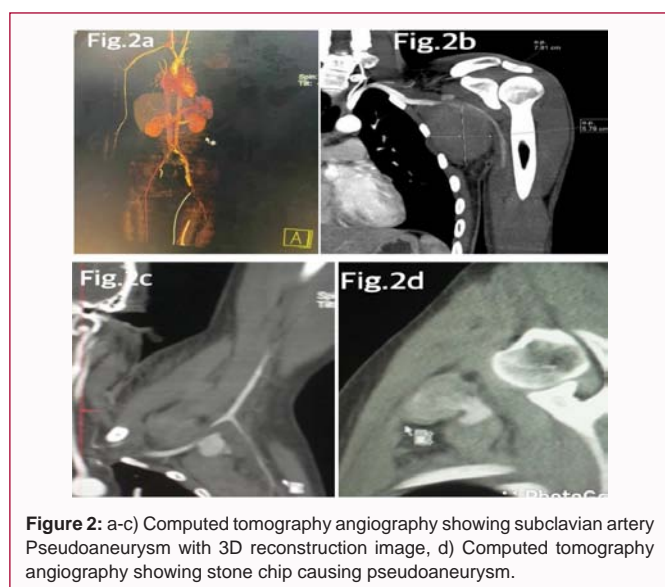
**Table 3:** Post-procedure follow up.

| Patient number | Duration of Surgery in hours | Duration of ICU stay in days | Duration of Hospital stay in days | Number of blood transfusion (pints) | Postoperative Doppler study |
|----------------|------------------------------|------------------------------|-----------------------------------|-------------------------------------|-----------------------------|
| 1              | 03:00                        | 1                            | 6                                 | 2                                   | Normal                      |
| 2              | 02:30                        | 1                            | 8                                 | 0                                   | Normal                      |
| 3              | 03:00                        | 1                            | 7                                 | 3                                   | Normal                      |
| 4              | 03:30                        | 1                            | 7                                 | 1                                   | Normal                      |
| 5              | 02:30                        | 2                            | 7                                 | 1                                   | Normal                      |
| 6              | 04:00                        | 2                            | 6                                 | 1                                   | Normal                      |
| 7              | 02:45                        | 1                            | 5                                 | 2                                   | Normal                      |
| 8              | 03:30                        | 1                            | 8                                 | 2                                   | Normal                      |
| 9              | 02:30                        | 1                            | 7                                 | 1                                   | Normal                      |
| 10             | 03:00                        | 1                            | 5                                 | 2                                   | Normal                      |

size. Extrathoracic aneurysm usually presents with pulsatile swelling over deltopectoral groove with pulsation and vascular murmurs, whereas intrathoracic aneurysm or post-stenotic dilated aneurysm may compress the brachial plexus or upper extremity vessels leading to the ischemia of the limb. Aneurysm eroding the apex of lung might cause hemoptysis, compress recurrent laryngeal nerve resulting in hoarse voice. Besides, there are reports about dysphagia and Horner’s syndrome as well. However, dyspnea caused by trachea compression is seldom reported.

Angiogram is extremely helpful to determine the site of injury, whether patients get benefit from endovascular intervention and most importantly for planning the surgical approach. In our cases we used CT angiogram to confirm the extent of the injury and surgical approach for the operative procedure. In the management of penetrating subclavian artery aneurysm, recent studies showed that use of subclavian artery stent to close the neck of subclavian artery pseudoaneurysm is not superior to surgical correction because there may remain at a higher risk for infection in the residual pseudoaneurysm sac. A more delayed presentation may necessitate repair with subclavian artery excision with interposition grafting. Excision of residual pseudoaneurysm is mandatory [9].

Various types of surgical approaches have been described in different literature for the management of penetrating subclavian



**Figure 2:** a-c) Computed tomography angiography showing subclavian artery Pseudoaneurysm with 3D reconstruction image, d) Computed tomography angiography showing stone chip causing pseudoaneurysm.

artery injuries like midline sternotomy, anterolateral thoracotomy (trap door incision) [8,9]. In our cases we used the sternotomy and/or the supraclavicular incision for excellent exposure and proximal vascular controls which minimizes the risk of bleeding as well as complete excision of pseudoaneurysmal sac with repair of vascular injury. When necessary, in nominate artery and carotid artery are supposed to be occluded, or the operation should be performed in a profound hypothermic circulatory arrest under extracorporeal circulation. It is highly recommended not to open the aneurysm sac if the aneurysm sac is adherent to the surrounding tissues with rich collateral circulation, as ligation of bilateral ends is effective as well. Exposure of aneurysm body, aneurysm inflow, and aneurysm tract control along with intracapsular bleeding control after aneurysm dissection are crucial for the success of the operation. There were no major postoperative vascular complications in our cases. Regarding brachial plexus injuries studies mentioned earlier, were encountered in 12% of cases and neurological deficit remains the leading cause of morbidity of those case. Neurological deficit on presentation of some cases were results from compression of the nerves by a hematoma or an aneurysm and resolves after surgical intervention [8].

## Conclusion

Proximal and distal control of artery is must for safe excision of any pseudoaneurysm. Timely management is important to prevent complications such as infection, rupture, and gangrene. Although recently published meta-analysis showed no superiority of subclavian artery stenting in such pseudoaneurysm because even after closing the opening which connect subclavian artery with the pseudoaneurysm, the residual pseudoaneurysm is at a high risk of infection [9]. So excision of that pseudoaneurysm is a must and in experienced hands, the morbidity of the procedure is less and mortality is nil with good results.

## Ethical Approval

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

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