UPPER LIMB MONOPARESIS: IMAGING EVALUATION AND ENDOVASCULAR MANAGEMENT OF IATROGENIC PSEUDOANEURYSM

Vaishnavi Thakker 1,a, Sambhaji Pawal b, Rahul Arkar b and Vijetha Chanabasanavar a

a Department of Radiodiagnosis, Dr D Y Patil Medical College, Hospital and Research centre, Pimpri-411018, 

b Department of Interventional Radiology, Dr D Y Patil Medical College, Hospital and Research centre, Pimpri-411018.

ABSTRACT Background: Cannulation of the internal jugular vein is a common procedure in hospitals. The development of false aneurysms, emboli, fistulae and hematomas are common complications due to vascular interventions. False aneurysms, or pseudoaneurysms, constitute the majority of these iatrogenic complications. Pseudoaneurysms can be life-threatening and are considered a surgical emergency due to their high relative risk of rupture and bleeding. Case Presentation: This is a case of a 29-year-old female who presented with symptoms of delayed paralysis of the brachial plexus due to transverse cervical artery pseudoaneurysm following iatrogenic trauma. Discussion: The brachial plexus is the primary source of peripheral nervous innervation to the upper extremity, associated muscles of the upper chest and cutaneous supply to the skin and hand. In the thoracic outlet region, the brachial plexus comes in close contact with major subclavian vessels supplying the upper extremity. Because of the anatomic proximity between the brachial plexus and transverse cervical artery in the thoracic outlet, a pseudo aneurysm or hematoma in this region can cause compression of the neu roplexus and lead to the gradually progressive neurological deficit over days to weeks as opposed to direct penetrating injuries. If left untreated, brachial plexopathy has an unfavourable prognosis. Endovascular therapy and surgical management play a crucial role in their treatment. Endovascular repair has been more widely accepted in recent years due to increased procedural efficacy and its less invasive nature. Since the subclavian artery exposure and difficult vascular control in open surgery pose a challenge in managing pseudoaneurysms, endovascular treatment is the preferred treatment method.

KEYWORDS Pseudoaneurysm, Complications, Endovascular treatment/therapy, Subclavian artery, Digital subtraction angiography

Introduction

Cannulation of the internal jugular vein is a common procedure in hospitals. Development of false aneurysms, emboli, fistulae and hematomas are common complications due to vascular interventions. False aneurysms, or pseudoaneurysms, constitute most of these iatrogenic complications. A ne aneurysm can also be referred to as a pulsatile hematoma or communicating hematoma.

Aneurysms can be discussed under two broad categories – true and false. True aneurysms are bounded by all 3 layers of the blood vessel. In contrast, a pseudoaneurysm is described as an encapsulated pulsatile hematoma communicating with the lumen of a ruptured vessel following the disruption of one of its layers. This deficiency in the 3-layered wall structure makes it more susceptible to rupture; hence, Pseudoaneurysms can be life-threatening and are considered a surgical emergency due to
their high relative risk of rupture and bleeding.\(^{(5)}\)

More often than not, aneurysms and pseudoaneurysms of the subclavian artery causing compressive myelopathy are responsible for sudden or delayed onset limb paresis.\(^{(6)}\)

In this case, we report endovascular therapy’s utility in managing a subclavian artery pseudoaneurysm following iatrogenic trauma producing symptoms of delayed paralysis of the brachial plexus.

**Ethical Considerations**

This report followed all ethical standards for research. Written informed consent was obtained from the patient prior to conducting the study and for publication, along with relevant images. Patient identity is not disclosed.

**Case presentation**

A 29-year-old female patient was admitted to our hospital with complaints of diminished vision in the right eye, associated with pain and redness. She also complained of non-specific lower limb weakness for 10 months without fever, diarrhoea, or vaccination. She denied any history of trauma to the head or eye region, hypertension, diabetes, rash, and joint pain. There was no family history of autoimmune disease.

Following back her clinical history, it was discovered that she was diagnosed with Neuromyelitis Optica. Magnetic resonance imaging showed a bulky right optic nerve with mild post-contrast enhancement. One year later, the patient presented with bilateral diminution of vision, and she underwent serial magnetic resonance imaging which was suggestive of bilateral optic neuritis. (Figure 1)\(^{(7)}\)

The patient was put on high-dose methylprednisolone therapy. However, the patient did not regain complete vision over a period of one month. Due to steroid refractory NMO, the patient was started on plasmapheresis one month later.

In an attempt to place a central line, an 18-gauge introducer needle was inserted. However, the procedure was unsuccessful, and a hematoma formation was noted. This was contained by applying manual pressure over the site of entry. No intervention was performed following this event.

Two days after attempted cannulation, the patient developed pain and paraesthesia of the right arm. Her symptoms worsened in the supine position and were relieved to some extent by leaning forward. However, there was a loss of sensation over the ulnar aspect of the right hand and forearm and decreased muscle strength in the right biceps brachia, extensors and small muscles of the right hand, including interossei muscles.

On physical examination, a painless, pulsatile mass was observed on the right side of the neck. The patient underwent magnetic resonance imaging screening of the whole spine and brachial plexus to evaluate the aetiology of the limb paraesthesia. (Figure 2)\(^{(8)}\)

A well-defined T2/STIR hyperintense lesion of size approx. 12x12mm was noted in the right lower cervical region, superior to the first segment of the right subclavian artery. Post-contrast dynamic study shows enhancement in the arterial phase with connection to the proximal part of the right thyrocervical branch - likely pseudoaneurysm.

A larger, fairly well-defined hematoma with blood fluid levels of 36x23x19mm was noted adjacent to the region in the right scalene triangle, involving all three scalene muscles causing mass effect and displacing the right IJV, longus coli muscle medially, anterolateral displacement of the scaleni muscles. The nerve roots of C5, C6, and C7 are displaced superiorly. The C8 and T1 nerve roots were displaced anteriorly. The trunks were displaced anterior to the hematoma and show STIR hyperintensity. The superior trunk appears bulky with STIR hyperintensity.

**Management and Outcome**

**Role of Interventional Radiology in the management of pseudoaneurysm**

Under local anaesthesia, 6F right femoral arterial access was taken. Right, subclavian angiogram showed small (approximately 2.0 x1.5mm size), anterosuperior projecting pseudoaneurysm arising from a transverse cervical branch of right thyrocervical trunk. (Figure 3)\(^{(9)}\)

6F Envoy guiding catheter was placed in the right thyrocervical trunk using Terumo guidewire. Transverse cervical artery pseudoaneurysm was crossed with 0.014 Gandslam J guidewire. Subsequently, Graftmaster (3.5 x16mm) stent graft was deployed across the pseudoaneurysm. (Figure 4)\(^{(10)}\)

Post-procedure right subclavian angiogram showed complete exclusion of transverse cervical artery pseudoaneurysm from circulation. The procedure was uneventful. (Figure 5)\(^{(11)}\)
Discussion

The brachial plexus is the primary source of peripheral nervous innervation to the upper extremity, associated muscles of the upper chest and cutaneous supply to the skin and hand. In the thoracic outlet region, the brachial plexus comes in close contact with major subclavian vessels supplying the upper extremity. It is known to course postero-superiorly to the subclavian artery and vein. Anatomically, the subclavian artery, the transverse cervical artery, courses along the base of the scalene triangle bounded on either side by the anterior and middle scalene muscles. Brachial plexopathy can result from various causes such as traumatic vascular and nervous injuries, invasion by intrinsic masses, compression by extrinsic masses such as pseudoaneurysms, and hematoma formation.\(^{12}\)

Although rare, injuries of the transverse cervical artery account for 1–2% of all vascular injuries.\(^{13}\) More often than not, they arise due to iatrogenic causes, such as unintended arterial puncture during internal jugular venous cannulation\(^{14}\), as was in our case. Because of the anatomic proximity between the brachial plexus and transverse cervical artery in the thoracic outlet, a pseudo aneurysm or hematoma in this region can cause compression of the neuroplexus and lead to the gradually progressive neurological deficit over days to weeks as opposed to direct penetrating injuries. Direct injuries to the brachial plexus are more readily picked up in clinical practice due to the sudden onset of paralysis.\(^{15}\)

If left untreated, brachial plexopathy has an unfavourable prognosis and can lead to irreparable damage causing functional disturbance of the involved extremity. Increasing neurological deficits in patients with such injuries should urge speedy surgical intervention to prevent permanent damage.\(^{16}\)

Pseudo aneurysms warrant prompt treatment and life-threatening risk of rupture and neurological and embolic complications. Endovascular therapy and surgical management play a crucial role in their treatment.\(^{16}\) MR imaging is pertinent in order to identify and differentiate between various causes of brachial plexopathy. Aneurysms and pseudo aneurysms are represented by concentric rings of varying signal intensities due to various stages of blood products in the walls of pseudoaneurysms or as flow voids in T2WI depending on the flow rate through the artery.\(^{12}\)

Due to increased procedural efficacy and its less invasive nature, endovascular repair has been more widely accepted in recent years.\(^{17}\)

Since the subclavian artery exposure and difficult vascular control in open surgery pose a challenge in managing pseudoaneurysms\(^{18}\), endovascular treatment is the preferred treatment method. Self-expanding systems seem to be exceptionally promising in the endovascular management of pseudo aneurysms, owing it their flexibility.\(^{14}\) Arterial dissections, arterio-venous fistulae and aneurysms in various arterial vessels have been treated using stent grafts and bare stents.\(^{14}\) Selective coil placement can be used to treat traumatic pseudo aneurysms quickly since they heal spontaneously in most cases.\(^{19}\) Although promising results have been obtained, the data on the outcome of endovascular treatment in the subclavian artery is currently limited due to its infrequent occurrence.\(^{20}\)

Acknowledgements

Department of Interventional Radiology

Competing interests

The authors declare that we have no financial or personal relationship that may have inappropriately influenced them in writing this article.
Author contributions
All authors meet the criteria for authorship as outlined in the authorship policy and author contribution statement policies.

Funding
We have not received any specific grant or funding to conduct this study.

Data availability
All research articles are encouraged to have a data availability statement.

Disclaimer
The views expressed in the submitted article are the author’s own and not an official position of the institution or funder.

References
1. van der Weijde E, Vos JA, Heijmen RH. Hybrid repair of a large pseudoaneurysm of the proximal right subclavian artery in a Marfan patient. Journal of vascular surgery cases and innovative techniques. 2017 Dec 1;3(4):215-7.
2. Kent KC, Mc Ardle CR, Kennedy B, et al. A prospective study of the clinical outcome of femoral pseudoaneurysms and arteriovenous fistulas induced by arterial puncture. J Vasc Surg 1993; 17:125–133.
3. Franklin JA, Brigham D, Bogey WM, Powell CS. Treatment of iatrogenic false aneurysms. Journal of the American College of Surgeons. 2003 Aug 1;197(2):293- 301.
4. Jariwala P, Punjani A, Kamble R. Endovascular management of the post-traumatic common carotid artery pseudoaneurysms. Polish Journal of Radiology. 2021;86:e287.
5. Sueyoshi E, Sakamoto I, Nakashima K, Minami K, Hayashi K. Visceral and peripheral arterial pseudoaneurysms. American Journal of Roentgenology. 2005 Sep;185(3):741-9.
6. Schellhammer, Müller. Endovascular treatment of subclavian pseudoaneurysm causing delayed brachial plexus paralysis. Vasa. 2004 Nov 1;33(4):239-41.
7. Figure 1 – self obtained image
8. Figure 2 – self obtained image
9. Figure 3 – self obtained image
10. Figure 4 – self obtained image
11. Figure 5 – self obtained image
12. Aralasmak A, Karaali K, Cevikol C, Uysal H, Senol U. MR imaging findings in brachial plexopathy with thoracic outlet syndrome. American journal of neuroradiology. 2010 Mar 1;31(3):410-7.
13. Sturm JT, Dorsey JS, Olson FR, Perry Jr JF. The management of subclavian artery injuries following blunt thoracic trauma. The Annals of thoracic surgery. 1984 Sep 1;38(3):188-91.
14. Hernandez JA, Pershad A, Laufer N. Subclavian artery pseudoaneurysm successful exclusion with a covered self-expanding stent. The Journal of invasive cardiology. 2002 May 1;14(5):278-9.
15. Tarrng DC, Huang TP, Lin KP. Brachial plexus compression due to subclavian pseudoaneurysm from cannulation of jugular vein hemodialysis catheter. American journal of kidney diseases. 1998 Apr 1;31(4):694-7.
16. Hansky B, Murray E, Minami K, Körfer R. Delayed brachial plexus paralysis due to subclavian pseudoaneurysm after clavicular fracture. European journal of cardio-thoracic surgery: official journal of the European Association for Cardio-thoracic Surgery. 1993 Jan 1;7(9):497-8.
17. Maskanakis A, Patelis N, Moris D, et al. Stenting of Subclavian Artery True and False Aneurysms: A Systematic Review. ANN VASC SURG 20182018-02-01;47:291-304.
18. Costa MC, Robbs JV. Nonpenetrating subclavian artery trauma. Journal of vascular surgery. 1988 Jul 1;8(1):71-5.
19. Maškovič J, Radonić V, Janković S, Cambj-Sapunar L, Mimica Ž, Bačić A. Traumatic false aneurysm of the subclavian artery treated by insertion of Memotherm stent. European journal of radiology. 2001 Jun 1;38(3):205-8.
20. Al-Mubarak N, Liu MW, Dean LS, Al-Shaibi K, Chastain HD, Iyer SS, Roubin GS. Immediate and late outcomes of subclavian artery stenting. Catheterization and Cardiovascular Interventions. 1999 Feb;46(2):169-72.