

Quadrilateral Space Syndrome: The Mayo Clinic Experience With a New Classification System and Case Series

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Abstract

Quadrilateral space syndrome (QSS) arises from compression or mechanical injury to the axillary nerve or the posterior circumflex humeral artery (PCHA) as they pass through the quadrilateral space (QS). Quadrilateral space syndrome is an uncommon cause of paresthesia and an underdiagnosed cause of digital ischemia in overhead athletes. Quadrilateral space syndrome can present with neurogenic symptoms (pain and weakness) secondary to axillary nerve compression. In addition, repeated abduction and external rotation of the arm is felt to lead to injury of the PCHA within the QSS. This often results in PCHA thrombosis and aneurysm formation, with distal emboli. Because of relative infrequency, QSS is rarely diagnosed on evaluation of athletes with such symptoms. We report on 9 patients who presented at Mayo Clinic with QSS. Differential diagnosis, a new classification system, and the management of QSS are discussed, with a comprehensive literature review. The following search terms were used on PubMed: *axillary nerve*, *posterior circumflex humeral artery*, *quadrilateral space*, and *quadrangular space*. Articles were selected if they described patients with symptoms from axillary nerve entrapment or PCHA thrombosis, or if related screening or imaging methods were assessed. References available within the obtained articles were also pursued. There was no date or language restriction for article inclusion; 5 studies in languages besides English were reported in German, French, Spanish, Turkish, and Chinese.

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Quadrilateral space syndrome (QSS) arises from compression or mechanical injury to the axillary nerve (neurogenic quadrilateral space syndrome [nQSS]) and/or posterior circumflex humeral artery (PCHA) (vascular quadrilateral space syndrome [vQSS]) as they pass through the quadrilateral space (QS). The QS is bounded by the edge of the long head of the triceps medially, the medial edge of the surgical neck of the humerus laterally, the tendon of the teres major and latissimus dorsi muscles inferiorly, and the teres minor muscle or the scapulohumeral capsule superiorly^{1,2} (Supplemental Figure 1,³ available online at <http://www.mayoclinicproceedings.org>).

The term QSS was first coined by Cahill in 1980⁴ and then again in 1983 in a subsequent article describing several patients with axillary

nerve compression.⁵ McCarthy et al⁶ later reported partial occlusion of the PCHA in a baseball pitcher, with distal embolization to the right third digit, felt to be due to PCHA injury within the QS. Subsequently, QSS has been reported most commonly in overhead or “throwing” athletes in sports that heavily involve abduction and external rotation (AER), including volleyball,⁷⁻¹⁶ baseball,¹⁷⁻²² and swimming.^{23,24} Quadrilateral space syndrome has also been associated with other activities with frequent AER, such as yoga²⁵ or window cleaning.²⁶

Patients with QSS manifest with various symptoms (Figure 1). Neurogenic manifestations may include nondermatomal neuropathic pain, numbness, and weakness in the shoulder (usually posterior²⁷), often radiating down the arm. Vascular manifestations may



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ARTICLE HIGHLIGHTS

- Quadrilateral space syndrome (QSS) is a rare and underdiagnosed yet potentially debilitating neurovascular syndrome; physicians, particularly those treating elite athletes and perhaps those in sports medicine, vascular medicine, and neurology, should continue to pursue understanding of the recognition, differential diagnosis, discrimination, and prognosis of both neurogenic quadrilateral space syndrome (nQSS) and vascular quadrilateral space syndrome (vQSS).
- Fixed structural impaction of the quadrilateral space (QS) with space-occupying lesions or fibrous bands leads to nQSS with nondermatomal paresthesias and QS point tenderness.
- Repetitive mechanical injury to the posterior circumflex humeral artery (PCHA) as it passes through the tight QS and wraps around the humeral neck during abduction and external rotation leads to vQSS with PCHA thrombosis and/or aneurysm with distal embolization and digital ischemia.
- The prevalence of nQSS relative to vQSS is 1.5:1, with a male predominance (male/female ratio, 7:1) for all QSS, and an almost exclusive male population for vQSS (likely due to traditional sex distribution in overhead athletics).
- Posterior circumflex humeral artery ligation is used to surgically treat vQSS to prevent distal embolization, along with thrombolysis for acute thrombotic embolization. Surgical neurolysis and QS decompression are used to definitively treat nQSS.

include thrombosis, microembolism or macroembolism, digital or hand ischemia, and the full spectrum of signs and symptoms associated with acute ischemia such as pain, pallor, and absent pulses (Figure 1). Vascular manifestations are frequently not reported under the term QSS, but as “PCHA injury,”¹⁰ “compression syndrome of the PCHA,”⁹ “aneurysm of the PCHA,”^{8,11,25,28} “PCHA pathological lesions with digital ischemia,”⁷ or “Pitcher syndrome.”²⁵

We report a case series of 9 patients presenting to Mayo Clinic with nQSS or vQSS; patients 2 and 3 were previously reported.²⁹ Each patient underwent diagnosis and treatment according to the algorithm provided in Figure 1. For a comprehensive literature review on PubMed, we used the following search terms: *axillary nerve*, *posterior circumflex*

humeral artery, *quadrilateral space*, and *quadrangular space*. Articles were selected if they described patients with symptoms from axillary nerve entrapment or PCHA thrombosis, or if related screening or imaging methods were assessed. References available within the obtained articles were also pursued. There was no date or language restriction for article inclusion; 5 studies in languages besides English were reported in German, French, Spanish, Turkish, and Chinese.

CASE PRESENTATIONS

Patient 1: vQSS Due to PCHA Thrombosis and Distal Embolism

A 20-year-old right-handed female collegiate volleyball player presented with a 2-week history of paresthesias and purplish discoloration involving multiple digits of the right hand. She was a nonsmoker without known thrombophilia. Examination revealed a pale, cool right hand with splinter hemorrhages (Supplemental Figure 2A, available online at <http://www.mayoclinicproceedings.org>) and absent radial and ulnar pulses. No motor or sensory deficits were noted. Arterial Doppler signals at the wrist were reduced.

Computed tomography angiography (CTA) revealed multifocal occlusion of the right ulnar and common interosseous arteries with distal reconstitution, as well as long-segment occlusion of the right radial artery. There was no evidence of thoracic outlet arterial compression or aneurysm suggestive of a more proximal embolic source. She was anticoagulated with intravenous heparin. An arch angiogram with right upper extremity runoff confirmed the CTA findings (Figure 2) and revealed a thrombosed PCHA (Figure 3).

After 48 hours of catheter-directed thrombolysis, there was minimal improvement in flow to the hand. Surgical exploration revealed acute dissection with fresh thrombus in the PCHA. The thrombus was removed, and the PCHA was ligated. Embolectomy of the radial, ulnar, and interosseous arteries was performed (Supplemental Figure 2, B-D) on 2 different occasions. She was maintained on therapeutic anticoagulation. At 3 months, she continued to work with her volleyball trainer, with gradual improvement. An iatrogenic right femoral artery dissection from her angiogram

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