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NATIONAL GUIDELINE CLEARINGHOUSE

General

Guideline Title

ACR Appropriateness Criteria® imaging in the diagnosis of thoracic outlet syndrome.

Bibliographic Source(s)

Moriarty JM, Bandyk DF, Broderick DF, Cornelius RS, Dill KE, Francois CJ, Gerhard-Herman MD, Ginsburg ME, Hanley M, Kalva SP, Kanne JP, Ketai LH, Majdalany BS, Ravenel JG, Roth CJ, Saleh AG, Schenker MP, Mohammed TLH, Rybicki FJ, Expert Panels on Vascular Imaging, Neurologic Imaging and Thoracic Imaging. ACR Appropriateness CriteriaÂ® imaging in the diagnosis of thoracic outlet syndrome [online publication]. Reston (VA): American College of Radiology (ACR); 2014. 8 p. [50 references]

Guideline Status

This is the current release of the guideline.

Recommendations

Major Recommendations

ACR Appropriateness Criteria®

Clinical Condition: Imaging in the Diagnosis of Thoracic Outlet Syndrome

Radiologic Procedure	Rating	Comments	RRL*
X-ray chest	8		
MRA chest without and with contrast	8	See statement regarding contrast in the text below under "Anticipated Exceptions."	O
CTA chest with contrast	7		
MRI chest without contrast	7		O
US duplex Doppler subclavian artery and vein	6		O
Digital subtraction angiography upper	5		*Relative

Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

extremity.

Radiologic Procedure	Rating	Comments	RRL*
CT chest without contrast	3		
MRA chest without contrast	2		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Note: Abbreviations used in the table are listed at the end of the "Major Recommendations" field.

Summary of Literature Review

Introduction/Background

Thoracic outlet syndrome (TOS) is a clinical entity characterized by compression of the neurovascular bundle of the upper limb as it passes from the upper thoracic aperture to the axilla. Although thrombosis of the axillosubclavian vein was first reported by Paget in 1875 and Von Schroetter in 1884, and was coined "Paget-Schroetter syndrome" by Hughes in 1949, the term "Thoracic Outlet Syndrome" was coined in the 1950s to reflect the fact that TOS has many variants, ranging from vascular involvement of the subclavian artery (SCA) or vein (SCV) to the more common neurogenic form with compression of the brachial plexus.

TOS most commonly occurs in females (4:1) between the ages of 20 and 40. The site of compression occurs either at the interscalene triangle, the costoclavicular space, or the retropectoralis minor space. However, as the thoracic outlet is defined anatomically as the interscalene space, and compression is most common at this site, it has been proposed to more precisely categorize patients into TOS, costoclavicular and pectoralis minor subtypes. Both congenital and acquired etiologies may play a role, including bony issues such as first rib abnormalities, cervical ribs and bony tubercles, and soft-tissue anomalies such as fibrous bands, cervical muscle hypertrophy, or postural problems such as drooping or sagging of the shoulders.

Symptomatology will vary depending on the site of compression and the nature of the compressed structure; clinically, patients can be divided into neurogenic, arterial, venous, mixed (neurogenic and vascular), and nonspecific subtypes. Neurogenic symptoms are most common, accounting for greater than 90% of all TOS cases. In neurogenic TOS (nTOS), compression of the peripheral nerves of the brachial plexus gives rise to pain, paresthesia, dysesthesia, or weakness in the upper limb. Vascular involvement may present with swelling, edema, skin changes, or upper limb weakness and fatigue on exercise. This diverse presentation makes the true incidence of TOS unknown, although it has been estimated as 5 per 100,000.

Evaluation of potential TOS comprises a careful examination to discern any arterial, venous, or neurologic compromise. To this end, evaluation of peripheral pulses and pressures is followed by neurologic testing using compressive or provocative tests such as Tinel sign, Adson test, Roos test, Wright test, and the hyperabduction maneuver. Radiography (to evaluate for cervical ribs or first rib bony spurs) and electrodiagnostic tests such as brachial plexus neurography are typically performed prior to further imaging.

The goal of further imaging is to confirm the diagnosis of TOS, exclude mimics such as cervical spondylosis or shoulder joint or lung apex pathology, allow accurate classification into nTOS versus venous (Paget-Schroetter) versus arterial TOS, and guide treatment selection to minimize morbidity and mortality. Complications of vascular involvement include arterial compression leading to limb ischemia, or embolic phenomena from arterial thrombosis causing stroke or digital ischemia. With venous involvement, deep venous thrombosis (DVT) can lead to postphlebitic limb, with the feared complications of phlegmasia cerulea dolens and venous gangrene in severe cases. The risk of pulmonary embolism (PE) in upper-limb DVT is controversial, with some authors stating that the risk of incidence of PE attributable to previously documented upper extremity DVT is very small (1%) regardless of anticoagulant therapy, whereas other authors postulate a risk of PE of up to 9%.

Treatment of TOS is based on the causing etiology, the symptom complex, and the presence of complications at the time of diagnosis. In venous TOS the role of venous thrombolysis prior to surgical decompression has gained widespread favor, although the timing of subsequent surgery remains debatable. Although surgical first rib resection, via either an anterior or transaxillary approach, remains the gold standard for decompression of TOS, minimally invasive methods of treatment of nTOS, including scalene blocks or botulinum toxin injection with either ultrasound (US) or computed tomography (CT) guidance, are gaining favor.

Overview of Imaging Modalities

The goal of imaging, regardless of modality, is to localize the site of compression, the compressing structure, and the compressed organ or vessel. By convention, abduction of the upper limb has been shown to be relevant in diagnosing TOS and is thus chosen as the postural maneuver of choice for cross-sectional imaging. In the abduction of the upper limb, narrowing of the subclavian vessel is considered significant if the percentage change of the vessel's diameter between the neutral and the abducted positions is 30% or greater for the SCA and 50% or greater for the SCV.

Digital Subtraction Angiography

Although historically direct arteriography or venography would have been considered the gold standard for evaluation of extrinsic compression of the subclavian vessels, the lack of visualization of the impinging structure and nonvisualization of neurologic structures means digital subtraction angiography and venography is almost exclusively reserved for intraprocedural interventional guidance.

Chest Radiography

Chest radiographs are frequently used as an initial imaging modality in suspected TOS due to the ease of access, safety profile, low cost, and the ability to evaluate several of the osseous abnormalities associated with TOS. These include first rib anomalies, cervical ribs, congenital osseous malformations, and focal bone lesions. Soft-tissue lesions, such as lung neoplasms, may also be evaluated, although the negative predictive value of chest radiography is debatable.

Ultrasound

US is widely used as a cost-effective, safe, and quick imaging modality in the initial evaluation of patients with either arterial or venous pathology throughout the body. Real-time duplex US is noninvasive and can be easily performed during dynamic maneuvers.

The technique involves B-mode US and Doppler study of the subclavian vessels, typically performed at rest (neutral position) and with provocative maneuvers such as Adson, Eden, and 90° Wright tests. These tests were considered positive if they produced flow acceleration followed by turbulence and, finally, by an arrest in signal propagation. Evaluation of the cross-sectional area of the costocervical space may also be performed. For venous TOS, US has a longstanding and well-documented role in the diagnosis of upper extremity DVT.

However, although the main advantage of US is the ability to directly compare between provocatively induced symptoms and concurrent direct vessel visualization, there is debate in the literature as to the significance of imaging findings, particularly with respect to maneuvers to minimize the thoracic outlet and associated spaces as described above. Moreover, although visualization of the vessels is a strength of US, sonographic diagnosis of compressive effects upon the brachial plexus is a challenge, and symptoms of TOS may unmask a deeper regional pathology such as Pancoast tumor or cervical spondylopathy, requiring further imaging.

Computed Tomography Angiography

Contrast-enhanced CT evaluation of TOS is typically performed as a 2-step procedure in which initial "neutral" images are obtained from elbow to aortic arch with the arms adducted to the side, followed by abduction and repeat imaging in an effort to reproduce the neurovascular compression seen on provocative maneuvers. Some centers add the additional step of placing the contralateral arm in abduction (with the symptomatic ipsilateral arm in the neutral position) in order to minimize streak artifact. Scan acquisition is typically performed with a contralateral antecubital injection of contrast material, with either an empiric scan delay of 15 to 20 seconds or bolus tracking over the ascending aorta.

Multiple studies have demonstrated the utility of CT in evaluation of the upper-limb arteries and veins; however, reliance on axial slices alone can lead to misrepresentation of the degree of any stenosis, with one study showing underestimation of stenosis found in 43% of transverse CT scans but only 10% of sagittal reformations. Overestimation of stenosis was also more frequent on surface displays with 3-dimensional (3-D) shading (16%) than on volume-rendered images (7%), advancing the case for evaluation of these studies on vascular workstations. Beyond the vessels themselves, CT allows quantification of the change in costoclavicular or interscalene spaces with provocative maneuvers, the presence of bony abnormalities, or superior sulcus pathology.

The efficacy of CT in evaluation of TOS depends greatly on the classification. For arterial compression, there is evidence of good correlation of CT findings with operative findings and results of decompression. However, venous findings are less predictive due to the prevalence of compression of the vein frequently seen in all compartments of the thoracic outlet after arm abduction. CT for the evaluation of nTOS is limited by the lack of contrast resolution of neural structures, although evaluation of the space sizes gives secondary indicators that may aid in diagnosis.

Magnetic Resonance Imaging (MRI)/Magnetic Resonance Angiography (MRA)

MRI is now a widely available and utilized modality for reliable, reproducible, noninvasive, and nonionizing evaluation of the vasculature, nervous system, and soft tissues. MRI has inherent advantages over US in its ability to delineate extravascular anatomy, particularly in anatomic sites with poor sonographic windows, and it has advantages over CT in its characterization and differentiation of soft tissues. MRI does, however, have

contraindications and is not recommended in certain patients, such as the very obese, claustrophobic, or those with MRI unsafe devices.

MRI has been shown to accurately demonstrate upper-limb arterial and venous thrombus, using both contrast-enhanced and noncontrast sequences. Typically MRI for TOS is performed with high-resolution T1-weighted and T2-weighted sequences in sagittal and axial planes to delineate anatomy and evaluate cervical radiculopathy, the brachial plexus, muscular attachments, and sites of compression. Evaluation of the vasculature is then performed in both neutral and arms-abducted positions. Noncontrast-enhanced MRI can be sufficient to diagnose nTOS. This is the most common variant of TOS and may be the sole manifestation of the syndrome or occur in conjunction with vascular obstruction. In patients with nTOS, sagittal T1-weighted imaging performed with patient's arms in abduction typically demonstrates effacement of fat adjacent to the brachial plexus roots, trunks, or cords within the interscalene triangle or costoclavicular space. T1-weighted imaging performed in sagittal and axial planes can also demonstrate causative lesions of nTOS, including cervical ribs, congenital fibromuscular anomalies, and muscular hypertrophy (e.g., subclavius muscle). Imaging with turbospin echo T2-weighted or short tau inversion recovery sequences can be useful in cases where spinal cord lesions or primary disorders of the brachial plexus (e.g., brachial plexitis) are considered as alternative diagnoses to nTOS.

For noncontrast time-of-flight (TOF) imaging, a saturation band can then be applied medial to the imaging slice for the SCV, lateral for the artery, and since no intravenous contrast is required, a potential advantage of TOF imaging is the ability to repeat acquisitions in different stress positions without venous contamination. Among the limitations of noncontrast imaging are intraluminal filling defects related to flow or in-plane saturation effects. Hence the majority of MRA/MR venography (MRV) for TOS is performed with contrast-enhanced sequences. A recently published study described a protocol on either 1.5-T or 3.0-T MRI scanners whereby breath-hold arterial and venous-phase contrast-enhanced 3-D MRA and MRV/equilibrium-phase images were obtained with a 3-D gradient-echo pulse sequence with fat suppression. Images were obtained in both the arms-abducted and neutral positions. Extracellular contrast agents were used, although blood pool agents, although perhaps limiting pure angiographic rendering in both positions, may facilitate a high-quality venous and arterial study. Use of open scanners for evaluation of TOS has also been reported.

Use of either contrast-enhanced or noncontrast imaging depends on factors such as patient renal and respiratory function and expertise of the radiologist. However, although both forms of MRA may demonstrate TOS with significant arterial impingement, in comparison with TOF sequences contrast-enhanced MRA generally offers extensive vessel coverage, is less prone to artifact, and more frequently demonstrates the underlying cause of TOS when studies are reformatted. Several studies have demonstrated excellent utility of contrast-enhanced MRA in showing a significant difference in MRA/MRV findings between the neutral and provocative positions. Of note, however, care is needed as compression of vessels, particularly the vein, can be seen in up to 47% of normal patients with dynamic maneuvers, so clinical evaluation and correlation is vital.

Summary

- TOS is characterized by compression of the neurovascular bundle as it passes from the upper thorax to the axilla. There are arterial, venous, and neurogenic forms.
- It may be congenital or acquired and may be secondary to bony issues such as first rib abnormalities, cervical ribs and bony tubercles, or soft-tissue anomalies such as fibrous bands or cervical muscle hypertrophy.
- The goal of further imaging is to confirm the diagnosis of TOS, exclude mimics such as cervical spondylosis or shoulder joint or lung apex pathology, allow accurate classification into neurogenic TOS versus venous (Paget-Schroetter) versus arterial TOS, and guide treatment selection to minimize morbidity and mortality.
- Abduction of the upper limb has been shown to be relevant in diagnosing TOS and thus is the postural maneuver of choice for cross-sectional imaging.
- Digital subtraction angiography, US, CTA, and MRA may allow evaluation of vascular structures and the secondary effects of compression, whereas CT and MR allow identification and evaluation of surrounding neurologic, soft-tissue, and bony structures.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m^2), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m^2. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

Abbreviations

- CT, computed tomography
- CTA, computed tomography angiography
- MRA, magnetic resonance angiography
- MRI, magnetic resonance imaging
- US, ultrasound

Relative Radiation Level Designations

Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
	<0.1 mSv	<0.03 mSv
	0.1-1 mSv	0.03-0.3 mSv
	1-10 mSv	0.3-3 mSv
	10-30 mSv	3-10 mSv
	30-100 mSv	10-30 mSv
*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (e.g., region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as "Varies."		

Clinical Algorithm(s)

Algorithms were not developed from criteria guidelines.

Scope

Disease/Condition(s)

Thoracic outlet syndrome

Guideline Category

Diagnosis

Evaluation

Clinical Specialty

Family Practice

Internal Medicine

Neurology

Radiology

Surgery

Thoracic Surgery

Intended Users

Health Plans

Hospitals

Managed Care Organizations

Physicians

Utilization Management

Guideline Objective(s)

To evaluate the appropriateness of initial radiologic examinations for patients with suspected thoracic outlet syndrome

Target Population

Patients with suspected thoracic outlet syndrome

Interventions and Practices Considered

1. X-ray chest
2. Magnetic resonance angiography (MRA) chest
    - Without and with contrast
    - Without contrast
3. Computed tomography angiography (CTA) chest with contrast
4. Magnetic resonance imaging (MRI) chest without contrast
5. Ultrasound (US) duplex Doppler subclavian artery and vein
6. Digital subtraction angiography upper extremity
7. Computed tomography (CT) chest without contrast

Major Outcomes Considered

Utility of radiologic examinations in diagnosing thoracic outlet syndrome

Methodology

Methods Used to Collect/Select the Evidence

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Literature Search Procedure

Staff search in PubMed only for peer reviewed medical literature for routine searches. Any article or guideline may be used by the author in the narrative but those materials may have been identified outside of the routine literature search process.

The Medline literature search is based on keywords provided by the topic author. The two general classes of keywords are those related to the condition (e.g., ankle pain, fever) and those that describe the diagnostic or therapeutic intervention of interest (e.g., mammography, MRI).

The search terms and parameters are manipulated to produce the most relevant, current evidence to address the American College of Radiology Appropriateness Criteria (ACR AC) topic being reviewed or developed. Combining the clinical conditions and diagnostic modalities or therapeutic procedures narrows the search to be relevant to the topic. Exploding the term "diagnostic imaging" captures relevant results for diagnostic topics.

The following criteria/limits are used in the searches.

1. Articles that have abstracts available and are concerned with humans.
2. Restrict the search to the year prior to the last topic update or in some cases the author of the topic may specify which year range to use in the search. For new topics, the year range is restricted to the last 10 years unless the topic author provides other instructions.
3. May restrict the search to Adults only or Pediatrics only.
4. Articles consisting of only summaries or case reports are often excluded from final results.

The search strategy may be revised to improve the output as needed.

Number of Source Documents

The total number of source documents identified as the result of the literature search is not known.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Study Quality Category Definitions

Category 1 - The study is well-designed and accounts for common biases.

Category 2 - The study is moderately well-designed and accounts for most common biases.

Category 3 - There are important study design limitations.

Category 4 - The study is not useful as primary evidence. The article may not be a clinical study or the study design is invalid, or conclusions are based on expert consensus. For example:

a. The study does not meet the criteria for or is not a hypothesis-based clinical study (e.g., a book chapter or case report or case series description).
b. The study may synthesize and draw conclusions about several studies such as a literature review article or book chapter but is not primary evidence.
c. The study is an expert opinion or consensus document.

Methods Used to Analyze the Evidence

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

The topic author drafts or revises the narrative text summarizing the evidence found in the literature. American College of Radiology (ACR) staff draft an evidence table based on the analysis of the selected literature. These tables rate the strength of the evidence (study quality) for each article included in the narrative text.

The expert panel reviews the narrative text, evidence table, and the supporting literature for each of the topic-variant combinations and assigns an appropriateness rating for each procedure listed in the table. Each individual panel member assigns a rating based on his/her interpretation of the available evidence.

More information about the evidence table development process can be found in the ACR Appropriateness Criteria® Evidence Table Development document (see the "Availability of Companion Documents" field).

Methods Used to Formulate the Recommendations

Expert Consensus (Delphi)

Description of Methods Used to Formulate the Recommendations

Rating Appropriateness

The appropriateness ratings for each of the procedures included in the Appropriateness Criteria topics are determined using a modified Delphi methodology. A series of surveys are conducted to elicit each panelist's expert interpretation of the evidence, based on the available data, regarding the appropriateness of an imaging or therapeutic procedure for a specific clinical scenario. American College of Radiology (ACR) staff distributes surveys to the panelists along with the evidence table and narrative. Each panelist interprets the available evidence and rates each procedure. The surveys are completed by panelists without consulting other panelists. The appropriateness rating scale is an ordinal scale that uses integers from 1 to 9 grouped into three categories: 1, 2, or 3 are in the category "usually not appropriate"; 4, 5, or 6 are in the category "may be appropriate"; and 7, 8, or 9 are in the category "usually appropriate." Each panel member assigns one rating for each procedure for a clinical scenario. The ratings assigned by each panel member are presented in a table displaying the frequency distribution of the ratings without identifying which members provided any particular rating.

If consensus is reached, the median rating is assigned as the panel's final recommendation/rating. Consensus is defined as eighty percent (80%) agreement within a rating category. A maximum of three rounds may be conducted to reach consensus. Consensus among the panel members must be achieved to determine the final rating for each procedure.

If consensus is not reached, the panel is convened by conference call. The strengths and weaknesses of each imaging procedure that has not reached consensus are discussed and a final rating is proposed. If the panelists on the call agree, the rating is proposed as the panel's consensus. The document is circulated to all the panelists to make the final determination. If consensus cannot be reached on the call or when the document is circulated, "No consensus" appears in the rating column and the reasons for this decision are added to the comment sections.

This modified Delphi method enables each panelist to express individual interpretations of the evidence and his or her expert opinion without excessive influence from fellow panelists in a simple, standardized and economical process. A more detailed explanation of the complete process can be found in additional methodology documents found on the ACR Web site (see also the "Availability of Companion Documents" field).

Rating Scheme for the Strength of the Recommendations

Not applicable

Cost Analysis

A formal cost analysis was not performed and published cost analyses were not reviewed.

Method of Guideline Validation

Internal Peer Review

Description of Method of Guideline Validation

Criteria developed by the Expert Panels are reviewed by the American College of Radiology (ACR) Committee on Appropriateness Criteria.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

The recommendations are based on analysis of the current literature and expert panel consensus.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

Selection of appropriate radiologic imaging procedures for evaluation and diagnosis of patients with thoracic outlet syndrome (TOS)

Potential Harms

Reliance on axial slices alone in computed tomography (CT) evaluation of the upper-limb arteries and veins can lead to misrepresentation of the degree of any stenosis (underestimation or overestimation).

Gadolinium-Based Contrast Agents

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (i.e., <30 mL/min/1.73 m^2), and almost never in other patients. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73 m^2. For more information, please see the American College of Radiology (ACR) Manual on Contrast Media (see the "Availability of Companion Documents" field).

Relative Radiation Level

Potential adverse health effects associated with radiation exposure are an important factor to consider when selecting the appropriate imaging procedure. Because there is a wide range of radiation exposures associated with different diagnostic procedures, a relative radiation level (RRL) indication has been included for each imaging examination. The RRLs are based on effective dose, which is a radiation dose quantity that is used to estimate population total radiation risk associated with an imaging procedure. Patients in the pediatric age group are at inherently higher risk from exposure, both because of organ sensitivity and longer life expectancy (relevant to the long latency that appears to accompany radiation exposure). For these reasons, the RRL dose estimate ranges for pediatric examinations are lower as compared to those specified for adults. Additional information regarding radiation dose assessment for imaging examinations can be found in the ACR Appropriateness Criteria® Radiation Dose Assessment Introduction document (see "Availability of Companion Documents" field).

Contraindications

Contraindications

Magnetic resonance imaging (MRI) has contraindications and is not recommended in certain patients, such as the very obese, claustrophobic, or those with MRI unsafe devices.

Qualifying Statements

Qualifying Statements

The American College of Radiology (ACR) Committee on Appropriateness Criteria and its expert panels have developed criteria for determining appropriate imaging examinations for diagnosis and treatment of specified medical condition(s). These criteria are intended to guide radiologists, radiation oncologists and referring physicians in making decisions regarding radiologic imaging and treatment. Generally, the complexity and severity of a patient's clinical condition should dictate the selection of appropriate imaging procedures or treatments. Only those examinations generally used for evaluation of the patient's condition are ranked. Other imaging studies necessary to evaluate other co-existent diseases or other medical consequences of this condition are not considered in this document. The availability of equipment or personnel may influence the selection of appropriate imaging procedures or treatments. Imaging techniques classified as investigational by the U.S. Food and Drug Administration (FDA) have not been considered in developing these criteria; however, study of new equipment and applications should be encouraged. The ultimate decision regarding the appropriateness of any specific radiologic examination or treatment must be made by the referring physician and radiologist in light of all the circumstances presented in an individual examination.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

Living with Illness

IOM Domain

Effectiveness

Identifying Information and Availability

Bibliographic Source(s)

Moriarty JM, Bandyk DF, Broderick DF, Cornelius RS, Dill KE, Francois CJ, Gerhard-Herman MD, Ginsburg ME, Hanley M, Kalva SP, Kanne JP, Ketai LH, Majdalany BS, Ravenel JG, Roth CJ, Saleh AG, Schenker MP, Mohammed TLH, Rybicki FJ, Expert Panels on Vascular Imaging, Neurologic Imaging and Thoracic Imaging. ACR Appropriateness CriteriaÂ® imaging in the diagnosis of thoracic outlet syndrome [online publication]. Reston (VA): American College of Radiology (ACR); 2014. 8 p. [50 references]

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2014

Guideline Developer(s)

American College of Radiology - Medical Specialty Society

Source(s) of Funding

The American College of Radiology (ACR) provided the funding and the resources for these ACR Appropriateness Criteria®.

Guideline Committee

Committee on Appropriateness Criteria, Expert Panels on Vascular Imaging, Neurologic Imaging and Thoracic Imaging

Composition of Group That Authored the Guideline

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Financial Disclosures/Conflicts of Interest

Not stated

Guideline Status

This is the current release of the guideline.

Guideline Availability

Electronic copies: Available from the American College of Radiology (ACR) Web site .

Print copies: Available from the American College of Radiology, 1891 Preston White Drive, Reston, VA 20191. Telephone: (703) 648-8900.

Availability of Companion Documents

The following are available:

- ACR Appropriateness Criteria®. Overview. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available from the American College of Radiology (ACR) Web site .
- ACR Appropriateness Criteria®. Literature search process. Reston (VA): American College of Radiology; 2013 Apr. 1 p. Electronic copies: Available from the ACR Web site .
- ACR Appropriateness Criteria®. Evidence table development – diagnostic studies. Reston (VA): American College of Radiology; 2013 Nov. 3 p. Electronic copies: Available from the ACR Web site .
- ACR Appropriateness Criteria®. Radiation dose assessment introduction. Reston (VA): American College of Radiology; 2103 Nov. 3 p. Electronic copies: Available from the ACR Web site .
- ACR Appropriateness Criteria®. Manual on contrast media. Reston (VA): American College of Radiology; 90 p. Electronic copies: Available from the ACR Web site .
- ACR Appropriateness Criteria®. Procedure information. Reston (VA): American College of Radiology; 1 p. Electronic copies: Available

from the ACR Web site .

- ACR Appropriateness Criteria® imaging in the diagnosis of thoracic outlet syndrome. Evidence table. Reston (VA): American College of Radiology; 2014. 21 p. Electronic copies: Available from the ACR Web site .

Patient Resources

None available

NGC Status

This NGC summary was completed by ECRI Institute on July 31, 2014.

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