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2024 Magnetic Resonance Angiography/ Magnetic Resonance Venography (MRA/ MRV) Chest

Diagnostic Imaging

MRA-Chest-HH

Last Review Date: 12/09/2024
Previous Review Date: 10/28/2024
Guideline Initiated: 06/30/2019

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Magnetic Resonance Angiography/Magnetic Resonance Venography (MRA/MRV) Chest

MRA Contraindications

An MRA may be contraindicated for **ANY** of the following:

- Safety, related to clinical status (eg, body mass index exceeds MR capability, intravascular stents within recent 6 weeks)
  References: [10] [31] [23] [16] [5]
- Safety, related to contrast (eg, allergy, renal impairment)
  References: [10] [31] [23] [16] [5]
- Safety, related to implanted devices (aneurysm clip, cochlear implant, insulin pump, spinal cord stimulator)
  References: [10] [31] [23] [16] [5]

IMPORTANT
Some implanted devices that were once absolute contraindications to a MRI, may now be accepted. Considerations include if the MRI is able to accommodate the device, or the device is deemed safe for MRI.

NCD 220.2
See also, **NCD 220.2**: Magnetic Resonance Imaging at https://www.cms.gov/medicare-coverage-database/search.aspx *if applicable to individual's healthplan membership*.

Preamble: Pediatric Diagnostic Imaging

HealthHelp's clinical guidelines for the Diagnostic Imaging program, are intended to apply to both adults and pediatrics (21 years of age or younger), unless otherwise specified within the criteria.

MRA/MRV Chest Guideline

Magnetic resonance angiography/magnetic resonance venography (MRA/MRV) of the chest for evaluation of intrathoracic blood vessels is considered medically appropriate when the documentation demonstrates **ANY** of the following:

1. Arterial occlusion of the upper extremity is known **AND** embolic source is suspected.
2. Congenital malformations (all ages) evaluation with **ANY** of the following:
    a. Congenital heart disease **AND** pulmonary hypertension **OR** vascular anomalies
    b. Pulmonary sequestration
    c. Thoracic malformation is suspected, based on prior imaging (eg, chest x-ray, echocardiogram [ECHO], gastrointestinal study) **OR** computed tomography (CT) is non-diagnostic or indeterminate. [4]

    References: [26] [15] [12] [20]
3. Peri-procedural chest intervention evaluation of **ANY** of the following:
    a. Atrial fibrillation **AND** ablation is planned.
    b. Open aortic vascular repair, with **NO** residual aortopathy: follow-up within 1st post-op year, then every 5 years (*__NOTE__: *if residual aortopathy is present, or surveillance findings are abnormal, follow-up annually*.)
    c. Pre-operative evaluation for a planned chest surgery or procedure or post-operative evaluation for suspected complications.
    d. Thoracic endovascular aortic repair (TEVAR) follow-up at 1 month, 1 year post-op (if stable), then annually

    References: [2] [30] [11] [9] [17]
4. Prior imaging MRA/MRV chest is non-diagnostic or indeterminate. (*__NOTE__: *One follow-up is appropriate to evaluate for changes since preceding imaging finding[s]. Further surveillance is appropriate when lesion is specified as "highly suspicious" or there is a change since last exam.*)
5. Pulmonary hypertension is suspected based on ECHO **OR** right-heart catheterization.
    References: [28] [27]
6. Thoracic aortic disease for screening **OR** initial diagnosis and **ANY** of the following:
    a. Aneurysm is demonstrated on chest X-ray or ECHO.
    b. Bicuspid aortic valve family history in 1st degree relative (child, parent, sibling)
    c. Bicuspid aortic valve is known, to screen for thoracic aorta aneurysm: screen every 3 to 5 years when results are normal.
    d. Dysphagia or expiratory wheezing, when a vascular cause is suspected **AND** prior imaging is abnormal, non-diagnostic or indeterminate.

e. Genetic conditions/connective tissue disorders (eg, Ehlers-Danlos, Loeys-Dietz or Marfan syndrome), predisposing to aneurysm or dissection, are known and **EITHER** of the following:

i. Loeys-Dietz syndrome: imaging at diagnosis and then every 2 years (imaging is more often if abnormalities are found)

ii. Marfan's or Ehlers-Danlos syndromes: one time study for follow-up

f. Thoracic aortic aneurysm (50% or more above normal) or dissection family history in 1st degree relative (child, parent, sibling)

g. Turner's syndrome is known, to evaluate for thoracic aortic aneurysm or coarctation: every 5 to 10 years when results are normal , or annually when results are abnormal.

References: [7] [22] [15] [29] [18] [20] [25] [14]

7. Thoracic aneurysm surveillance for **ANY** of the following:

a. Aortic dissection, follow-up after medical treatment: acute dissection at 1 month, 6 months, then annually; chronic dissection, annually

b. Ascending aortic dilation is known **OR** ascending aortic dissection history is known, with clinical changes (eg, abnormal testing, symptoms), for reevaluation when study results may impact treatment planning.

c. Thoracic aorta, dilated, 6 months follow-up after initial finding, for assessment of rate of change in **ANY** of the following:

i. Aortic root **OR** ascending aorta and **ANY** of the following:

A. 3.5 cm to 4.4 cm, annually

B. 4.5 cm to 5.5 cm **OR** growth rate greater than 0.5 cm per year, every 6 months

ii. Descending aorta and **ANY** of the following:

A. 4.0 cm to 4.9 cm, annually

B. 5.0 cm to 6.0 cm, every 6 months

iii. Genetically mediated (aortic root or ascending aorta, Marfan's syndrome) and **ANY** of the following:

A. 3.5 cm to 4.4 cm, annually

B. 4.5 cm to 5.5 cm **OR** growth rate greater than 0.5 cm, every 6 months

C. 5.0 cm or greater, consider surgery

References: [7] [22] [11] [13]

8. Vascular disease evaluation for **ANY** of the following:
    a. Acute aortic dissection is suspected with a sudden, painful ripping sensation **AND** clinically symptomatic (eg, cardiac tamponade, distant heart sounds, hypotension, new diastolic murmur, shock). []
    b. Subclavian steal syndrome **AND** prior ultrasound is positive, non-diagnostic or indeterminate.
    c. Superior vena cava (SVC) syndrome
    d. Takayasu's arteritis
    e. Thoracic outlet syndrome

References: [7] [19] [6] [24] [1] [32]

MR Pulmonary Angiography (MRPA) Guideline

Magnetic resonance pulmonary angiography (MRPA) is considered medically appropriate when the documentation demonstrates **ANY** of the following: (*__NOTE__: *Pretest probability can be calculated using the pulmonary embolism rule out criteria (PERC) found in the definitions section or* (https://reference.medscape.com/calculator/330/perc-rule-for-pulmonary-embolism)

1. Pretest probability for pulmonary embolism (PE) is high and only at centers that routinely perform it well **AND** standard tests are **contraindicated or unavailable**.
Reference: [8]
2. Pretest probability for PE is intermediate with a positive D-dimer and only at centers that routinely perform it well **AND** standard tests are **contraindicated or unavailable**. (*__NOTE__: *computed tomography angiography [CTA] is preferred, unless contraindicated.*)
Reference: [8]
3. Pulmonary arteriovenous malformation (PAVM) is suspected and **ANY** of the following:
    a. Asymptomatic, with family history of hereditary hemorrhagic telangiectasia (HHT) **OR** prior imaging (computed tomography [CT] or chest X-ray) is non-diagnostic or indeterminate.
    b. Neurological pathology is present (eg, brain abscess, seizures, transient ischemic attack [TIA]) **AND** prior chest X-ray is positive for a lung nodule.
    c. Shortness of breath, hemothorax or hemoptysis is known, with history of epistaxis **AND** family history of HHT.

References: [8] [3]

4. PAVM follow-up after embolization.
   References: [8] [3]

Combination MRA Chest, MRA Abdomen and/or MRA Pelvis

Magnetic resonance angiography (MRA) of the chest combined with MRA of the abdomen and/or pelvis are considered medically appropriate when the documentation demonstrates **ANY** of the following:

1. Acute aortic syndrome is suspected.
   References: [19] [7]
2. Arterial occlusion is known in the mesenteric or renal system or multiple organ systems, embolic source is suspected, to evaluate for embolic source.
   Reference: [26]
3. Connective tissue disease (eg, Loeys Dietz, Marfan's syndrome, vascular Ehlers-Danlos syndrome)
   References: [29] [25] [20]
4. Lower extremity vascular disease is known, echocardiogram is completed, to evaluate for embolic source.
   Reference: [26]
5. Spontaneous coronary artery dissection (SCAD)
   References: [19] [7]
6. Takayasu’s arteritis
   References: [1] [24]
7. Transcatheter aortic valve replacement (TAVR) for pre-operative or pre-procedural planning
   Reference: [21]
8. Vascular complications are post-traumatic, post-procedural or post-operative.
9. Vascular disease involving the chest and abdominal cavities is extensive (eg, intestinal ischemic syndrome, thoracic outlet syndrome), for evaluation.

LCD 34372
See also, **LCD 34372**: Magnetic Resonance Angiography (MRA) at https://www.cms.gov/medicare-coverage-database/search.aspx *if applicable to individual's healthplan membership*.

LCD 33633
See also, **LCD 33633**: Magnetic Resonance Angiography (MRA) at https://www.cms.gov/medicare-coverage-database/search.aspx *if applicable to individual's healthplan membership*.

LCD 34865
See also, **LCD 34865**: Magnetic Resonance Angiography (MRA) at https://www.cms.gov/medicare-coverage-database/search.aspx *if applicable to individual's healthplan membership*.

MRA/MRV Chest Procedure Codes

Table 1. MRA Chest Associated Procedure Codes

CODE	DESCRIPTION
71555	Magnetic resonance angiography, chest (excluding myocardium), with or without contrast material(s)
C8909	Magnetic resonance angiography with contrast, chest (excluding myocardium)
C8910	Magnetic resonance angiography without contrast, chest (excluding myocardium)
C8911	Magnetic resonance angiography without contrast followed by with contrast, chest (excluding myocardium)

MRA/MRV Chest Summary of Changes

MRA/MRV Chest guideline had the following version changes from 2023 to 2024:

- Added the following to keep in line with current research:
  - Indications under "Genetic conditions"
  - "Open aortic repair" under "Peri-procedural evaluation"
  - "Thoracic endovascular repair" indication under "Peri-procedural evaluation"
- Removed "Pulmonary arteriovenous malformation" indication under "Vascular disease" as current research no longer supports the indication.
- Mid-cycle update: added Pediatric Preamble
- 12/10/2024 mid-cycle update:
  - changed parameters under "Descending aorta" to reduce redundancy

MRA/MRV Chest Definitions

Ablation therapy uses extremely high or low temperatures to destroy abnormal tissue or tumors, or to treat other conditions.
Aneurysm refers to weakness in an artery wall, allowing it to abnormally balloon out or widen.
Aortopathy is a type of heart disease that affects the aorta, the body's main artery. The aorta carries oxygen-rich blood to the body's organs and the rest of the body. Aortopathy can cause limited or decreased blood flow in the body.
Aortic dissection is a serious condition in which the integrity of the body's main artery (aorta) is compromised and blood passes through the inner lining and between the layers of the arterial wall.
Aortic dissection types:

- **Type A** is the most common and dangerous type involves a tear in the part of the aorta where it exits the heart. The tear may also occur in the upper aorta (ascending aorta), which may extend into the abdomen.
- **Type B** involves a tear in the lower aorta only (descending aorta), which may also extend into the abdomen

Aortic root is where the aorta and the heart connect.
Atrial fibrillation (AF) is a cardiac rhythm disorder characterized by uncontrolled atrial activation without effective atrial contraction. On the electrocardiogram (ECG), P waves are absent. AF is characterized by rapid oscillations or fibrillatory waves that vary in amplitude, shape and timing associated with an irregular ventricular response.

- **Paroxysmal AF** terminates spontaneously or with intervention within 7 days of onset. Episodes typically convert back to sinus rhythm within 48 hours.
- **Persistent AF** is continuous AF sustained beyond 7 days.is a type of arrhythmia, or abnormal heartbeat. Afib is caused by extremely fast and irregular beats from the upper chambers of the heart (usually more than 400 beats per minute).

Bicuspid aortic valve (BAV) is a heart defect that occurs when the aortic valve has two leaflets instead of three. BAV is the most common type of congenital heart disease. It's present from birth and can go unnoticed until later in life.
Coarctation is a stricture or narrowing especially of a canal or vessel.
Computed tomography (CT) refers to a computerized X-ray imaging procedure in which a three-dimensional image of a body structure is revealed through a series of cross-sectional images or "slices."
Congenital is a condition or trait present from birth.

D-dimer is a protein fragment that's produced when a blood clot breaks down in the body. D-dimer is usually undetectable or only detectable at very low levels unless the body is forming and breaking down significant blood clots.
Dissection is the abnormal and usually abrupt formation of a tear or separation of the layers inside the wall of an artery.
Dysphagia is difficulty with swallowing or the sensation of food getting stuck in the esophagus.
Echocardiogram (ECHO) is a test that uses high frequency sound waves (ultrasound) to make pictures of the heart. The test is also called echocardiography or diagnostic cardiac ultrasound. An echo uses sound waves to create pictures of the heart's chambers, valves, walls and the blood vessels (aorta, arteries, veins). A probe called a transducer is passed over the chest. The probe produces sound waves that bounce off the heart and "echo" back to the probe. These waves are changed into pictures viewed on a video monitor.
Ehlers-Danlos syndrome is a group of hereditary connective tissue disorders that manifests clinically with skin hyperelasticity, hypermobility of joints, atrophic scarring, and fragility of blood vessels.
Endovascular aneurysm repair (EVAR) is a minimally invasive procedure that treats abdominal aortic aneurysms (AAAs). The procedure involves placing a stent-graft within the aorta to reduce the risk of rupture.
Epistaxis is the medical term for a nosebleed, which is bleeding from the inside of the nose.
Dysphagia is difficulty with swallowing or the sensation of food getting stuck in the esophagus.
Hemoptysis is the expectoration of blood from some part of the respiratory tract.
Hemothorax is a serious condition that occurs when blood collects in the pleural space, the hollow area between the lungs and rib cage.
Hereditary hemorrhagic telangiectasia (HHT) is a genetic disorder that causes abnormal blood vessels to develop, which can lead to bleeding. It's also known as Osler-Weber-Rendu syndrome.
Indeterminate findings are inconclusive or insufficient for treatment planning.
Loeys-Dietz syndrome is a disorder that affects the connective tissues of the body and increases the risk of aneurysm in arteries such as the aorta.
Magnetic resonance angiogram (MRA) is a test that uses a magnetic field and pulses of radio wave energy to provide images of blood vessels inside the body, allowing for evaluation of blood flow and blood vessel wall condition. MRA is used to look for aneurysms, clots, tears in the aorta, arteriovenous malformations and stenosis caused by plaque in the carotid arteries (neck) or blood vessels leading to the lungs, kidneys or legs.
Magnetic resonance venogram (MRV) is a diagnostic procedure that uses a combination of a large magnet, radiofrequencies, and a computer to produce detailed images of organs and structures within the body. An MRV uses magnetic resonance technology and intravenous (IV) contrast dye to visualize the veins. Contrast dye causes the blood vessels to appear opaque on the

X-ray image, allowing the visualization the blood vessels being evaluated. MRV is useful in some cases because it can help detect causes of leg pain other than vein problems.

Marfan syndrome is a disorder of connective tissue inherited as a dominant trait, characterized by abnormal elongation of the long bones and often with ocular and circulatory defects.

Modified Wells criteria objectifies the risk for pulmonary embolism (PE) and provides an estimated pre-test probability. The physician can then chose what further testing is required for diagnosing pulmonary embolism (eg, d-dimer or CT angiogram). https://www.mdcalc.com/calc/115/wells-criteria-pulmonary-embolism

Non-diagnostic is a result that does not lead to a confirmed diagnosis.

Pediatric approximate ages are defined by the US Department of Health (USDH), the Food and Drug Administration (FDA), and the American Academy of Pediatrics (AAP) as the following:

- Infancy, between birth and 2 years of age
- Childhood, from 2 to 12 years of age
- Adolescence, from 12 to 21 years of age, further defined by the AAP into:
    1. Early (ages 11–14 years)
    2. Middle (ages 15–17 years),
    3. Late (ages 18–21 years)
    4. Older ages may be appropriate for children with special healthcare needs.

Pulmonary embolism rule out criteria (PERC) scoring system is used to rule out pulmonary embolism in those where the clinical gestalt is that they are low risk (eg, less than 15% risk of pulmonary embolism).

Pulmonary embolism can be ruled out if **none** of the following features are identified:

1. Age is greater than or equal to 50 years old.
2. Heart rate is greater than or equal to 100 beats per minute (BPM).
3. Oxygen saturation is less than 95%.
4. Hemoptysis
5. Estrogen use
6. Prior DVT or PE
7. Unilateral leg swelling
8. Surgery/trauma within the past 4 weeks

In patients with a low pre-test probability of PE who meet any of these criteria, further testing could be considered to more definitely rule out pulmonary embolism. The PERC test calculator can be located at: https://reference.medscape.com/calculator/330/perc-rule-for-pulmonary-embolism

Pulmonary embolism is an obstruction of a pulmonary artery or one of its branches that is usually produced by a blood clot originated in a vein of the leg or pelvis and traveled to the lungs that is marked by labored breathing, chest pain, fainting, rapid heart rate, cyanosis, shock and sometimes death.

Pulmonary hypertension describes when the pressure in the blood vessels leading from the heart to the lungs is too high.

Pulmonary sequestration vascular syndrome is a condition in which a segment or lobe of dysplastic lung tissue exists with no communication with the rest of the tracheobronchial tree and receives an anomalous systemic vascular supply, separate from the rest of the lung. It is, therefore, a nonfunctional tissue.

Screening does not diagnose the illness. The goal is early detection and lifestyle changes or surveillance, to reduce the risk of disease, or to detect it early enough to treat it most effectively.

Subclavian steal syndrome (Vertebral artery flow reversal) is a phenomenon causing retrograde flow in an ipsilateral vertebral artery due to stenosis or occlusion of the subclavian artery, proximal to the origin of the vertebral artery.

Superior vena cava syndrome (SVC) is a condition characterized by elevated venous pressure of the upper extremities with accompanying distension of the affected veins and swelling of the face and neck. Caused by blockage (as by a thrombus or an aneurysm) or compression (as by a tumor) of the superior vena cava.

Surveillance in cancer is the ongoing, timely and systematic collection and analysis of information on new cancer cases, extent of disease, screening tests, treatment, survival and cancer deaths.

Takayasu's arteritis is a chronic inflammatory disease especially of the aorta and its major branches (the brachiocephalic artery and left common carotid artery) that result in progressive stenosis, occlusion and aneurysm formation marked by diminution or loss of the pulse (as in the arm) and ischemic symptoms.

Thorackc endovascular aortic repair (TEVAR) is a minimally invasive procedure that treats aneurysms in the upper part of the aorta, or body's largest artery. TEVAR is especially suited to treat aneurysms in the descending aorta, which moves down through the chest toward the belly.

Thoracic outlet syndrome is a term that refers to three related syndromes involving compression of the nerves, arteries, and veins in the lower neck and upper chest area. This compression causes pain in the arm, shoulder, and neck.

Turner's syndrome is a genetically determined condition that is typically associated with the presence of only one complete X chromosome and no Y chromosome. It is characterized by a female phenotype with underdeveloped (and usually infertile) ovaries and short stature.

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MRA/MRV Chest References

[1] Aghayev, A., Steigner, M.L., . . . Dill, K.E. (2021). ACR Appropriateness Criteria Noncerebral Vasculitis. *Journal of the American College of Radiology, 18*(11S), S380-S393.

[2] American College of Radiology. (2024). ACR Appropriateness Criteria Preprocedural Planning for Left Atrial Procedures in Atrial Fibrillation. *American College of Radiology*. Retrieved: May 2024. https://gravitas.acr.org/ACPortal/GetDataForOneTopic?topicId=319

[3] American College of Radiology. (2024). ACR Appropriateness Criteria Pulmonary Arteriovenous Malformation (PAVM). *American College of Radiology*. Retrieved: May 2024. https://gravitas.acr.org/ACPortal/GetDataForOneTopic?topicId=218

[4] American College of Radiology. (2024). ACR Appropriateness Criteria Soft Tissue Vascular Anomalies: Vascular Malformations and Infantile Vascular Tumors (Non-CNS)-Child. *American College of Radiology*. Retrieved: May 2024. https://gravitas.acr.org/ACPortal/GetDataForOneTopic?topicId=309

[5] American College of Radiology. (2023). ACR Manual on Contrast Media. *American College of Radiology*. Retrieved: May 2024. https://www.acr.org/-/media/ACR/Files/Clinical-Resources/Contrast_Media.pdf

[6] Azizi, A.H., Shafi, I., . . . Bashir, R. (2020). Superior Vena Cava Syndrome. *Journal of the American College of Cardiology: Cardiovascular Interventions*, *13*(24), 2896-2910.

[7] Bennett, S.J., Dill, K.E., . . . Rybicki, F.J. (2018). ACR Appropriateness Criteria Suspected Thoracic Aortic Aneurysm. *Journal of the American College of Radiology, 15*(5S), S208-S214.

[8] Bergmann, L.L., Ackman, J.B., . . . Schiebler, M.L. (2023). MR Angiography of Pulmonary Vasculature. *Magnetic Resonance Imaging Clinics of North America, 31*(3), 475-491.

[9] Bonci, G., Steigner, M.L., . . . Dill, K.E. (2017). ACR Appropriateness Criteria Thoracic Aorta Interventional Planning and Follow-Up. *Journal of the American College of Radiology, 14*(11S), S570-S583.

[10] Carpenter, J.P., Litt, H. & Gowda, M. (2023). Magnetic Resonance Imaging and Arteriography. A.N. Sidawy (Eds.). *Rutherford's Vascular Surgery and Endovascular Therapy* (30). (pp. 336-394.e4). Philadelphia, PA: Elsevier.

[11] Contrella, B.N., Minhajuddin, S.K., . . . Steigner, M.L. (2023). ACR Appropriateness Criteria Thoracoabdominal Aortic Aneurysm or Dissection: Treatment Planning and Follow-Up. *Journal of the American College of Radiology, 20*(5), S265-S284.

[12] Elders, B.B.L.J., Kersten, C.M., . . . Ciet, P. (2023). Congenital lung abnormalities on magnetic resonance imaging: the CLAM study. *Radiology, 33*, 4767-4779.

[13] Fleischmann, D., Afifi, R.O., . . . Fischbein, M.P. (2022). Imaging and Surveillance of Chronic Aortic Dissection: A Scientific Statement From the American Heart Association. *Circulation: Cardiovascular Imaging, 15*(3), e000075.

[14] Galian-Gay, L., Rodriguez-Palomares, J., . . . Evangelista, A. (2020). Multimodality imaging in bicuspid aortic valve. *Progress in Cardiovascular Diseases, 63*(4), 442-451.

[15] Gunn, A.J., Kalva, S.P., . . . Dill, K.E. (2021). ACR Appropriateness Criteria Nontraumatic Aortic Disease. *Journal of the American College of Radiology, 18*(5S), S106-S118.

[16] Gupta, S.K., Ya'qoub, L., . . . Saeed, I.M. (2020). Safety and Clinical Impact of MRI in Patients with Non–MRI-conditional Cardiac Devices. *Radiology: Cardiothoracic Imaging, 2*(5), e200086.

[17] Hedgire, S.S., Saboo, S.S., . . . Steigner, M.L. (2023). ACR Appropriateness Criteria Preprocedural Planning for Transcatheter Aortic Valve Replacement: 2023 Update. *Journal of the American College of Radiology, 20*(11), S501-S512.

[18] Kallianos, K.G. & Burris, N.S. (2020). Imaging Thoracic Aortic Aneurysm. *Radiologic Clinics of North America, 58*(4), 721-731.

[19] Kicska, G.A., Koweek, L.M.H., . . . Abbara, S. (2021). ACR Appropriateness Criteria Suspected Acute Aortic Syndrome. *Journal of the American College of Radiology, 18*(11S), S474-S481.

[20] Krishnamurthy, R., Suman, G., . . . Abbara, S. (2023). ACR Appropriateness Criteria Congenital or Acquired Heart Disease. *Journal of the American College of Radiology, 20*(11), S351-S381.

[21] Leipsic, J.A., Blanke, P., . . . Dill, K.E. (2017). ACR Appropriateness Criteria Imaging for Transcatheter Aortic Valve Replacement. *Journal of the American College of Radiology, 14*(11S), S449-S455.

[22] Mani, P., Reyaldeen, R. & Xu, B. (2021). Multimodality imaging assessment of bicuspid aortic valve disease, thoracic aortic ectasia, and thoracic aortic aneurysmal disease. *Cardiovascular Diagnosis & Therapy, 11*(3), 896-910.

[23] Maralani, P.J., Schieda, N., . . . Weinreb, J. (2020). MRI safety and devices: An update and expert consensus. *Journal of Magnetic Resonance Imaging, 51*(3), 657-674.

[24] Misra, D.P., Singh, K., . . . Agarwal, V. (2023). Management of Takayasu arteritis. *Best Practice & Research: Clinical Rheumatology, 37*(1), 101826.

[25] Odofin, X., Houbby, N., . . . Harky, A. (2021). Thoracic aortic aneurysms in patients with heritable connective tissue disease. *Journal of Cardiac Surgery, 36*(3), 1083-1090.

[26] Parenti, V.G., Vijay, K., . . . Dill, K.E. (2023). ACR Appropriateness Criteria Workup of Noncerebral Systemic Arterial Embolic Source. *Journal of the American College of Radiology, 20*(5), S285-S300.

[27] Remy-Jardin, M., Ryerson, C.J., . . . Humbert, M. (2021). Imaging of Pulmonary Hypertension in Adults: A Position Paper from the Fleischner Society. *Radiology, 298*(3), 531-549.

[28] Sirajuddin, A., Mirmomen, S.M., . . . Donnelly, E.F. (2022). ACR Appropriateness Criteria Suspected Pulmonary Hypertension: 2022 Update. *Journal of the American College of Radiology, 19*(11), S502-S512.

[29] Tijmes, F.S. & Karur, G.R. (2022). Imaging of Heritable Thoracic Aortic Disease. *Seminars in Roentgenology, 57*(4), 364-379.
[30] Upchurch, G.R., Escobar, G.A., . . . Wang, G.J. (2021). Society for Vascular Surgery clinical practice guidelines of thoracic endovascular aortic repair for descending thoracic aortic aneurysms. *Journal of Vascular Surgery, 73*(1), 55S-83S.
[31] Witte, D.H. (2021). Advanced Imaging in Orthopaedics. F.M. Azar & J.H. Beaty (Eds.). *Campbell's Operative Orthopaedics* (14), (pp. 141-176). Philadelphia, PA: Elsevier.
[32] Zurkiya, O., Ganguli, S., . . . Dill, K.E. (2020). ACR Appropriateness Criteria Thoracic Outlet Syndrome *Journal of the American College of Radiology, 17*(5S), S323-S334.

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Purpose

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