Multidetector CT in the Evaluation of Thoracic Outlet Syndrome in Children

Introduction

Thoracic outlet syndrome (TOS) is an entity often associated with rib anomalies in the pediatric population. Evaluation with Doppler ultrasonography and conventional angiography are complementary tools to document the significance of vascular compromise related to rib anomalies. Multidetector CT (MDCT) with planar reformating can provide additional valuable information for both diagnosis and surgical planning.

Background

The subclavian vessels and brachial plexus pass through three narrow passageways. The most proximal of these is the interscalene triangle, which is bordered by the anterior scalene muscle anteriorly, the middle scalene muscle posteriorly, and the medial surface of the first rib inferiorly. This area may be abnormal and may become more so with provocative maneuvers. Anomalous structures, such as fibrous bands, cervical ribs, and thymic remnants, may also be present.

The second passageway is the costoclavicular triangle, which is bordered anteriorly by the first rib, posteriorly by the first rib, and superiorly by the upper border of the scapula. The test nomenclature of the subclavicular space toward the conoid process just deep to the pectoralis minor tendon.

In adults, the majority of patients present with neurogenic symptoms (80%). Vascular compression contributes 2% to 3% of cases and arterial compression contributes 0.5% to 2%. Data for the pediatric population are less well reported. One series of 100 patients between the ages of 12 and 19 years reported 11 patients with venous manifestations, 11 with neurological symptoms, and 63 with arterial symptoms. A second patient case series reported various manifestations in 6 of 10 patients.

In adults, TOS is most associated with occupational activity involving overhead work or computer use. In the pediatric population, TOS is more commonly found in athletes who engage in repetitive overhead maneuvers such as baseball or tennis or computer use in non-ergonomic postures, as well as prior trauma. In older teenagers, TOS is associated with poor posture and elevation of the scapula.

Anatomic and schematic depiction of the thoracic outlet. The interscalene and costoclavicular triangles are indicated by green and blue shading, respectively.

Evaluation of TOS

Clinical history should direct the approach to diagnosis of TOS. Clinical nystagmy may demarcate a cervical rib, rib anomaly, or clavicular deformity.

Continuous wave Doppler ultrasonography is useful to evaluate arterial compromise in postures which produce the symptoms of concern. US is effective in confirming vascular compromise, and allows non-invasive sequential patient positioning in order to more accurately replicate the symptomatic posture. US does not adequately define the osseous and muscular anatomy of the thoracic outlet, however, and does not precisely localize the location of vascular compression.

MDCT imaging, with its excellent soft tissue contrast, is ideal for the evaluation of neurovascular TOS. Sequences may be performed with the arm in neutral and maximally abducted positions. Loss of planes between the subclavian and subclavicular vessels is suggestive of osseous compression. The MDCT data may also be used for volume rendering for surgical planning.

Rib Anomalies

We have encountered multiple patients with similar first rib anomalies. In these cases, the first rib is a hypoplastic and terminates in a pseudarticulation with the lateral aspect of the second rib. Three successive cases from our institution are presented here. Two of these patients recently received clinical diagnoses of TOS.

Case 1

A 12-year-old white male presents with positional right upper extremity pain over the past year. During running, certain activities, and certain sleep postures, his pain is increased over his shoulder. Clinical examination demonstrated loss of the radial and ulnar artery pulses to maximal abduction.放射线学的研究提示，动脉性症状在右肩屈和前屈位置时在造影剂中显示。CT arteriography demonstrated right subclavian artery in a pseudoarticulation with its second rib. There was no evidence of an arterial pseudoarticulation but pseudoarticulation with a rib was identified.

Case 2

A 3-year-old male presents with positional right upper extremity pain over the past year. During running, certain activities, and certain sleep postures, his pain is increased over his shoulder. Clinical examination demonstrated loss of the radial and ulnar artery pulses to maximal abduction.放射线学的研究提示，动脉性症状在右肩屈和前屈位置时在造影剂中显示。CT arteriography demonstrated right subclavian artery in a pseudoarticulation with its second rib. There was no evidence of an arterial pseudoarticulation but pseudoarticulation with a rib was identified.

Case 3

A 4-year-old male presented with a palpable and tender supraclavicular mass. The patient promptly responded to a provocative maneuver of the upper extremity, emphasizing the importance of clinical history for the radiologic diagnosis of TOS.

Conclusion

MDCT with provocative maneuvers as a primary diagnostic modality for TOS has been well documented in the adult population. Pediatric literature largely focuses upon doppler sonography and MRI angiography in evaluating suspect vascular etiologies of thoracic outlet syndrome.

As seen in adults, however, MDCT with 3D reconstruction and multiplanar reformats offers several advantages for diagnosis and surgical planning with its more complete depiction of the intricate anatomy of the complete region. In the pediatric population, these advantages may prove more significant. The current literature suggests that MDCT is more often used for vascular compromise compared with the adult population. Pediatric TOS is considered less specific due to the high incidence of venous compression.

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In the presented cases, congenital defects were frequently associated with abnormal course of the scalene muscle. Though the anatomy is asymptomatic in some patients, two of our patients presented with signs of TOS. MDCT with multidetector reformats allowed the examining of the spaces of the thoracic outlet by osseous and muscular structures. The degree of osseous detail MDCT is difficult to obtain with MRI. CT reconstructions delineated the anatomy and allowed the surgical team to plan a surgical procedure before surgical exploration was performed, as conventional surgical techniques for TOS may need modification.

MDCT can play a key role in the evaluation and management of pediatric TOS. In these cases of suspected vascular TOS, MDCT can play a valuable role because both vascular and congenital osseous deformities can be accurately delineated. MDCT can provide benefit over other commonly used modalities.

References


