The Axillary Artery and Humeral Head in ATOS

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Abstract

Classic arterial thoracic outlet syndrome (ATOS) involves injury and often aneurysmal degeneration of the subclavian artery. There exists a less commonly encountered variant that involves injury to the third portion of the axillary artery (or adjacent branch artery) due to stresses exerted by the humeral head. This is typically seen in high performance athletes in sports with frequent and repetitive overhead movements, and the presenting symptoms are similar to that of the more commonly seen ATOS. Management involves intervention for distal emboli and vascular reconstruction of the axillary artery and/or ligation of the branch artery.

Critical Take-Home Points

1. Injury to the axillary artery can occur in the setting of compression by the humeral head
2. This is typically seen in patients with frequent, repetitive, overhead motion (such as high-performance athletes).
3. Management involves limb revascularization in the setting of distal emboli and arterial reconstruction or ligation, as appropriate.

87.1 Introduction

Repetitive trauma to the axillosubclavian artery and its branches via dynamic compression from adjacent structures manifests as a clinical spectrum known as arterial thoracic outlet syndrome (ATOS). This compression is related to structures such as a cervical rib, anomalous first rib, fibrocartilaginous bands, or callous formation associated with prior clavicular trauma. The vast majority of ATOS lesions are found in the subclavian artery within the scalene triangle. However, it is important to note that a variant of this condition can occur in both the axillary artery as well as its branches, particularly the circumflex humeral arteries, given dynamic compression exerted by the humerus.

87.2 Anatomy/Pathophysiology

The shoulder is a complex joint whose primary actions include flexion and extension, internal and external rotation, and abduction and adduction. Its appearance is one of a ball-and-socket type joint. While described as the most complex joint in the human body, it may be better

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perceived as a complex made of multiple, interrelated units [1]. The shoulder complex is comprised of four specific joints (glenohumeral, sternoclavicular, acromioclavicular, and scapulothoracic joints) and four major ligaments (superior, middle, and inferior glenohumeral ligaments as well as coracohumeral ligament) [2]. The rotator cuff as well as multiple other surrounding musculature are critical for shoulder and upper extremity motion and stability. These joints, ligaments, and muscles work together in a synchronous fashion to produce coordinated movements of the upper extremity with strength and precision. Function of the upper extremity is primarily dependent on this shoulder complex with the goal being full use of the hand [1].

The subclavian artery continues as the axillary artery as it extends towards the upper extremity. The lateral margin of the first rib and teres major muscle mark the proximal and distal extent of the axillary artery, respectively. It is divided into three anatomic segments based on its relation to the pectoralis minor muscle. The first portion of the axillary artery, located proximal to the pectoralis minor muscle, gives rise to the superior thoracic artery. Branches of the second portion of the axillary artery, which is anatomically situated deep to the muscle, include the thoracoacromial and lateral thoracic artery. Distal to the pectoralis minor muscle lies the third portion of the axillary artery with its associated branches, the subscapular artery, anterior circumflex humeral artery (ACHA), and posterior circumflex humeral artery (PCHA).

The anterior and posterior circumflex humeral arteries wrap around the surgical neck of the humerus [3]. This renders the third portion of the axillary artery and these branches in a fairly fixed position relative to the humeral head and subject to its associated stressors. It is important to note that the ACHA provides the majority of the arterial supply to the humeral head. Intermittent axillary artery and branch artery compression via dynamic compression by the humeral head can lead to intimal injury, stenosis, and post stenotic dilation [4]. This dilation can progress to aneurysmal degeneration with the development of mural thrombus along the wall of the aneurysm. Sequelae involve anything from asymptomatic mural thrombus within an aneurysm to distal embolic phenomena to vessel occlusion.

Classically described ATOS suggests arterial injury at the level of the subclavian artery. In 1958, Lord and Rosati [5] first described injury of the axillary artery due to compression via the humeral head. There were few similar reports larger than a case series over the next 50 years detailing cases of axillary artery and/or axillary artery branch lesion variants of ATOS [6–10]. In an incidence study, dynamic compression of the third portion of the axillary artery was demonstrated via duplex ultrasonography in 83% of 92 extremities (of which, 19 of these subjects were major league baseball players) [11]. Only 7.6% of these demonstrated a stenosis estimated as >50%. This ATOS variant is primarily seen in overhead high performance athletes in sports such as baseball and volleyball given the extreme abduction and external rotation that is necessary for their athletic activities [12]. There are, as well, descriptions of compression of the axillary nerve and posterior circumflex humeral artery within the quadrilateral space termed quadrilateral space syndrome [13].

87.3 Evaluation and Management

Dynamic and intermittent axillary artery compression and/or injury can present along a wide spectrum, similar to subclavian artery injury secondary to ATOS. These symptoms can include anything from effort-induced arm pain to finger numbness, cold sensitivity, ulcerations, or digital gangrene. Given the rich collateral network around the shoulder girdle, it is quite uncommon for an acute axillary artery thrombosis to present with severe arm ischemia. Musculoskeletal pain, present in many young, active individuals, can mimic some of these more minor manifestations and, as such, can contribute to delays in diagnosis. Arterial duplex ultrasonography as well as contrast enhanced imaging (cross sectional imag-

ing with computed tomography angiography or magnetic resonance angiography of the chest and arm and/or upper extremity arteriogram) are necessary to delineate the level of arterial insult as well as evaluate for dynamic arterial compression in the event a clear lesion is not seen upon static imaging.

Dynamic compression and subsequent injury with aneurysmal degeneration of the ACHA, PCHA, or subscapular artery can lead to pain, thrombosis, distal embolization, and, infrequently, rupture. In these clinical settings, these arteries are most often managed via open exposure with vessel ligation. Vessel reconstruction is most often not necessary. Techniques describing exposure of the quadrilateral space are detailed in a separate chapter.

87.4 Summary

ATOS is classically seen after repeated injury to the subclavian artery within the thoracic outlet, development of aneurysmal degeneration in that location, and distal thromboembolic complications in the affected upper extremity. A variant of ATOS exists that involves stress on the axillary artery by the humeral head typically from repetitive overhead movements and can present very similarly to classic ATOS. Management involves branch vessel ligation and/or axillary artery repair as well as management of distal emboli.

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