



Delayed presentation of upper extremity arteriovenous fistula after total shoulder replacement

Isabel Reedy, BS, Bernadette Aulivola, MD, Nickolas Garbis, MD*

Loyola University Medical Center, Maywood, IL, USA



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The total shoulder arthroplasty (TSA) is considered a safe and effective procedure used to treat glenohumeral osteoarthritis.^{1,3,5,14} TSA is associated with known complications, including rotator cuff tears, infection, glenohumeral instability, nerve damage, and peri-prosthetic humeral fracture.^{1,3,5}

Very few case reports have described vascular injury as a complication of a TSA, with most describing signs and symptoms of vascular injury occurring within one month of the surgery.^{1,2,7,9,19} Vascular injuries associated with TSA are more often associated with traumatic humeral fractures and dislocations.^{6,11,13,21}

We present the case of a patient who underwent a TSA during which arterial bleeding was encountered in the axillary region but was controlled intraoperatively and the patient had an uneventful recovery. Nine years later, the patient was diagnosed with an arteriovenous fistula (AVF) after workup after a bruit was auscultated on physical examination by her primary care physician.

Case description

A 76-year-old female patient underwent a right TSA at an outside facility for glenohumeral osteoarthritis 9 years before the current presentation. At the time of this procedure, the patient had a past medical history significant for prior left TSA, right total knee arthroplasty, hypertension, and anemia. The patient underwent a regional block, as well as general anesthesia for the procedure. During the case, the patient underwent a standard deltopectoral approach, and bleeding was noted from the axillary region during

glenoid cementation. It was unclear when the actual injury happened, but it was potentially during removal of the anterior inferior labrum and capsulectomy. Exploration revealed a bleeding source caudal and medial to the glenoid. There was concern that a more extensive dissection would be required to achieve hemostasis, but after viewing the axillary region under loupe magnification, the operating surgeon identified a small area of arterial bleeding and treated it with a tamponade of fibrin sealant and epinephrine-soaked Gel-Foam. A drain was left in place. The estimated blood loss during the case was 1 liter.

Postoperatively, given acute blood loss anemia, the patient required transfusion of 3 units of packed red blood cells. Two units were given immediately postoperatively and then one more one day postoperatively. Immediately after surgery, the patient had a hemoglobin concentration of 7.6 g/dL and then 9.5 g/dL on postoperative day one. The drain was pulled on postoperative day one. The patient stabilized at a hemoglobin concentration of 8.5 g/dL on postoperative day two. As per the outside facility's notes, no further imaging was ordered as it was felt to be a terminal branch of the circumflex vessels by the operating surgeon.

After her initial hospital stay, the patient's recovery was uneventful. Nine years postoperatively, the patient reports adequate overall pain relief and function provided by the shoulder replacement (Figs. 1 and 2).

During a routine visit with her primary care physician, the patient complained of intermittent shoulder pain and was found to have a palpable thrill and a loud bruit posterior to the right axillary fold. The patient was referred to a vascular surgeon for evaluation and management. A right upper extremity arterial duplex study was performed and demonstrated evidence of an aneurysmal malformation in the right axilla that was difficult to characterize. The patient subsequently underwent computed tomography angiogram to attempt to characterize the malformation. From these

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*Corresponding author: Nickolas Garbis, MD, Loyola University Medical Center, 2160 S. First Ave., Maywood, IL 60153, USA.

E-mail address: ngarbis@lumc.edu (N. Garbis).

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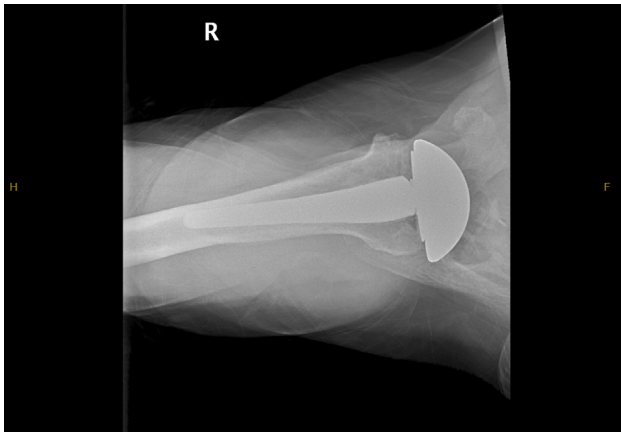


Figure 1 The axial radiograph with the TSA implant. TSA, total shoulder arthroplasty.

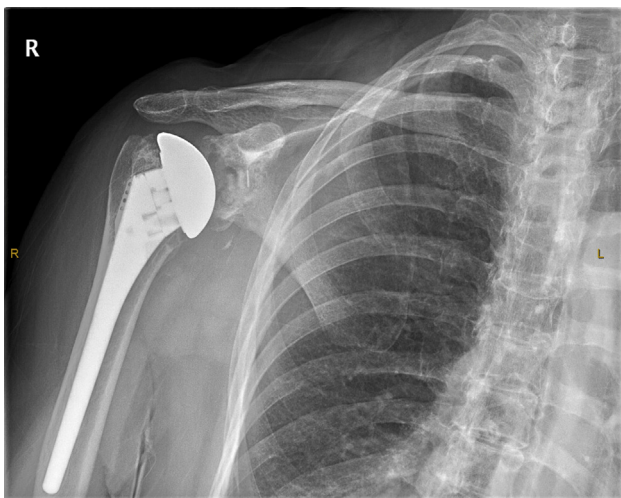


Figure 2 The anterior-posterior radiograph with the TSA implant. TSA, total shoulder arthroplasty.

images, the malformation was determined to be a likely AVF with dilation of right axillary veins and possible thoracic outlet compression and constriction. Computed tomography imaging was nondiagnostic given the artifact from the shoulder implant and the right upper extremity intravenous contrast injection. The differential diagnosis included AVF and arterial aneurysm/pseudoaneurysm. To confirm the diagnosis as well as establish a definitive management plan, the patient was advised to undergo diagnostic arteriogram.

An arteriogram was performed via a right brachial artery access. Selective catheterization for arteriogram revealed evidence of an enlarged subscapular AVF (Figs. 3 and 4) and brisk shunting of contrast dye from the subscapular artery to the neighboring veins with filling of dilated venous collaterals and early filling of the subclavian vein (Figs. 5–7). Coil embolization of the subscapular artery was considered; however, because of brisk, high-volume flow and markedly dilated venous outflow collaterals, this was not utilized given risk of migration of the coils to the central venous system and pulmonary artery. As arterial aneurysm was ruled out and the patient was relatively asymptomatic with relation to the AVF, specifically denying symptoms of ipsilateral upper extremity ischemia, pain or discomfort, or congestive heart failure, continued observation was advised.

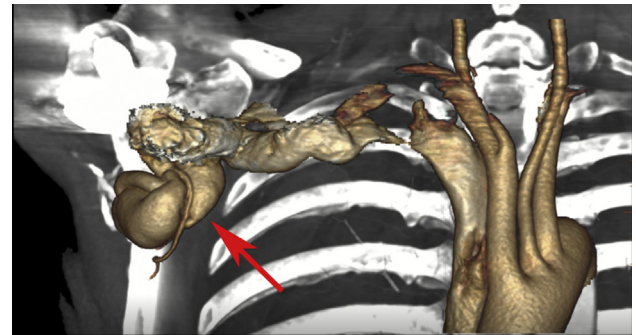


Figure 3 Volume-rendered image of AVF. Red arrow shows location of the AVF. AVF, arteriovenous fistula.



Figure 4 AVF three-dimensional replication with TSA implant seen in red. Red arrow shows location of the AVF. AVF, arteriovenous fistula; TSA, total shoulder arthroplasty.



Figure 5 The digital subtraction angiogram image as contrast injected into the axillary artery.

Discussion

Although rare, axillary artery injury as a result of a TSA can have delayed, negative effects on a patient’s health. It has been estimated that vascular injuries occur in only 0.005% of all elective orthopedic surgery cases.¹⁸ In the literature, there have been described cases of delayed presentation of arterial injury symptoms and axillary



Figure 6 The digital subtraction angiogram image as contrast flows into the arteriovenous fistula.

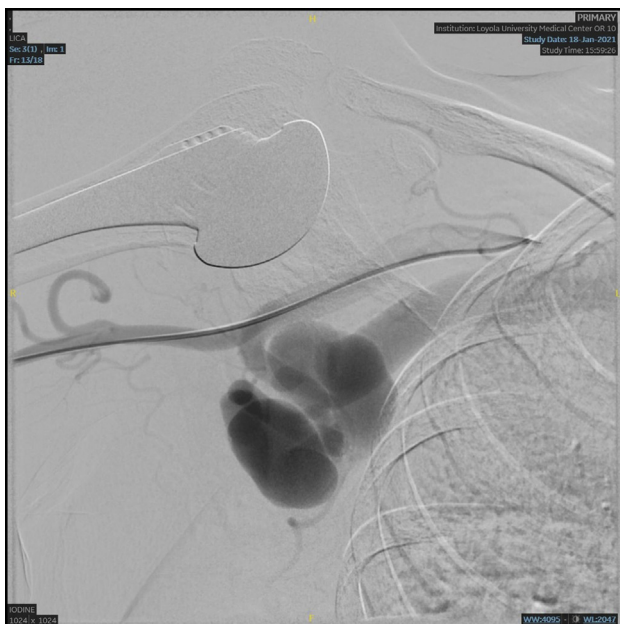


Figure 7 The digital subtraction angiogram image as contrast flows into the axillary vein.

artery injury after a TSA, but there has not been a reported case in which the diagnosis of vascular injury occurred more than one month after a TSA.^{1,2,7,9,16,19} All these cases emphasize the importance of early detection and treatment of the injury.

To our knowledge, this is the first reported case of axillary region AVF development after a TSA, as well as the first reported case of AVF development after a TSA with a delayed presentation.

A review of the relevant vascular anatomy is warranted. During TSA, the axillary artery can be at risk during preparation of the glenoid and during capsular resection at the anterior inferior joint.

The axillary artery carries oxygenated blood to the upper limb, the axilla, and the lateral thorax.^{10,17} It originates at the lateral-most point of the first rib and extends to the inferior border of the teres major muscle. Typically divided into three parts, with six major branches, the axillary artery's parts are classified based on the location relative to the pectoralis minor muscle, which lies superficial to the artery.^{10,17} The first part of the axillary artery is located medial to the pectoralis minor and has one branch (the superior thoracic artery) providing blood flow to the first two intercostal spaces. The second part of the axillary artery is located directly posterior to the pectoralis minor muscle and has two branches (the thoracoacromial trunk and lateral thoracic artery) providing blood to the acromion region of the scapula, the pectoralis major and minor muscles, the subclavius muscle, deltoid, lateral aspects of the chest wall, and mammary gland.^{10,17} The third part of the axillary artery is located lateral to the pectoralis minor muscle and has three branches (the subscapular trunk, anterior humeral circumflex artery, and posterior humeral circumflex artery) providing blood to the scapular region, the latissimus dorsi muscle, the head of the humerus, and the shoulder joint.^{4,10,17}

AVFs are abnormal connections in between an artery and a vein that are classified as either congenital or acquired.^{4,16,17} Acquired AVFs can result from blunt trauma or puncture wounds and are further classified as iatrogenic fistulas when they occur as a result of an intervention such as an arterial or venous access procedure.^{4,16,17} Many acquired AVFs are asymptomatic and spontaneously resolve, but those that are determined to be clinically significant require surgical intervention.^{8,16} According to Yagubyan et al, approximately 10% of acquired axillary artery injuries are treated conservatively as the axillary artery has five branches to support the upper extremity and ischemia rarely results.²⁰ It is of note, although, that surgical intervention is indicated when there is detection of a laceration or occlusion of an artery.^{12,15}

We hypothesize that this is a case of an acquired, iatrogenic AVF, most likely related to the arterial injury recognized at the time of the index operation. It is likely that the arterial injury at the index operation was associated with a concomitant neighboring venous injury and that AVF resulted. During TSA, as with any other surgical procedure, it is essential that encountered bleeding is appropriately controlled; however, intraoperative consultation with a vascular surgeon may offer insight into the definitive management and consequences of vascular injury.^{12,15,18}

Conclusion

We have presented the case of a 76-year-old female patient who underwent a TSA nine years ago and exhibited delayed signs of arterial and venous injury. This case highlights the importance of ensuring dissection is undertaken with cautery or suture ligation of the vessels when working in the region of the circumflex vessels, particularly when a subscapularis tenotomy is used. In addition, if the injury is more medial, then potential deeper exploration is warranted. After workup, the injury was classified as a subscapular AVF. It was determined during a diagnostic arteriogram that the AVF would be best managed with continued observation given the patient's asymptomatic status, but with a large AVF, the patient was educated on the signs and symptoms that would suggest symptoms related to the AVF including congestive heart failure, arm ischemia, and significant discomfort. Although iatrogenic vascular injuries during a TSA are rare, this case exhibits the importance of prompt recognition and postoperative treatment of vascular injury during a TSA. Delayed vascular treatment can result in negative effects on a patient's health.

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References

1. Abbenhaus E, Kamineneni S. Shoulder arthroplasty death with axillary artery and brachial plexus damage: Lessons from a tragedy. *JSES Int* 2020;4:133-7. <https://doi.org/10.1016/j.jses.2019.09.001>.
2. Bents RT. Axillary artery thrombosis after humeral resurfacing arthroplasty. *Am J Orthop (Belle Mead Nj)* 2011;40:135.
3. Bohsali KI, Bois AJ, Wirth MA. Complications of Shoulder Arthroplasty. *J Bone Joint Surg Am* 2017;99:256-69. <https://doi.org/10.2106/JBJS.16.00935>.
4. Cavdar S, Zeybek A, Bayramiçli M. Rare variation of the axillary artery. *Clin Anat* 2000;13:66-8.
5. Chin PY, Sperling JW, Cofield RH, Schleck C. Complications of total shoulder arthroplasty: Are they fewer or different? *J Shoulder Elbow Surg* 2006;15:19-22. <https://doi.org/10.1016/j.jse.2005.05.005>.
6. Clayton DB, Ratzlaff RA. Axillary artery laceration after an anterior shoulder dislocation presenting as hypovolemic shock. *Am J Emerg Med* 2016;34:1739.e1-4. <https://doi.org/10.1016/j.ajem.2015.12.087>.
7. Elhassan B, Shin A, Bishop A, Spinner R. Neurovascular injury after shoulder hemiarthroplasty: A case report and review of the literature. *J Shoulder Elbow Surg* 2008;17:1. <https://doi.org/10.1016/j.jse.2007.06.019>.
8. Gallucci G, Ranalletta M, Gallucci J, De Carli P, Maignon G. Late onset of axillary artery thrombosis after a nondisplaced humeral neck fracture: A case report. *J Shoulder Elbow Surg* 2007;16:7. <https://doi.org/10.1016/j.jse.2006.04.009>.
9. Ghanem OM, Sacco J, Heitmiller RF, Gashti SM. Delayed axillary artery occlusion after reverse total shoulder arthroplasty. *Case Rep Orthopedics* 2016;2016:5463514. <https://doi.org/10.1155/2016/5463514>.
10. Gray H, Standring S, editors. *Gray's anatomy: The anatomical basis of clinical practice*. 41st edition. Philadelphia, PA: Elsevier Limited; 2015. p. 827-9.
11. Hofman M, Grommes J, Krombach GA, Schmidt-Rohlfing B. Vascular injury accompanying displaced proximal humeral fractures: two cases and a review of the literature. *Emerg Med Int* 2011;2011:742870. <https://doi.org/10.1155/2011/742870>.
12. Jensen BV, Jacobsen J, Andreassen H. Late appearance of arterial injury caused by fracture of the neck of the humerus. *J Trauma* 1987;27:1368-9.
13. Karita Y, Kimura Y, Sasaki S, Nitobe T, Tsuda E, Ishibashi Y. Axillary artery and brachial plexus injury secondary to proximal humeral fractures: A report of 2 cases. *Int J Surg Case Rep* 2018;50:106-10. <https://doi.org/10.1016/j.ijscr.2018.04.044>.
14. Lung BE, Kanjiya S, Bisogno M, Komatsu DE, Wang ED. Preoperative indications for total shoulder arthroplasty predict adverse postoperative complications. *JSES Open Access* 2019;3:99-107. <https://doi.org/10.1016/j.jses.2019.03.003>.
15. O'Neill DR, King JJ, Farmer KW. Reverse total shoulder arthroplasty after iatrogenic axillary artery injury: A case report. *J Shoulder Elbow Surg* 2021;30:e121-8. <https://doi.org/10.1016/j.jse.2020.10.019>.
16. Stathis A, Gan J. Traumatic arteriovenous fistula: A 25-year delay in presentation. *J Surg Case Rep* 2020;2020:rjaa042. <https://doi.org/10.1093/jscr/rjaa042>.
17. Thiel R, Munjal A, Daly DT. *Anatomy, shoulder and upper limb, axillary artery*. In: *StatPearls*. Treasure Island, FL: StatPearls Publishing; 2020.
18. Wilson JS, Miranda A, Johnson BL, Shames ML, Back MR, Bandyk DF. Vascular injuries associated with elective orthopedic procedures. *Ann Vasc Surg* 2003;17:641-4. <https://doi.org/10.1007/s10016-003-0074-2>.
19. Wright AE, Wall M, Slaney P, Downing R. An unusual presentation of thoracoacromial artery pseudoaneurysm following shoulder arthroplasty. *BMJ Case Rep* 2014;2014. <https://doi.org/10.1136/bcr-2014-204625>.
20. Yagubyan M, Panneton JM. Axillary artery injury from humeral neck fracture: A rare but disabling traumatic event. *Vasc Endovascular Surg* 2004;38:175-84. <https://doi.org/10.1177/153857440403800210>.
21. Zuckerman JD, Flugstad DL, Teitz CC, King HA. Axillary artery injury as a complication of proximal humeral fractures. two case reports and a review of the literature. *Clin Orthop Relat Res* 1984;189:234-7.