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An Evidence-based Review of Magnetic Resonance Angiography for Diagnosing Arterial Thoracic Outlet Syndrome

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ABSTRACT: Arterial thoracic outlet syndrome (TOS) can be difficult to diagnose clinically. Recently, Magnetic Resonance Angiography (MRA) has been used to assist in the diagnosis of arterial TOS. The purpose of this article is to survey the current literature to establish the evidence for or against the use of MRA in the diagnosis of arterial TOS. The evidence-based search was conducted using PubMed, PEDro, Hooked on Evidence, EBM Journals, Ovid, Cochrane, and E medicine. The studies were graded as to the strength of recommendation and to the actual level of evidence. Statistics were calculated when sufficient data were present. The search yielded a total of seven studies. The studies received grades of recommendation that ranged from B to D. The current evidence in support of MRA as a valid test for diagnosing arterial TOS is weak and studies are not based on strong design.
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DEVELOPING THE QUESTION

The first images produced with magnetic resonance (MR) were generated in the 1970s. Since this time, MR has been an important tool, valued for its clarity of imaging of soft tissue abnormality and pathology. Different techniques and various sequences (pulses) have been used and vary on the structures being imaged. In the 1990s, MR techniques were used to image the brachial plexus and the thoracic outlet.[1–10]

Although thoracic outlet syndrome (TOS) is not a rare condition, it is not often diagnosed accurately. According to Brantigan: ''thoracic outlet syndrome is a common condition that is recognized uncommonly because the manifestations are varied and there is no single definitive test.''[11] However, with the increase in cumulative trauma disorders related to highly repetitive tasks, the incidence of TOS seems to be increasing.[11] Because of the difficulty in making a diagnosis of TOS, objective diagnostic tests are needed, and recent studies have suggested the use of MR Angiography (MRA) to aid in the diagnosis of TOS.[7,9,12–16]

Individuals with TOS and other upper extremity disorders are commonly seen by physical and occupational therapists in the clinic. Therapists may perform provocative tests such as the Adson's, costoclavicular, and hyperabduction maneuvers as indicators of arterial TOS. However, such tests have high false-positive rates in the general population. Rayan and Jensen[17] found that a vascular response was present in 13.5% of the general population with performance of Adson's maneuver, 47% with the costoclavicular maneuver, and 57% with the hyperabduction maneuver. Plewa and Delinger[18] noted pulse alterations in 11% of the healthy population tested with Adson's maneuver, 11% with the costoclavicular maneuver, 62% with the EAST test (elevated arm stress test), and 21% with the supraclavicular pressure test. In a clinical setting, these tests would not provide absolute evidence of vascular TOS.

An accurate diagnosis is important to maximize treatment outcomes. Therapists must know how to apply the results of clinical testing as well as the results of diagnostic studies such as MRA to plan the proper intervention and establish an accurate prognosis. To date, there have been no evidence-based

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reviews of the literature to assess the strength of evidence for or against the use of MRA in the diagnosis of arterial TOS.

THE THORACIC OUTLET

The thoracic outlet can be divided into four sections (from distal to proximal): the pectoralis minor space, the costoclavicular space, the scalene triangle, and the sternocostovertebral space.[19] The pectoralis minor space lies between the insertion of the pectoralis minor tendon and the ribs of the chest wall. The costoclavicular space is formed between the clavicle and the first rib. The scalene triangle is created from the base of the first rib, the middle, and anterior scalene muscles. The sternoclavicular space is formed by the sternum anteriorly, the spine posteriorly, and the first rib laterally. The space is traversed by the subclavian vein, the subclavian artery, and the roots of the brachial plexus.[19] The spaces may be narrowed by anatomic variants that compromise the structures traversing the space.

TYPES OF TOS

According to Charon et al.[12], ''TOS refers to clinical manifestations attributable to impingement of the brachial plexus and the subclavian vessels as they pass from the thoracic cavity to the axilla''. TOS occurs three times more often in women than in men, though it is not known why.[11] The symptoms may occur spontaneously or may develop secondarily to repetitive overuse of the upper limb or from direct trauma. In more than 80% of individuals with TOS, the symptoms are preceded by some type of repetitive use or external trauma.[19]

Four types of TOS are described: arterial, venous, neurogenic, and disputed neurogenic. Arterial TOS involves compression of the subclavian artery and accounts for approximately 5% of all TOS surgeries.[20] However, arterial TOS is responsible for high numbers of TOS-associated disabilities, particularly neuropathic pain.[19] Boney anomalies, such as cervical ribs, have been associated with arterial TOS and injuries to the intima of the artery may occur as the artery is pressed against a hard edge.[19] Repeated trauma to the artery may cause focal stenosis, leading to stenotic dilatation, and finally to embolization and tissue loss.[12] Stenosis can also result from extrinsic arterial compression.[19] The symptoms of arterial TOS include pallor, pulselessness, and coolness of the upper extremity, and a blood pressure reading of 20 mm less than the opposite arm.[11] Tests that have been used in the diagnosis of arterial TOS include Duplex Ultra Sonography,[19,21] Computerized Tomography angiography,[11] angiography,[13] arteriography,[11,19] and more recently MRA.[7,9,11–16]

Venous TOS accounts for approximately 1.5% of all TOS cases.[11] There are a number of etiologies in the development of venous TOS, one of which may present as thrombosis of the subclavian vein, known as Paget-von Schrotter syndrome.[21] Venous thrombosis may also be caused by dehydration, malignancy, infection, glomerulonephritis, thromboangiitis obliterans, paroxysmal nocturnal hemoglobinuira, cryoglobulinemia, or polycythemia rubra vera.[22] The nonthrombolitic causes of venous TOS include subclavian vein compression within the thoracic outlet.[22] There is a greater incidence among younger men with a history of heavy work.[21] Aching and pain may be the initial symptoms,[22] and other symptoms include edema and cyanosis of the upper extremity,[11] and distended superficial veins of chest and shoulder.[22] The diagnostic tests for venous TOS include color flow Duplex Ultra Sonography,[19,21] venography,[19,21] and MR Venography (MRV).[11]

Neurogenic TOS accounts for 98% of all TOS cases and is seen most often in females.[11] Classic symptoms are very characteristic. The individual may present with atrophy of the abductor pollicis brevis, interossei, and hypothenar muscles (Gilliatt-Sumner hand),[23] and other symptoms that include a sensory loss or paresthesia of the ulnar arm and forearm including the fourth and fifth digit.[22] There may also be a dull, aching nondermatomal pain in the cervical spine, shoulder, axilla, scapula, and the inner aspect of arm. This pain is often aggravated by repetitive use and overhead activities.[21] In addition, irritation of the symptoms may also occur from stretching of the brachial plexus and with carrying.[22] Diagnostic tests include nerve conduction velocity,[11,19,23] electromyography,[11,19,23] and MR Neurography (MRN). The clinical diagnosis may be made by progressive neural tension testing.[11]

The diagnosis of disputed neurogenic TOS remains controversial.[2] The epidemiology may be related to geographical location, type of insurance, age, and gender. Prevalence is three to four times more likely in women.[23] Symptoms include cervico-brachial neuralgia and hand paresthesia, which is aggravated by arm elevation.[24] The disputed form of neurogenic TOS accounts for approximately 90% of all TOS operations. However, diagnostic tests are generally negative.[23]

ANOMALIES OF THE THORACIC OUTLET

The spatial dimensions of the thoracic outlet may be reduced by the presence of variants or anomalies, systemic and local diseases, or pathologic muscular function.[11,25] Anomalies of the thoracic outlet are well documented and may predispose an individual to the development of TOS.[11] Rusnak-Smith et al.[26]