Guidelines for Clinical Review Determination

Preamble
Magellen is committed to the philosophy of supporting safe and effective treatment for patients. The medical necessity criteria that follow are guidelines for the provision of diagnostic imaging. These criteria are designed to guide both providers and reviewers to the most appropriate diagnostic tests based on a patient’s unique circumstances. In all cases, clinical judgment consistent with the standards of good medical practice will be used when applying the guidelines. Guideline determinations are made based on the information provided at the time of the request. It is expected that medical necessity decisions may change as new information is provided or based on unique aspects of the patient’s condition. The treating clinician has final authority and responsibility for treatment decisions regarding the care of the patient.

Guideline Development Process
These medical necessity criteria were developed by Magellan Healthcare for the purpose of making clinical review determinations for requests for diagnostic tests. The developers of the criteria sets included representatives from the disciplines of radiology, internal medicine, nursing, and cardiology and other specialty groups. They were developed following a literature search pertaining to established clinical guidelines and accepted diagnostic imaging practices.

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## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>TOC</th>
<th>ADVANCED IMAGING GUIDELINES</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>70336</td>
<td>MRI Temporomandibular Joint (TMJ)</td>
<td>4</td>
</tr>
<tr>
<td>70540</td>
<td>MRI Orbit</td>
<td>6</td>
</tr>
<tr>
<td>70540</td>
<td>MRI Face</td>
<td>9</td>
</tr>
<tr>
<td>70540</td>
<td>MRI Neck</td>
<td>10</td>
</tr>
<tr>
<td>70540</td>
<td>MRI Sinus</td>
<td>13</td>
</tr>
<tr>
<td>70544</td>
<td>MR Angiography Head/Brain</td>
<td>15</td>
</tr>
<tr>
<td>70547</td>
<td>MR Angiography Neck</td>
<td>19</td>
</tr>
<tr>
<td>70551</td>
<td>MRI Brain (includes Internal Auditory Canal)</td>
<td>22</td>
</tr>
<tr>
<td>70554</td>
<td>Functional MRI Brain</td>
<td>29</td>
</tr>
<tr>
<td>71550</td>
<td>MRI Chest (Thorax)</td>
<td>31</td>
</tr>
<tr>
<td>71555</td>
<td>MR Angiography Chest (excluding myocardium)</td>
<td>34</td>
</tr>
<tr>
<td>72141</td>
<td>MRI Cervical Spine</td>
<td>37</td>
</tr>
<tr>
<td>72146</td>
<td>MRI Thoracic Spine</td>
<td>42</td>
</tr>
<tr>
<td>72148</td>
<td>MRI Lumbar Spine</td>
<td>47</td>
</tr>
<tr>
<td>72159</td>
<td>MR Angiography Spinal Canal</td>
<td>53</td>
</tr>
<tr>
<td>72196</td>
<td>MRI Pelvis</td>
<td>55</td>
</tr>
<tr>
<td>72198</td>
<td>MR Angiography, Pelvis</td>
<td>61</td>
</tr>
<tr>
<td>73220</td>
<td>MRI Upper Extremity</td>
<td>64</td>
</tr>
<tr>
<td>73225</td>
<td>MR Angiography Upper Extremity</td>
<td>69</td>
</tr>
<tr>
<td>73720</td>
<td>MRI Lower Extremity (Ankle, Foot, Knee, Hip, Leg)</td>
<td>71</td>
</tr>
<tr>
<td>73725</td>
<td>MR Angiography, Lower Extremity</td>
<td>76</td>
</tr>
<tr>
<td>74181</td>
<td>MRI Abdomen</td>
<td>78</td>
</tr>
<tr>
<td>74185</td>
<td>MR Angiography, Abdomen</td>
<td>83</td>
</tr>
<tr>
<td>75557</td>
<td>MRI Heart</td>
<td>87</td>
</tr>
<tr>
<td>77058</td>
<td>MRI Breast</td>
<td>102</td>
</tr>
<tr>
<td>78451</td>
<td>Myocardial Perfusion Imaging (Nuc Card)</td>
<td>107</td>
</tr>
<tr>
<td>78459</td>
<td>PET Scan, Heart (Cardiac)</td>
<td>123</td>
</tr>
<tr>
<td>78472</td>
<td>MUGA Scan</td>
<td>131</td>
</tr>
<tr>
<td>78608</td>
<td>PET Scan, Brain</td>
<td>134</td>
</tr>
<tr>
<td>78813</td>
<td>PET Scan</td>
<td>137</td>
</tr>
</tbody>
</table>

All guidelines were reviewed between January 1, 2016 and September 1, 2016.

Prepared February 28, 2017
INTRODUCTION:
Temporomandibular joint (TMJ) dysfunction causes pain and dysfunction in the jaw joint and muscles controlling jaw movement. Symptoms may include: jaw pain, jaw muscle stiffness, limited movement or locking of the jaw, clicking or popping in jaw joint when opening or closing the mouth, and a change in how the upper and lower teeth fit together. The cause of the condition is not always clear but may include trauma to the jaw or temporomandibular joint, e.g., grinding of teeth, clenching of jaw, or impact in an accident. Osteoarthritis or rheumatoid arthritis may also contribute to the condition. The modality of choice for the evaluation of temporomandibular joint dysfunction is magnetic resonance imaging (MRI) which provides tissue contrast for visualizing the soft tissue and periarticular structures of the TMJ.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR TEMPOROMANDIBULAR JOINT (TMJ) MRI:
- For evaluation of dysfunctional temporomandibular joint after unsuccessful conservative therapy for at least four (4) weeks with bite block or splint and anti-inflammatory medicine.
- For pre-operative evaluation of dysfunctional temporomandibular joint in candidates for orthognathic surgery.
- For evaluation of locked or frozen jaw.
- For persistent temporomandibular joint dysfunction after surgical repair.

ADDITIONAL INFORMATION RELATED TO TEMPOROMANDIBULAR JOINT (TMJ) MRI:

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

MRI Imaging of Temporomandibular Joint – Imaging of the temporomandibular joint has been difficult as the mandibular condyle is small and located close to dense and complex anatomic structures. MRI produces cross-sectional multiplanar images that document both soft and osseous tissue abnormalities of the joint and the surrounding structures and may help in determining the pathology around the joint.

REFERENCES:


CPT Codes: 70540, 70542, 70543

INTRODUCTION:
Magnetic resonance imaging (MRI) is a noninvasive and radiation free radiologic technique used in the diagnosis and management of ocular and orbital disorders. Common uses include the evaluation of suspected optic nerve involvement in patients suspected of having multiple sclerosis and assessment of tumor invasion of the orbit. MRI is used in the evaluation of hyperthyroid related exophthalmos as well as in identifying the structural causes of unilateral proptosis. It is a sensitive method for showing soft tissue abnormalities which makes it a useful technique in evaluating orbital disorders, e.g., orbital pseudotumor.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR ORBIT MRI:
- For assessment of proptosis (exophthalmos).
- For evaluation of progressive vision loss.
- For evaluation of decreased range of motion of the eyes.
- For screening and evaluation of ocular tumor, especially melanoma.
- For screening and assessment of suspected hyperthyroidism (such as Graves’ disease).
- For assessment of trauma.
- For screening and assessment of known or suspected optic neuritis.
- For evaluation of unilateral visual deficit.
- For screening and evaluation of suspected orbital Pseudotumor.
- Papilledema
- Orbital infection

COMBINATION OF STUDIES WITH ORBIT MRI:
- Brain MRI/Orbit MRI –
  - For approved indications as noted above and being performed in a child under 3 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial tumor (e.g. "trilateral retinoblastoma")
  - Unilateral papilledema: to distinguish a compressive lesion on the optic nerve or optic disc swelling associated with acute demyelinating optic neuritis in multiple sclerosis from nonarteritic anterior ischemic optic neuropathy (AION), central retinal vein occlusion or optic nerve infiltrative disorders.

ADDITIONAL INFORMATION RELATED TO ORBIT MRI:

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.
**MRI imaging** – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

**MRI and Optic Neuritis** – MRI is useful in the evaluation of patients who have signs and symptoms of optic neuritis. These signs and symptoms may be the first indications of demyelinating disease, e.g., multiple sclerosis (MS). MRI findings showing the presence of three or more bright spots in brain white matter on T₂-weighted images are indicative of MS and may be used as a criterion for initiating treatment.

**MRI and Exophthalmos (Proptosis)** – Proptosis is characterized by a bulging of one or two eyes and may be caused by hyperthyroidism (Grave’s disease) or it may be caused by other conditions, e.g., orbital tumors, infection and inflammation. The degree of exophthalmos in thyroid-associated opthalmopathy is related to the orbital fatty tissue volume. MRI is able to define orbital soft tissues and measure the volumetric change in orbital fatty tissues.

**MRI and Orbit Tumors** – The most common intraocular malignant tumor is choroidal melanoma. Most choroidal melanomas can be evaluated by ophthalmoscopy and ultrasonography. MRI may be used to differentiate the types of mass lesions and to define their extent.

**Retinoblastoma and intracranial tumors:** Histologically similar tumors may occur in the pineal, suprasellar or parasellar regions of patients with ocular retinoblastoma, also known as “trilateral retinoblastoma”. The incidence of these intracranial tumors in either unilateral or bilateral retinoblastoma patients is 1.5%-5%.

**Unilateral papilledema:** The most common causes of unilateral optic disc edema are nonarteritic anterior ischemic optic neuropathy (AION), optic neuritis (termed papillitis when disc swelling is present), and orbital compressive lesions. Idiopathic intracranial hypertension (pseudotumor cerebri) and central retinal vein occlusive lesions can also present with unilateral papilledema.

**Nonarteritic anterior ischemic optic neuropathy (NAION)** – Nonarteritic anterior ischemic optic neuropathy (NAION) is the most common form of ischemic optic neuropathy. It is an idiopathic, ischemic insult of the optic nerve head characterized by acute, monocular, painless visual loss with optic disc swelling. The pathophysiology for reduction in blood flow to the optic nerve is controversial.

**REFERENCES**


CPT Codes: 70540, 70542, 70543

INTRODUCTION:

Magnetic resonance imaging (MRI) is useful in the evaluation of the soft tissues of the face, facial tumors, and osteomyelitis. It is indicated for evaluating soft-tissue within the sinuses and is sensitive for differentiating between inflammatory disease and malignant tumors.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR FACE MRI:

- For evaluation of sinonasal and/or facial soft tissue masses or tumors.
- For evaluation of osteomyelitis.
- For evaluation of parotid tumors.

ADDITIONAL INFORMATION RELATED TO FACE MRI:

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

MRI and Sinonasal Tumors – Sinus tumors are rare, but the prognosis is often poor due to advanced disease at diagnosis. MRI can distinguish between tumor and retained secretions or inflammatory sinus disease. Squamous cell carcinoma is the most common malignant tumor of the sinonasal cavity. On MRI these tumors are hypointense on T2W images and heterogeneous with solid enhancement, unlike the uniform appearance of secretions.

MRI and Chronic Osteomyelitis – MRI may be used in patient with chronic osteomyelitis to identify soft tissue involvement. It may demonstrate edema in soft tissues beyond the usual sites of enhancement and the full extent of soft-tissue mass.

REFERENCES

CPT Codes: 70540, 70542, 70543

INTRODUCTION:

Magnetic resonance imaging (MRI) is used in the evaluation of head and neck region tumors. The soft-tissue contrast among normal and abnormal tissues provided by MRI permits the exact delineation of tumor margins in regions, e.g., the nasopharynx, oropharynx, and skull base regions. MRI is used for therapy planning and follow-up of head and neck neoplasms. It is also used for the evaluation of neck lymphadenopathy, tracheal stenosis, and vocal cord lesions.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR NECK MRI:

For evaluation of **known** tumor, cancer or mass:
- Evaluation of neck tumor, mass or cancer for patient with history of cancer with suspected recurrence or metastasis [based on symptoms or examination findings (may include new or changing lymph nodes)].
- Evaluation of skull base tumor, mass or cancer.
- Evaluation of tumors of the tongue, larynx, nasopharynx pharynx, or salivary glands.
- Evaluation of parathyroid tumor when:
  - CA> normal and PTH > normal WITH
  - Previous nondiagnostic ultrasound or nuclear medicine scan AND
  - Surgery planned.

**Indication for combination studies for the initial pre-therapy staging of cancer, OR ongoing tumor/cancer surveillance OR evaluation of suspected metastases:**
- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine.
  - Cancer surveillance – Active monitoring for recurrence as clinically indicated.

For evaluation of **suspected** tumor, cancer or mass:
- Evaluation of neck tumor, mass or with suspected recurrence or metastasis [based on symptoms or examination findings (may include new or changing lymph nodes)].
- Evaluation of palpable lesions in mouth or throat.
- Evaluation of non-thyroid masses in the neck when persistent, greater than one month, and ≥ 1 cm or associated with generalized lymphadenopathy.

For evaluation of **known or suspected** inflammatory disease or infections:
- Evaluation of lymphadenopathy in the neck when greater than one month, and ≥ 1 cm or associated with generalized lymphadenopathy.

Pre-operative evaluation.

Post-operative/procedural evaluation (e.g. post neck dissection/exploration):
• A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Other indications for a Neck MRI:
• For evaluation of vocal cord lesions or vocal cord paralysis.
• For evaluation of stones of the parotid and submandibular glands and ducts.
• Brachial plexus dysfunction (Brachial plexopathy/Thoracic Outlet Syndrome).

Indications for combination studies:
• Abdomen CT/Pelvis CT/Chest CT/Neck MRI/Neck CT with MUGA – known tumor/cancer for initial staging or evaluation before starting chemotherapy or radiation treatment.

ADDITIONAL INFORMATION RELATED TO NECK MRI:

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

MRI and Brachial Plexus - MRI is the only diagnostic tool that accurately provides high resolution imaging of the brachial plexus. The brachial plexus is formed by the cervical ventral rami of the lower cervical and upper thoracic nerves which arise from the cervical spinal cord, exit the bony confines of the cervical spine, and traverse along the soft tissues of the neck, upper chest, and course into the arms.

MRI and Neck Tumors – MRI plays a positive role in the therapeutic management of neck tumors, both benign and malignant. It is the method of choice for therapy planning as well as follow-up of neck tumors. For skull base tumors, CT is preferred but MRI provides valuable information to support diagnosis of the disease.

MRI and Vocal Cord Paralysis or Tumors –MRI helps in the discovery of tumors or in estimating the depth of invasion of a malignant process. It provides a visualization of pathological changes beneath the surface of the larynx. MRI scans may indicate the presence or absence of palsy and possible reasons for it. If one or both vocal cords show no movement during phonation, palsy may be assumed.

MRI and Cervical Lymphadenopathy – MRI can show a conglomerate nodal mass that was thought to be a solitary node. It can also help to visualize central nodal necrosis and identify nodes containing metastatic disease. Imaging of the neck is not done just to evaluate lymphadenopathy, but is performed to evaluate a swollen lymph node and an unknown primary tumor site. Sometimes it is necessary to require a second imaging study using another imaging modality, e.g., a CT study to provide additional information.

MRI and Submandibular Stones – Early diagnosis and intervention are important because patients with submandibular stones may eventually develop sialadenitis. MRI provides excellent image contrast and resolution of the submandibular gland and duct and helps in the evaluation of stones.
REFERENCES


CPT Codes: 70540, 70542, 70543

INTRODUCTION:

MRI of the sinus is useful for evaluating soft tissue involvement. It can help rule out fungal sinusitis and may differentiate between inflammatory disease and malignant tumors. MRI may also identify encephaloceles or a cerebrospinal fluid (CSF) leak.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR SINUS MRI:

- Evidence of tumor from a physical exam, plain sinus x-ray or previous CT.
- Cerebrospinal Fluid (CSF) leak.
- Unresolved sinusitis after four (4) consecutive weeks of medication, e.g., antibiotics, steroids or antihistamines.
- Osteomyelitis (rare) of the facial bone.

ADDITIONAL INFORMATION RELATED TO SINUS MRI:

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

Sinusitis - In addition to CT scanning, magnetic resonance (MR) imaging of the sinuses, orbits, and brain should be performed whenever extensive or multiple complications of sinusitis are suspected.

Limitations of sinus MRI - MRI has limitations in the definition of the bony anatomy, but is sensitive for differentiating between inflammatory disease and malignant tumors.

REFERENCES


CPT Codes: 70544, 70545, 70546

INTRODUCTION:
Magnetic resonance angiography (MRA) or magnetic resonance venography (MRV) can be used as a first line investigation of intracranial vascular disease. It is an alternative to invasive intra-catheter angiography that was once the mainstay for the investigation of intracranial vascular disease. MRA/MRV may use a contrast agent, gadolinium, which is non-iodine-based, for better visualization. It can be used in patients who have history of contrast allergy and who are at high risk of kidney failure. A single authorization covers both MRA and MRV.

Three different techniques of MRA/MRV are: time of flight (both 2D and 3D TOF), phase contrast (PC), and contrasted enhanced angiography. Time of flight MRA takes advantage of the phenomena of flow related enhancement and is the preferred MRA technique due to the speed at which the exam can be acquired.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR BRAIN (HEAD) MRA/MRV:

For evaluation of known intracranial vascular disease:
- To evaluate known intracranial aneurysm or arteriovenous malformation (AVM).
- To evaluate known vertebrobasilar insufficiency (VBI).
- To re-evaluate vascular abnormality visualized on previous brain imaging.
- For evaluation of known vasculitis.

For evaluation of suspected intracranial vascular disease:
- To screen for suspected intracranial aneurysm in patient whose parent brother, sister or child has history of intracranial aneurysm. Note: If there is a first degree familial history, repeat study is recommended every 5 years.
- Screening for aneurysm in polycystic kidney disease, Ehlers-Danlos syndrome, fibromuscular dysplasia, neurofibromatosis, or known aortic coarctation.
- To evaluate previously diagnosed subarachnoid hemorrhage (SAH).
- To evaluate suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as vision changes, vertigo, or abnormal speech.
- To evaluate suspected arteriovenous malformation (AVM) in patient with previous or indeterminate imaging study.
- For evaluation of suspected venous thrombosis (dural sinus thrombosis).
- Distinguishing benign intracranial hypertension (pseudotumor cerebri) from dural sinus thrombosis.
- For evaluation of pulsatile tinnitus for vascular etiology.
- For evaluation of suspected vasculitis with abnormal lab results suggesting acute inflammation or autoimmune antibodies.
- For evaluation of stroke risk in sickle cell patients (2 - 16 years of age) with a transcranial doppler velocity >200.
Pre-operative evaluation for brain/skull surgery.

Post-operative/procedural evaluation:
- A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Indications for Brain MRA/Neck MRA combination studies:
- For evaluation of patients who have had a stroke or transient ischemic attack (TIA) within the past 2 weeks.
- For evaluation of known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as vision changes, vertigo, or abnormal speech.
- For evaluation of known or suspected carotid or cerebral artery occlusion in patients with a sudden onset of one-sided weakness, abnormal speech, vision defects or severe dizziness.
- For evaluation of head trauma in a patient with closed head injury for suspected carotid or vertebral artery dissection.
- For evaluation of pulsatile tinnitus for vascular etiology.

INFORMATION RELATED TO BRAIN (HEAD) MRA

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindications. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindications.

MRA and Cerebral Aneurysms – Studies that compared MRA with catheter angiography in detecting aneurysms found that MRA could find 77% - 94% of the aneurysms previously diagnosed by catheter angiography that were larger than 5 mm. For aneurysms smaller than 5 mm, MRI detected only 10% - 60% of those detected with catheter angiography. On the other hand, aneurysms that were missed by catheter angiography in patients with acute subarachnoid hemorrhage were detected with MRA due to the much larger number of projections available with MRA.

MRA and Cerebral Arteriovenous Malformations (AVM) – Brain arteriovenous malformation (AVM) may cause intracranial hemorrhage and is usually treated by surgery. 3D TOF-MRA is commonly used during the planning of radio-surgery to delineate the AVM nidus, but it is not highly specific for the detection of a small residual AVM after radio-surgery.

MRV - A pitfall of the TOF technique, particularly 3D TOF, is that in areas of slowly flowing blood, turbulence or blood which flows in the imaging plane there can be regions of absent or diminished signal. The signal loss can be confused with vascular occlusion or thrombi. To avoid this pitfall MRA performed after the intravenous administration of gadolinium based contrast agents is utilized at many facilities.

Intracranial magnetic resonance venography (MRV) is used primarily to evaluate the patency of the venous sinuses. The study can be performed with TOF, Phase contrast and IV contrast enhanced techniques. Delayed images to allow for enhancement of the venous system are required to obtain images when intravenous gadolinium enhanced studies are undertaken.

Saturation pulses are utilized in studies not undertaken with intravenous contrast to help eliminate flow related signal in a specified direction and thus display the desired arterial or venous structures on their own. In cranial applications, saturation pulses applied at the inferior margin of the imaging field
eliminate signal from arterial flow in order to visualize the veins. Conversely, superior saturation pulses are used to eliminate venous flow related enhancement when evaluation of the arterial structures is desired.

**REFERENCES**


[http://www.nepscc.org/NewFiles/CVA%20CPG%20NEPSCC%20Dec03.pdf](http://www.nepscc.org/NewFiles/CVA%20CPG%20NEPSCC%20Dec03.pdf)
INTRODUCTION:

Magnetic resonance angiography (MRA) of the neck uses magnetic resonance imaging (MRI) technology and may be performed after abnormal results are found on carotid duplex imaging. MRA is used for the evaluation and imaging of vessels in the head and the neck.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR NECK MRA:

For evaluation of vascular disease:
- For evaluation of patients with an abnormal ultrasound of the neck or carotid duplex imaging (e.g. carotid stenosis ≥ 60%, technically limited study, aberrant direction of flow in the carotid or vertebral arteries).
- For evaluation of head trauma in a patient with closed head injury for suspected carotid or vertebral artery dissection.

For evaluation of known or suspected tumor/mass:
- For evaluation of carotid body tumors, also called paragangliomas.
- For evaluation of pulsatile neck mass.

Pre-operative evaluation.

Post-operative/procedural evaluation (e.g. carotid endarterectomy):
- A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Indications for combination studies:

Neck MRA/Brain MRA:
- For evaluation of patients who have had a stroke or transient ischemic attack (TIA) within the past 2 weeks.
- For evaluation of known or suspected vertebrobasilar insufficiency (VBI) in patients with symptoms such as vision changes, vertigo, or abnormal speech.
- For evaluation of known or suspected carotid or cerebral artery occlusion in patients with a sudden onset of one-sided weakness, abnormal speech, vision defects or severe dizziness.
- For evaluation of head trauma in a patient with closed head injury for suspected carotid or vertebral artery dissection.
- For evaluation of pulsatile tinnitus for vascular etiology.

Neck MRA/Brain MRI:
- Confirmed carotid stenosis >60%, surgery or angioplasty candidate.
ADDITIONAL INFORMATION RELATED TO NECK MRA:

**MRI imaging** – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

**MRA and Carotid Body Tumor** – Carotid body tumors are found in the upper neck at the branching of the carotid artery. Although most of them are benign they may be locally aggressive with a small malignant potential. MRA may be used to identify a carotid body tumor due to its ability to define the extension of the tumor in relation to the carotid arteries, involvement of the base of the skull and bilateral tumors.

**Post-operative evaluation of carotid endarterectomy** – Carotid endarterectomy is a vascular surgical procedure that removes plaque from the carotid artery. MRA with multiprojection volume reconstruction is a non-invasive imaging modality that is an alternative to postoperative angiography following carotid endarterectomy. It allows the surgeon to get informative and comparative data.

**The Asymptomatic Carotid Atherosclerosis Study (ACAS):** The ACAS clinical trial is an often quoted study that demonstrated a 5-year reduction in stroke risk of asymptomatic patients with ≥ 60% carotid diameter reduction that underwent carotid endarterectomy compared to those who received medical treatment.

REFERENCES


CPT Codes:
70551, 70552, 70553 – Brain MRI
70540, 70542, 70543 - IAC

INTRODUCTION:

Brain (head) MRI is the procedure of choice for most brain disorders. It provides clear images of the brainstem and posterior brain, which are difficult to view on a CT scan. It is also useful for the diagnosis of demyelinating disorders (disorders such as multiple sclerosis (MS) that cause destruction of the myelin sheath of the nerve). The evaluation of blood flow and the flow of cerebrospinal fluid (CSF) is possible with this non-invasive procedure.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR BRAIN MRI:

For evaluation of suspected multiple sclerosis (MS):
- For evaluation of patient with neurologic symptoms or deficits within the last four (4) weeks.

For evaluation of known multiple sclerosis (MS):
- Stable condition with no prior imaging within the past ten (10) months.
- Exacerbation of symptoms or change in symptom characteristics such as frequency or type and demonstrated compliance with medical therapy.

For evaluation of known or suspected seizure disorder:
- New onset of a seizure.
- Medically refractory epilepsy.

For evaluation of suspected Parkinson’s disease:
- For evaluation of suspected Parkinson’s disease as a baseline study.

For evaluation of known Parkinson’s disease:
- For evaluation of new non-Parkinson symptoms complicating the evaluation of the current condition.

For evaluation of neurologic symptoms or deficits:
- Acute, new or fluctuating neurologic symptoms or deficits such as sensory deficits, limb weakness, speech difficulties, lack of coordination or mental status changes.

For evaluation of cognitive assessment:
- Change in mental status with a mental status score of either MMSE or MoCA of less than 26 or other similar mental status exams showing at least mild cognitive impairment AND a completed basic metabolic workup (such as thyroid function testing, liver function testing, complete blood count, electrolytes, and B12).
For evaluation of known or suspected trauma:
- Known or suspected trauma or injury to the head with documentation of one or more of the following acute, new or fluctuating:
  - Focal neurologic findings
  - Motor changes
  - Mental status changes
  - Amnesia
  - Vomiting
  - Seizures
  - Headache
  - Signs of increased intracranial pressure
- Known coagulopathy
- Known or suspected skull fracture by physical exam and positive x-ray.

For evaluation of headache:
- Chronic headache with a change in character/pattern (e.g., more frequent, increased severity or duration).
- New onset (< 48 hours) of “worst headache in my life” or “thunderclap” headache. Note: The duration of a thunderclap type headache lasts more than 5 minutes. Sudden onset new headache reaching maximum intensity within 2-3 minutes.
- New onset of headache with any acute, new or fluctuating neurologic deficits such as sensory deficits, limb weakness, speech difficulties, lack of coordination or mental status changes.
- Patient with history of cancer, or significantly immunocompromised, with new onset headache.
- New headache in occipitonal region in individual > 55 years old.
- New temporal headache in person > 55, with sedimentation rate (ESR) > 55 with tenderness over the temporal artery.
- Acute, sudden onset of headache with a family history (brother, sister, parent or child) of brain aneurysm or AVM (arteriovenous malformation).
- New severe unilateral headache with radiation to or from the neck. Associated with suspicion of carotid or vertebral artery dissection.
- New onset of headache in pregnancy.

For evaluation of known or suspected brain tumor, mass or metastasis:
- Known tumor and new onset of headache.
- Follow up for known tumor.
- Evaluation of suspected tumor with any acute, new or fluctuating neurologic symptoms or deficits such as sensory deficits, limb weakness, speech difficulties, lack of coordination or mental status changes.
- Known lung cancer, or rule out metastasis and/or preoperative evaluation.
- Evaluation of metastatic melanoma (not all melanomas).
- Known or suspected pituitary tumor with corroborating physical exam (galactorrhea) neurologic findings and/or lab abnormalities.

Indication for combination studies for the initial pre-therapy staging of cancer, OR ongoing tumor/cancer surveillance OR evaluation of suspected metastases:
- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine.
  - Cancer surveillance: Active monitoring for recurrence as clinically indicated.

For evaluation of known or suspected stroke:
• To evaluate patient with history of a known stroke with new and sudden onset of severe headache.
• Known or suspected stroke with any acute, new or fluctuating symptoms or deficits such as sensory deficits, limb weakness, speech difficulties, lack of coordination or mental status changes or with a family history (brother, sister, parent or child) of aneurysm.
• Symptoms of transient ischemic attack (TIA) (episodic neurologic symptoms).

**For evaluation of known or suspected inflammatory disease or infection (e.g., meningitis or abscess):**
• Intracranial abscess or brain infection with acute altered mental status OR positive lab findings (such as elevated WBC's) OR follow up assessment during or after treatment completed.
• Meningitis with positive physical findings (such as fever, stiff neck) and positive lab findings (such as elevated white blood cells or abnormal lumbar puncture fluid exam.)
• Suspected encephalitis with a severe headache, altered mental status OR positive lab finding, (such as elevated WBC's).
• Endocarditis with suspected septic emboli.
• Evaluation for Central Nervous System (CNS) involvement in patients with known or suspected vasculitis or autoimmune disease with positive lab findings.

**For evaluation of known or suspected congenital abnormality (such as hydrocephalus, craniosynostosis):**
• Known or suspected congenital abnormality with any acute, new or fluctuating neurologic, motor or mental status changes.
• Evaluation of macrocephaly with child >6 months of age.
• Evaluation of microcephaly.
• Follow up shunt evaluation within six (6) months of placement or one (1) year follow up and/or with neurologic symptoms.
• Evaluation of craniosynostosis and other head deformities
• To evaluate patient for suspected or known hydrocephalus.
• To evaluate patient for prior treatment OR treatment planned for congenital abnormality.

**Suspected normal pressure hydrocephalus, (NPH) with symptoms.**

**Pre-operative evaluation for brain/skull surgery:**

**Post-operative/procedural evaluation:**
• A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

**Indications for a Brain MRI with Internal Auditory Canal (IAC):**
• Unilateral non-pulsatile tinnitus.
• Pulsatile tinnitus.
• Suspected acoustic neuroma (Schwannoma) or cerebellar pontine angle tumor with any of the following signs and symptoms: unilateral hearing loss by audiometry, headache, disturbed balance or gait, unilateral tinnitus, facial weakness, or altered sense of taste.
• Suspected cholesteatoma.
• Suspected glomus tumor.
• Asymmetric sensorineural hearing loss on audiogram.

**Other indications for a Brain MRI:**
• Evaluation of suspected acute subarachnoid hemorrhage (SAH).
• Follow up for known hemorrhage, hematoma or vascular abnormalities.
• Developmental delay.
• Vertigo associated with headache, blurred or double vision, or a change in sensation after full neurologic examination and initial work-up.
• Abnormal eye findings on physical or neurologic examination (papilledema, nystagmus, ocular nerve palsies, visual field deficit etc).
• Anosmia (loss of smell) (documented by objective testing).
• For evaluation of known or suspected cerebrospinal fluid (CSF) leakage.
• Immunocompromised patient (e.g., transplant recipients, HIV with CD4<200, primary immunodeficiency syndromes, hematologic malignancies) with focal neurologic-symptoms, headaches, behavioral, cognitive or personality changes.
• Initial imaging of a suspected or known Arnold Chiari malformation (ACM)
• Optic neuritis.
• Initial evaluation for a known syrinx or syringomyelia.
• Suspected cholesteatoma.

Indications for combination studies:
• **Brain MRI/Neck MRA** –
  - Confirmed carotid occlusion >60%, surgery or angioplasty candidate.
• **Brain MRI/Cervical MRI** –
  - For evaluation of Arnold Chiari Malformation.
  - For follow-up of known multiple sclerosis (MS).
• **Brain MRI/Orbit MRI** –
  - For approved indications as noted above and being performed in a child under 3 years of age who will need anesthesia for the procedure and there is a suspicion of concurrent intracranial tumor (e.g. “trilateral retinoblastoma”)
  - Unilateral papilledema: to distinguish a compressive lesion on the optic nerve or optic disc swelling associated with acute demyelinating optic neuritis in multiple sclerosis from nonarteritic anterior ischemic optic neuropathy (AION), central retinal vein occlusion or optic nerve infiltrative disorders.

ADDITIONAL INFORMATION RELATED TO BRAIN MRI:

**MMSE** - The Mini Mental State Examination (MMSE) is a tool that can be used to systematically and thoroughly assess mental status. It is an 11-question measure that tests five areas of cognitive function: orientation, registration, attention and calculation, recall, and language. The MMSE has been the most commonly used measure of cognitive function in dementia research, but researchers have recognized that it is relatively insensitive and variable in mildly impaired individuals. The maximum score is 30. A score of 23 or lower is indicative of cognitive impairment. The MMSE takes only 5-10 minutes to administer and is therefore practical to use repeatedly and routinely.

**MoCA** - The Montreal Cognitive Assessment (MoCA) was designed as a rapid screening instrument for mild cognitive dysfunction. It assesses different cognitive domains: attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation. MoCA differs from the MMSE mainly by including tests of executive function and abstraction, and by putting less weight on orientation to time and place. Ten of the MMSE’s 30 points are scored solely on the time-place orientation test, whereas the MoCA assigns it a maximum of six points. The MoCA also puts more weight on recall and attention-calculation performance, while de-emphasizing language skill. Time to administer the MoCA is approximately 10 minutes. The total possible score is 30 points; a score of 26 or above is considered normal.
**MRI imaging** – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindications. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindications.

**Combination MRI/MRA of the Brain** – This is one of the most misused combination studies and these examinations should be ordered in sequence, not together. Vascular abnormalities can be visualized on the brain MRI.

**MRI for Headache** - Generally, magnetic resonance imaging is the preferred imaging technique for evaluating the brain parenchyma and CT is preferable for evaluating subarachnoid hemorrhage. CT is faster and more readily available than MRI and is often used in urgent clinical situations. Neurologic imaging is warranted in patients with headache disorders along with abnormal neurologic examination results or predisposing factors for brain pathology. Contrast enhanced MRI is performed for evaluation of inflammatory, infectious, neoplastic and demyelinating conditions.

**MRI for Macrocephaly** - Consider ultrasound for child <6 months of age for macrocephaly.

**MRI and Positron Emission Tomography (PET) for Chronic Seizures** – When MRI is performed in the evaluation of patients for epilepsy surgery, almost a third of those with electrographic evidence of temporal lobe epilepsy have normal MRI scans. Interictal positron emission tomography (PET) may be used to differentiate patients with MRI-negative temporal lobe epilepsy.

**MRI and Multiple Sclerosis** – Current advances in MRI improve the ability to diagnose, monitor and understand the pathophysiology of MS. Different magnetic resonance methods are sensitive to different aspects of MS pathology and by the combining of these methods, an understanding of the mechanisms underlying MS may be increased.

**MRI and Vertigo** – Magnetic resonance imaging is appropriate in the evaluation of patients with vertigo who have neurologic signs and symptoms, progressive unilateral hearing loss or risk factors for cerebrovascular disease. MRI is more appropriate than CT for diagnosing vertigo due to its superiority in visualizing the posterior portion of the brain, where most central nervous system disease that causes vertigo is found. MRI is helpful in diagnosing vascular causes of vertigo.

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CPT Codes: 70554, 70555

INTRODUCTION:

Functional MRI (fMRI) of the brain is a non-invasive imaging technique, using radio waves and a strong magnetic field, to image the brain activity of a patient undergoing brain surgery for tumors. It is based on the increase in blood flow to the local vasculature when parts of the brain are activated and helps to determine the location of vital areas of brain function. fMRI images capture blood oxygen levels in parts of the brain that are responsible for perception, cognition and movement, allowing neurosurgeons to operate with less possibility of harming areas that are critical to the patient’s quality of life. fMRI is also used to image and localize abnormal brain function in patients with seizures.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR FUNCTIONAL BRAIN MRI:

Pre-operative Evaluation:
- With brain tumors where fMRI may have a significant role in mapping lesions.
- With seizures where fMRI may have a significant role in mapping lesions.

ADDITIONAL INFORMATION RELATED TO BRAIN MRI:

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

fMRI and Brain Tumors – fMRI may significantly affect therapeutic planning in patients who have potentially resectable brain tumors. Due to its non-invasiveness, its relatively high spatial resolution and its pre-operative results, fMRI is used before surgery in the evaluation of patients with brain tumors. fMRI may have a significant role in mapping lesions that are located in close proximity to vital areas of brain function (language, sensory motor, and visual). It can determine the precise spatial relationship between the lesion and adjacent functionally essential parenchyma allowing removal of as much pathological tissue as possible during resection of brain tumors without compromising essential brain functions. fMRI provides an alternative to other invasive tests such as the Wada test and direct electrical stimulation.

fMRI and Seizures – Brain fMRI can influence the diagnostic and therapeutic decisions of the seizure team, thereby affecting the surgical approach and outcomes. Brain surgery is often the treatment for patients with epilepsy, especially patients with a single seizure focus. fMRI may have a significant role in
mapping lesions that are located in close proximity to vital areas of brain function (language, sensory motor, and visual).

fMRI can determine the location of the brain functions of areas bordering the lesion, resulting in better outcomes with less neurologic deficit.

**fMRI as an Alternative to the Invasive WADA test and Direct Electrical Stimulation** – fMRI is considered an alternative to the Wada test and direct electrical stimulation as it is a non-invasive method for location of vital brain areas. The Wada test is used for the pre-operative evaluations of patients with brain tumors and seizures to determine which side of the brain is responsible for vital cognitive functions, e.g., speech and memory. It can assess the surgical risk of damaging the vital areas of the brain. The Wada test is invasive, involving an angiography procedure to guide a catheter to the internal carotid where a barbiturate is injected, putting one hemisphere of the brain to sleep. Direct electrical stimulation mapping is invasive requiring the placement of electrodes in the brain. The electrodes are used to stimulate multiple cortical sites in the planned area of resection to allow the surgeons to identify and mark which areas can be safely resected.

**REFERENCES:**


CPT Codes: 71550, 71551, 71552

INTRODUCTION:

Magnetic Resonance Imaging (MRI) is a noninvasive imaging technique for detection and evaluation of various disease and conditions in the chest, e.g., congenital anomalies and aneurysms. MRI may be used instead of computed tomography (CT) in patients with allergies to radiographic contrast or with impaired renal function.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR CHEST MRI:

- For evaluation of mediastinal or hilar mass of patient with renal failure or allergy to contrast material.
- For evaluation of myasthenia gravis with suspected thymoma.
- For evaluation of brachial plexus dysfunction (brachial plexopathy/thoracic outlet syndrome).
- For evaluation of a thoracic/thoracoabdominal aneurysm or dissection (documentation of clinical history may include hypertension and reported “tearing or ripping type” chest pain).
- For evaluation of congenital heart disease, or cardiac and non-cardiac malformations, [e.g., vascular rings or pulmonary slings, aortic arch anomalies and patent ductus arteriosus (PDA)].
- For evaluating whether masses invade into specific thoracic structures (e.g. aorta, pulmonary artery, brachial plexus, subclavian vessels, or thoracic spine).
- To determine the consistency of thoracic masses (cystic vs. solid vs. mixed).

ADDITIONAL INFORMATION RELATED TO CHEST MRI:

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

MRI and Myasthenia Gravis – Myasthenia Gravis is a chronic autoimmune disease characterized by weakness of the skeletal muscles causing fatigue and exhaustion that is aggravated by activity and relieved by rest. It most often affects the ocular and other cranial muscles and is thought to be caused by the presence of circulating antibodies. Symptoms include ptosis, diplopia, chewing difficulties, and dysphagia. Thymoma has a known association with myasthenia. Contrast-enhanced MRI may be used to identify the presence of a mediastinal mass suggestive of myasthenia gravis in patients with renal failure or allergy to contrast material.
**MRI and Thoracic Outlet Syndrome** – Thoracic outlet syndrome is a group of disorders involving compression at the superior thoracic outlet that affects the brachial plexus, the subclavian artery and veins. It refers to neurovascular complaints due to compression of the brachial plexus or the subclavian vessels. Magnetic resonance multi-plane imaging shows bilateral images of the thorax and brachial plexus and can demonstrate the compression of the brachial plexus and venous obstruction.

**MRI and Brachial Plexus** – MRI is the only diagnostic tool that accurately provides high resolution imaging of the brachial plexus. The brachial plexus is formed by the cervical ventral rami of the lower cervical and upper thoracic nerves which arise from the cervical spinal cord, exit the bony confines of the cervical spine, and traverse along the soft tissues of the neck, upper chest, and course into the arms.

**REFERENCES**


Magnetic resonance angiography (MRA) is a noninvasive technique used to provide cross-sectional and projection images of the thoracic vasculature, including large and medium sized vessels, e.g., the thoracic aorta. It provides images of normal as well as diseased blood vessels and quantifies blood flow through these vessels. Successful vascular depiction relies on the proper imaging pulse sequences. MRA may use a contrast agent, gadolinium, which is non-iodine-based, for better visualization. It can be used in patients who have history of contrast allergy and who are at high risk of kidney failure.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

**INDICATIONS FOR CHEST MRA:**

*For evaluation of suspicious mass and CTA is contraindicated due to a history of contrast allergy or high risk for contrast induced renal failure.*

*For evaluation of suspected or known pulmonary embolism (excludes low risk*).

*For evaluation of suspected or known vascular abnormalities:*
  - Thoracic/thoracoabdominal aneurysm or dissection (documentation of clinical history may include hypertension and reported “tearing or ripping type” chest pain).
  - Congenital thoracic vascular anomaly, (e.g., coarctation of the aorta or evaluation of a vascular ring suggested by GI study).
  - Signs or symptoms of vascular insufficiency of the neck or arms (e.g., subclavian steal syndrome with abnormal ultrasound).
  - Follow-up evaluation of progressive vascular disease when new signs or symptoms are present.
  - Pulmonary hypertension.

**Preoperative evaluation**
- Known vascular abnormalities
- Proposed ablation procedure for atrial fibrillation.

**Postoperative or post-procedural evaluation**
- Known vascular abnormalities with physical evidence of post-operative bleeding complication or restenosis.
- Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

**ADDITIONAL INFORMATION RELATED TO CHEST MRA:**

**MRI imaging** – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.
MRA and Coarctation of the Aorta – One of the most common congenital vascular anomalies is coarctation of the aorta which is characterized by obstruction of the juxtaductal aorta. Clinical symptoms, e.g., murmur, systemic hypertension, difference in blood pressure in upper and lower extremities, absent femoral or pedal pulses, may be present. Gadolinium enhanced 3D MRA may assist in preoperative planning as it provides angiographic viewing of the aorta, the arch vessels and collateral vessels. It may also assist in the identification of postoperative complications.

MRA and Pulmonary Embolism (PE) – Note: D-Dimer blood test in patients at low risk* for DVT is indicated to prior to MRA imaging. Negative D-Dimer suggests alternative diagnosis in these patients.

*Low risk defined as NO to ALL of the following questions:
  1) evidence of current or prior DVT;
  2) HR > 100;
  3) cancer diagnosis;
  4) recent surgery or prolonged immobilization;
  5) hemoptysis;
  6) history of PE;
and another diagnosis is more likely

MRA and Thoracic Aortic Aneurysm – One of the most common indications for thoracic MRA is thoracic aortic aneurysm, most often caused by atherosclerosis. These aneurysms may also be due to aortic valvular disease. Aneurysms are defined by their enlargement and patients with rapidly expanding aortas, or with aortic diameters greater than five or six centimeters, are at high risk of rupture and may require surgery.

MRA and Thoracic Aortic Dissection – The most common clinical symptom of aortic dissection is tearing chest pain and the most common risk factor is hypertension. An intimal tear is the hallmark for aortic dissection and intramural hematoma may also be detected. Unfortunately, patients with aortic dissection may be unstable and not good candidates for routine MR evaluation; MRA may be indicated as a secondary study. 3D MRA is also useful in postoperative evaluation of patients with repaired aortic dissections.

MRA and Central Venous Thrombosis – MRA is useful in the identification of venous thrombi. Venous thrombosis can be evaluated by gadolinium enhanced 3D MRA as an alternative to CTA which may not be clinically feasible due to allergy to iodine contrast media or renal insufficiency.

Other MRA Indications – MRA is useful in the assessment for postoperative complications of pulmonary venous stenosis.

MRI and Patent Ductus Arteriosus – Patent ductus arteriosus (PDA) is a congenital heart problem in which the ductus arteriosus does not close after birth. It remains patent allowing oxygen-rich blood from the aorta to mix with oxygen-poor blood from the pulmonary artery. MRI can depict the precise anatomy of a PDA to aid in clinical decisions. It allows imaging in multiple planes without a need for contrast administration. Patients are not exposed to ionizing radiation.
REFERENCES


CPT Codes: 72141, 72142, 72156

INTRODUCTION:

Magnetic resonance imaging (MRI) produces high quality multiplanar images of organs and structures within the body without radiation. It is the preferred modality for evaluating the internal structure of the spinal cord, providing assessment of conditions such as degenerative disc pathology, osteomyelitis and discitis.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR CERVICAL SPINE MRI:

For evaluation of known or suspected multiple sclerosis (MS):
- Evidence of MS on recent baseline Brain MRI.
- Suspected MS with new or changing symptoms consistent with cervical spinal cord disease.
- Follow up to known Multiple Sclerosis.
- Follow up to the initiation or change in medication for patient with known Multiple Sclerosis.

For evaluation of neurologic deficits:
- With any of the following new neurological deficits: extremity weakness; abnormal reflexes; or abnormal sensory changes along a particular dermatome (nerve distribution) as documented on exam.

For evaluation of suspected myelopathy:
- Progressive symptoms including hand clumsiness, worsening handwriting, difficulty with grasping and holding objects, diffuse numbness in the hands, pins and needles sensation, increasing difficulty with balance and ambulation (unsteadiness, broad-based gait), increased muscle tone, weakness and wasting of the upper and lower limbs; diminished sensation to light touch, temperature, proprioception, vibration; bowel and bladder dysfunction in more severe cases).

For evaluation of chronic back pain with any of the following:
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months.
- With progression or worsening of symptoms during the course of conservative treatment*.
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality.

For evaluation of new onset of neck pain:
- Failure of conservative treatment*, for at least six (6) weeks.
- With progression or worsening of symptoms during the course of conservative treatment*.
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality.

For evaluation of trauma or acute injury within past 72 hours:
- Presents with radiculopathy, muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
• With progression or worsening of symptoms during the course of conservative treatment*

**For evaluation of known tumor, cancer, or evidence of metastasis:**
• For staging of known tumor.
• For follow-up evaluation of patient undergoing active treatment.
• Presents with new signs or symptoms (e.g., laboratory and/or imaging findings) of new tumor or change in tumor.
• Presents with radiculopathy, muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
• With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality
• With evidence of metastasis on bone scan or previous imaging study.
• With no imaging/restaging within the past ten (10) months.

**For evaluation of suspected tumor:**
• Prior abnormal or indeterminate imaging that requires further clarification.

**Indication for combination studies for the initial pre-therapy staging of cancer, OR ongoing tumor/cancer surveillance OR evaluation of suspected metastases:**
• < 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine.
  o Cancer surveillance – Active monitoring for recurrence as clinically indicated.

**For evaluation of known or suspected infection, abscess, or inflammatory disease:**
• As evidenced by signs/symptoms, laboratory or prior imaging findings.

**For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, lymphoma:**
• As evidenced by signs/symptoms, laboratory or prior imaging findings.

**For post-operative / procedural evaluation for surgery or fracture occurring within the past six (6) months:**
• A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.
• Changing neurologic status post-operatively.
• With an abnormal electromyography (EMG) or nerve conduction study if radicular symptoms are present.
• Surgical infection as evidenced by signs/symptoms, laboratory or prior imaging findings.
• Delayed or non-healing fracture as evidenced by signs/symptoms, laboratory or prior imaging findings.
• Continuing or recurring symptoms of any of the following neurological deficits: Lower extremity weakness, lower extremity asymmetric reflexes.

**Other indications for a Cervical Spine MRI:**
• For preoperative evaluation.
• Suspected cord compression with any of the following neurological deficits: extremity weakness; abnormal gait; asymmetric reflexes.
• For evaluation of suspicious sacral dimples associated with lesions such as hairy patches or hemangiomas.
- Known arnold-chiari syndrome.
- Syrinx or syringomyelia.

**COMBINATION OF STUDIES WITH CERVICAL SPINE MRI:**

**Cervical/Thoracic/Lumbar MRIs:**
- Any combination of these for scoliosis survey in infant/child.
- Any combination of these for spinal survey in patient with metastases.
- For evaluation of spinal abnormalities associated with Chiari Malformation.

**Cervical MRI/CT**
- For unstable craniocervical junction.

**Brain MRI/Cervical MRI** –
- For evaluation of Arnold Chiari malformation.
- For follow-up of known Multiple Sclerosis (MS).

**ADDITIONAL INFORMATION RELATED TO CERVICAL SPINE MRI:**

*Conservative Therapy:* (Spine) should include a multimodality approach consisting of a combination of active and inactive components. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a physician supervised home exercise program**, and/or chiropractic care.

**Home Exercise Program** - (HEP) – the following two elements are required to meet guidelines for completion of conservative therapy:
- Information provided on exercise prescription/plan AND
- Follow up with member with documentation provided regarding completion of HEP (after suitable 6 week period), or inability to complete HEP due to physical reason - i.e. increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).

**Cervical myelopathy:** Symptom severity varies and a high index of suspicion is essential for making the proper diagnosis in early cases. Symptoms of pain and radiculopathy may not be present. The natural history of myelopathy is characterized by neurological deterioration. The most frequently encountered symptom is gait abnormality (86%) followed by increased muscular reflexes (79.1%), pathological reflexes (65.1%), paresthesia of upper limb (69.8%) and pain (67.4%) Vitzthum, Hans-Ekkehart, Dalitz, Kristina

**MRI for Evaluation of Discitis** – Discitis is a known complication of cervical discography. Postoperative discitis in the cervical spine does not occur frequently but result from accidental inoculation of bacteria into the disc space intra-operatively by a contaminated spinal needle being used as a radiological marker. There may be other causes for postoperative discitis, e.g., esophageal perforation, hematogenous spread, inoculation of bacteria during surgery. Patients with an alteration in the nature of their symptoms after cervical discectomy and fusion may have discitis. Symptoms may include complaints of mild paresthesia in extremities and neck pain. MRI may be performed to reveal feature of discitis with associated abscesses and may help to confirm the diagnosis and decide on the further management.

**MRI for Cervical Radiculopathy** – MRI is a useful test to evaluate the spine because it can show abnormal areas of the soft tissues around the spine; it addition to the bones, it can also show pictures of the nerves
and discs and is used to find tumors, herniated discs or other soft-tissue disorders. MRI has a role both in the pre-operative screening and post-operative assessment of radicular symptoms due to either disc or osteophyte.

MRI and Multiple Sclerosis (MS) – MRI is a sensitive method of detecting the white matter lesions of MS. These plaques on MRI generally appear as multiple, well demarcated, homogenous, small ovoid lesions which lack mass effect and are oriented perpendicular to the long axis of the lateral ventricles. Sometimes they present as large, space occupying lesions that may be misinterpreted as tumors, abscesses or infarcts.

MRI and Neck Pain – Neck pain is common in the general population and usually relates to musculoskeletal causes but it may also be caused by spinal cord tumors. When neck pain is accompanied by extremity weakness, abnormal gait or asymmetric reflexes, spinal MRI may be performed to evaluate the cause of the pain. MRI may reveal areas of cystic expansion within the spinal cord. Enhancement with gadolinium contrast may suggest that the lesion is neoplastic.

Back Pain with Cancer History - Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history. This can make a diagnosis in many cases. This may occasionally allow for selection of bone scan in lieu of MRI in some cases. When radiographs do not answer the clinical question, then MRI may be appropriate after a consideration of conservative care.

For example, bone metastases occur in a minority of all breast cancer patients. Low stage breast cancer patients are very unlikely to have bone metastases (Coleman RE et al.). Radiographic (X-ray) evaluation prior to MRI is appropriate. A trial of conservative care in back pain is also indicated and appropriate in these low stage patients.

Advanced stage breast cancer patients do develop bone metastases in a slight majority of cases (Coleman RE et al.). Back pain in advanced stage breast cancer patients should still be initially evaluated with X-ray (which has the chance of demonstrating cause of pain, or identifying multiple metastases, and may change the subsequent imaging choice for optimal staging). However, these patients should, in most cases, not undergo a trial of conservative care.”

REFERENCES


CPT Codes: 72146, 72147, 72157

INTRODUCTION:

Magnetic resonance imaging produces high quality multiplanar images of organs and structures within the body without using ionizing radiation. It is used for evaluation, assessment of severity and follow-up of diseases of the spine and is the preferred modality for imaging intervertebral disc degeneration. High contrast resolution (soft tissue contrast) and multiplanar imaging (sagittal as well as axial planes) are helpful in the evaluation of possible disc herniation and detecting nerve root compression. MRI is one of the most useful techniques to evaluate spine infection and is also used to evaluate tumors, cancer and immune system suppression.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR THORACIC SPINE MRI:

For evaluation of neurologic deficits:
- With any of the following new neurological deficits: extremity weakness; abnormal reflexes; or abnormal sensory changes along a particular dermatome (nerve distribution) as documented on exam.

For evaluation of suspected myelopathy:
- Progressive symptoms including unsteadiness, broad-based gait, increased muscle tone, pins and needles sensation, weakness and wasting of the lower limbs, and diminished sensation to light touch, temperature, proprioception, and vibration; bowel and bladder dysfunction in more severe cases.

For evaluation of chronic back pain with any of the following:
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months.
- With progression or worsening of symptoms during the course of conservative treatment*.
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality.

For evaluation of new onset of back pain:
- Failure of conservative treatment* for at least six (6) weeks.
- With progression or worsening of symptoms during the course of conservative treatment*.
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality.

For evaluation of trauma or acute injury within past 72 hours:
- Presents with radiculopathy, muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
- With progression or worsening of symptoms during the course of conservative treatment*.

For evaluation of known tumor, cancer or evidence of metastasis:
- For staging of known tumor.
- For follow-up evaluation of patient undergoing active treatment.
• Presents with new signs or symptoms (e.g., laboratory and/or imaging findings) of new tumor or change in tumor
• Presents with radiculopathy, muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
• With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality.
• With evidence of metastasis on bone scan or previous imaging study.
• With no imaging/restaging within the past ten (10) months.

For evaluation of suspected tumor:
• Prior abnormal or indeterminate imaging that requires further clarification.

Indication for combination studies for the initial pre-therapy staging of cancer, OR ongoing tumor/cancer surveillance OR evaluation of suspected metastases:
• ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine.
  o Cancer surveillance – Active monitoring for recurrence as clinically indicated.

For evaluation of known or suspected infection, abscess, or inflammatory disease:
• As evidenced by signs/symptoms, laboratory or prior imaging findings.

For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, or lymphoma:
• As evidenced by signs/symptoms, laboratory or prior imaging findings.

For post-operative / procedural evaluation of surgery or fracture occurring within past six (6) months:
• A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.
• Changing neurologic status post-operatively.
• With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality.
• Surgical infection as evidenced by signs/symptoms, laboratory or prior imaging findings.
• Delayed or non-healing fracture as evidenced by signs/symptoms, laboratory or prior imaging findings.
• Continuing or recurring symptoms of any of the following neurological deficits: Lower extremity weakness, lower extremity asymmetric reflexes.

Other indications for a Thoracic Spine MRI:
• For preoperative evaluation
• Suspected cord compression with any of the following neurological deficits: extremity weakness; abnormal gait; asymmetric reflexes.
• For evaluation of suspicious sacral dimples associated with lesions such as hairy patches or hemangiomas.
• Known arnold-chiari syndrome.
• Syrinx or syringomyelia.

COMBINATION OF STUDIES WITH THORACIC SPINE MRI:

Cervical/Thoracic/Lumbar MRIs:
• Any combination of these for scoliosis survey in infant/child.
• Any combination of these for spinal survey in patient with metastases.
• For evaluation of spinal abnormalities associated with Chiari Malformation.

ADDITIONAL INFORMATION RELATED TO THORACIC SPINE MRI

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

*Conservative Therapy: (spine) should include a multimodality approach consisting of a combination of active and inactive components. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a physician supervised home exercise program**, and/or chiropractic care.

**Home Exercise Program - (HEP) – the following two elements are required to meet guidelines for completion of conservative therapy:
  o Information provided on exercise prescription/plan AND
  o Follow up with member with documentation provided regarding completion of HEP (after suitable 6 week period), or inability to complete HEP due to physical reason- i.e. increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).

MRI and Spinal Infections – Infection of the spine is not easy to differentiate from other spinal disorders, e.g., degenerative disease, spinal neoplasms, and noninfectious inflammatory lesions. Infections may affect different parts of the spine, e.g., vertebrae, intervertebral discs and paraspinal tissues. Imaging is important to obtain early diagnose and treatment to avoid permanent neurology deficits. MRI is the preferred imaging technique to evaluate infections of the spine. With its high contrast resolution and direct multiplanar imaging, it has the ability to detect and delineate infective lesions irrespective of their spinal location.

MRI and Degenerative Disc Disease – Degenerative disc disease is very common and MRI is indicated when chronic degenerative changes are accompanied by conditions, e.g., new neurological deficits; onset of joint tenderness of a localized area of the spine; new abnormal nerve conductions studies; exacerbation of chronic back pain unresponsive to conservative treatment; and unsuccessful physical therapy/home exercise program.

MRI and Multiple Sclerosis (MS) – MRI is a sensitive method of detecting the white matter lesions of MS. These plaques on MRI generally appear as multiple, well demarcatced, homogenous, small ovoid lesions which lack mass effect and are oriented perpendicular to the long axis of the lateral ventricles. Sometimes they present as large, space occupying lesions that may be misinterpreted as tumors, abscesses or infarcts.

Back Pain with Cancer History - Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history. This can make a diagnosis in many cases. This may occasionally allow for selection of bone scan in lieu of MRI in some cases. When radiographs do not answer the clinical question, then MRI may be appropriate after a consideration of conservative care.
For example, bone metastases occur in a minority of all breast cancer patients. Low stage breast cancer patients are very unlikely to have bone metastases (Coleman RE et al). Radiographic (X-ray) evaluation prior to MRI is appropriate. A trial of conservative care in back pain is also indicated and appropriate in these low stage patients.

Advanced stage breast cancer patients do develop bone metastases in a slight majority of cases (Coleman RE et al). Back pain in advanced stage breast cancer patients should still be initially evaluated with X-ray (which has the chance of demonstrating cause of pain, or identifying multiple metastases, and may change the subsequent imaging choice for optimal staging). However, these patients should, in most cases, not undergo a trial of conservative care."

REFERENCES


CPT Codes: 72148, 72149, 72158

INTRODUCTION:

Magnetic resonance imaging (MRI) is used in the evaluation, diagnosis and management of spine related conditions, e.g., degenerative disc disease, cauda equine compression, radiculopathy, infections, or cancer in the lumbar spine. MRI provides high quality multiplanar images of organs and structures within the body without the use of x-rays or radiation. In the lumbar area where gonadal exposure may occur, MRI’s lack of radiation is an advantage.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR LUMBAR SPINE MRI:

For evaluation of neurologic deficits:
- With any of the following new neurological deficits: lower extremity weakness; abnormal reflexes; abnormal sensory changes along a particular dermatome (nerve distribution) as documented on exam; evidence of Cauda Equina Syndrome; bowel or bladder dysfunction; new foot drop.

For evaluation of chronic back pain with any of the following:
- Failure of conservative treatment* for at least six (6) weeks within the last six (6) months
- With progression or worsening of symptoms during the course of conservative treatment*
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality

For evaluation of new onset of back pain:
- Failure of conservative treatment*, for at least six (6) weeks
- With progression or worsening of symptoms during the course of conservative treatment*
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality

For evaluation of trauma or acute injury within past 72 hours:
- Presents with radiculopathy, muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
- With progression or worsening of symptoms during the course of conservative treatment*.

For evaluation of known tumor, cancer or evidence of metastasis:
- For staging of known tumor.
- For follow-up evaluation of patient undergoing active treatment.
- Presents with new signs or symptoms (e.g., laboratory and/or imaging findings) of new tumor or change in tumor
- Presents with radiculopathy, muscle weakness, abnormal reflexes, and/or sensory changes along a particular dermatome (nerve distribution).
- With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality
• With evidence of metastasis on bone scan or previous imaging study.
• With no imaging/restaging within the past ten (10) months.

**For evaluation of suspected tumor:**
• Prior abnormal or indeterminate imaging that requires further clarification.

**Indication for combination studies for the initial pre-therapy staging of cancer, OR ongoing tumor/cancer surveillance OR evaluation of suspected metastases:**
• ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine.
  o Cancer surveillance – Active monitoring for recurrence as clinically indicated.

**For evaluation of known or suspected infection, abscess, or inflammatory disease:**
• As evidenced by signs/symptoms, laboratory or prior imaging findings.

**For evaluation of spine abnormalities related to immune system suppression, e.g., HIV, chemotherapy, leukemia, lymphoma:**
• As evidenced by signs/symptoms, laboratory or prior imaging findings.

**For post-operative / procedural evaluation of surgery or fracture occurring within past six (6) months:**
• A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.
• Changing neurologic status post-operatively.
• With an abnormal electromyography (EMG) or nerve conduction study (if performed) indicating a spinal abnormality.
• Surgical infection as evidenced by signs/symptoms, laboratory or prior imaging findings.
• Delayed or non-healing fracture as evidenced by signs/symptoms, laboratory or prior imaging findings.
• Continuing or recurring symptoms of any of the following neurological deficits: Lower extremity weakness, lower extremity asymmetric reflexes.

**Other indications for a Lumbar Spine MRI:**
• For preoperative evaluation.
• Tethered cord, known or suspected spinal dysraphism.
• For evaluation of suspicious sacral dimples associated with lesions such as hairy patches or hemangiomas.
• Ankylosing Spondylitis - For diagnosis when suspected as a cause of back or sacroiliac pain and completion of the following initial evaluation:
  o History of back pain associated with morning stiffness
  o Sedimentation rate and/or C-reactive protein
  o HLA B27
  o Non-diagnostic or indeterminate x-ray
• Known arnold-chiari syndrome.

**COMBINATION OF STUDIES WITH LUMBAR SPINE MRI:**

**Cervical/Thoracic/Lumbar MRIs:**
• Any combination of these for scoliosis survey in infant/child.
• Any combination of these for spinal survey in patient with metastasis.
• For evaluation of spinal abnormalities associated with Chiari Malformation.
ADDITIONAL INFORMATION RELATED TO LUMBAR SPINE MRI:

**MRI imaging** – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O2 tanks may also be contraindicated.

*Conservative Therapy*: (spine) should include a multimodality approach consisting of a combination of active and inactive components. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point), and diathermy can be utilized. Active modalities may consist of physical therapy, a physician supervised home exercise program**, and/or chiropractic care.

**Home Exercise Program - (HEP)** – the following two elements are required to meet guidelines for completion of conservative therapy:
- Information provided on exercise prescription/plan AND
- Follow up with member with documentation provided regarding completion of HEP (after suitable 6 week period), or inability to complete HEP due to physical reason i.e. increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).

**MRI and Back Pain** – MRI is the initial imaging modality of choice in the evaluation of complicated low back pain. Contrast administration may be used to evaluate suspected inflammatory disorders, e.g., discitis, and it is useful in evaluating suspected malignancy. Radiculopathy, disease of the nerve roots, is the most common indication for MRI of patients with low back pain. The nerve roots become irritated and inflamed, due to direct pressure from degenerative changes in the lumbar spine, creating pain and numbness. Symptoms of radiculopathy also include muscle weakness. MRI is indicated for this condition if the symptoms do not improve after conservative treatment over six weeks. MRI is also performed to evaluate Cauda equina syndrome, severe spinal compression.

**Tethered spinal cord syndrome** - a neurological disorder caused by tissue attachments that limit the movement of the spinal cord with the spinal column. Although this condition is rare, it can continue undiagnosed into adulthood. The primary cause is myelomeningocele and lipomyelomeningocele; the following are other associations that vary in severity of symptoms and treatment.
- Dermal sinus tract (a rare congenital deformity)
- Diastematomyelia (split spinal cord)
- Lipoma
- Tumor
- Thickened/tight filum terminale (a delicate filament near the tailbone)
- History of spine trauma/surgery
- Arnold Chiari Malformation

Magnetic resonance imaging (MRI) can display the low level of the spinal cord and a thickened filum terminale, the thread-like extension of the spinal cord in the lower back. Treatment depends upon the underlying cause of the tethering. If the only abnormality is a thickened, shortened filum then limited surgical treatment may suffice.

**Back Pain with Cancer History** – Radiographic (x-ray) examination should be performed in cases of back pain when a patient has a cancer history. This can make a diagnosis in many cases. This may
occasionally allow for selection of bone scan in lieu of MRI in some cases. When radiographs do not answer the clinical question, then MRI may be appropriate after a consideration of conservative care.

For example, bone metastases occur in a minority of all breast cancer patients. Low stage breast cancer patients are very unlikely to have bone metastases (Coleman RE et al). Radiographic (X-ray) evaluation prior to MRI is appropriate. A trial of conservative care in back pain is also indicated and appropriate in these low stage patients.

Advanced stage breast cancer patients do develop bone metastases in a slight majority of cases (Coleman RE et al). Back pain in advanced stage breast cancer patients should still be initially evaluated with X-ray (which has the chance of demonstrating cause of pain, or identifying multiple metastases, and may change the subsequent imaging choice for optimal staging). However, these patients should, in most cases, not undergo a trial of conservative care.”

REFERENCES


CPT Codes: 72159

INTRODUCTION:

Application of spinal magnetic resonance angiography (MRA) allows for more effective and noninvasive screening for vascular lesions than magnetic resonance imaging (MRI) alone. It may improve characterization of normal and abnormal intradural vessels while maintaining good spatial resolution. Spinal MRA is used for the evaluation of spinal arteriovenous malformations, cervical spine fractures and vertebral artery injuries.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR SPINAL CANAL MRA:

- For the evaluation of spinal arteriovenous malformation (AVM).
- For the evaluation of a cervical spine fracture.
- For the evaluation of known or suspected vertebral artery injury.

ADDITIONAL INFORMATION RELATED TO SPINAL CANAL MRA:

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

Spinal Arteriovenous Malformations (AVMs) – Spinal cord arteriovenous malformations are comprised of snarled tangles of arteries and veins which affect the spinal cord. They are fed by spinal cord arteries and drained by spinal cord veins. Magnetic resonance angiography (MRA) can record the pattern and velocity of blood flow through vascular lesions as well as the flow of cerebrospinal fluid throughout the spinal cord. MRA defines the vascular malformation and may assist in determining treatment.

Cervical Spine Fracture – The American College of Radiology (ACR) appropriateness criteria scale indicates that MRA of the neck is most appropriate for suspected acute cervical spine trauma and where clinical or imaging findings suggest arterial injury.

Vertebral Artery Injury – Two-dimensional time-of-flight (2D TOF) magnetic resonance angiography (MRA) is used for detecting vertebral artery injury in cervical spine trauma patients.
REFERENCES


INTRODUCTION:

Magnetic resonance imaging of the pelvis is a noninvasive technique for the evaluation, assessment of severity, and follow-up of diseases of the male and female pelvic organs. MRI provides excellent contrast of soft tissues and provides multiplanar and 3D depiction of pathology and anatomy. Patients undergoing MRI do not have exposure to ionizing radiation or iodinated contrast materials.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR PELVIC MRI:

For known or suspected prostate cancer and for recurrence workup:
- Initial treatment by radical prostatectomy:
  - Failure of PSA to fall to undetectable levels or PSA detectable and rising on at least 2 subsequent determinations.
- Initial treatment radiation therapy:
  - Post-RT rising PSA or positive digital exam and is candidate for local therapy.
- In patients without confirmed diagnosis of prostate cancer (with persistently elevated or rising PSA and prior negative biopsy).
- Prostatic cancer with:
  - PSA greater than twenty
  - Gleason score of seven or greater.

Evaluation of suspicious known mass/tumors (unconfirmed diagnosis of cancer) for further evaluation of indeterminate or questionable findings:
- Initial evaluation of suspicious pelvic masses/tumors found only in the pelvis by physical exam or imaging study, such as Ultrasound (US).
- Surveillance: One follow-up exam to ensure no suspicious change has occurred in a tumor in the pelvic. No further surveillance unless tumor(s) are specified as highly suspicious, or change was found on last follow-up.

Evaluation of known cancer for further evaluation of indeterminate or questionable findings, identified by physical examination or imaging exams such as Ultrasound (US) and CT:
- Initial staging of known cancer:
  - All cancers, excluding the following:
    - Basal Cell Carcinoma of the skin,
    - Melanoma without symptoms or signs of metastasis.
- Three (3) month follow-up of known pelvic cancer undergoing active treatment within the past year.
- Six (6) month follow-up of known pelvic cancer undergoing active treatment within the past year.
- Follow-up of known cancer of patient undergoing active treatment within the past year.
- Known cancer with suspected pelvic metastasis based on a sign, symptom or an abnormal lab value.
- Cancer surveillance: Active monitoring for recurrence as clinically indicated.
For evaluation of suspected infection or inflammatory disease:
- Suspected acute appendicitis (or severe acute diverticulitis) if pelvic pain and tenderness to palpation is present, with at LEAST one of the following:
  - WBC elevated
  - Fever
  - Anorexia or
  - Nausea and vomiting.
- Suspected complications of diverticulitis (known to be limited to the pelvis by prior imaging) with pelvic pain or severe tenderness, not responding to antibiotic treatment.
- Suspected infection in the pelvis.

For evaluation of known infection or inflammatory disease follow up:
- Complications of diverticulitis with severe abdominal pain or severe tenderness or mass, not responding to antibiotic treatment, (prior imaging study is not required for diverticulitis diagnosis).
- Known inflammatory bowel disease, (Crohn’s or ulcerative colitis) with recurrence or worsening signs/symptoms requiring re-evaluation.
- Any known infection that is clinically suspected to have created an abscess in the pelvis.
- Any history of fistula that is clinically suspected to have recurred.
- Abnormal fluid collection seen on prior imaging that needs follow-up evaluation.
- Known infection in the pelvis.

Pre-operative evaluation:
For pelvic surgery or procedure.

For post-operative/procedural evaluation:
- Follow-up of known or suspected post-operative complication involving the hips or the pelvis.
- A follow-up study to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed.

Indications for Musculoskeletal Pelvic MRI:
- Initial evaluation of suspicious mass/tumor of the bones, muscles or soft tissues of the pelvis found on an imaging study, and needing clarification, or found by physical exam and remains non-diagnostic after x-ray or ultrasound.
- Evaluation of suspected fracture and/or injury when initial imaging is inconclusive or needs further evaluation.
- For evaluation of known or suspected aseptic/avascular necrosis of hip(s).
- Sacroiliitis (infectious or inflammatory)
- Sacroiliac Joint Dysfunction:
  - Persistent back and/or sacral pain unresponsive to four (4) weeks of conservative treatment, received within the past six (6) months, including physical therapy or physician supervised home exercise plan (HEP).
- Persistent Pain:
  - For evaluation of persistent pain unresponsive to four (4) weeks of conservative treatment received within the past six (6) months.
- Pelvic floor failure:
  - For evaluation of incontinence and anatomical derangements including, but not limited to uterine prolapse, rectocele, cystocele.
For further evaluation of congenital anomalies of the sacrum and pelvis and initial imaging has been performed.

Athletic pubalgia:

For evaluation of persistent groin or symphsis pubis pain related to a suspected diagnosis of athletic pubalgia (sports hernia), when ordered by a general surgeon, orthopedic surgeon or sports medicine specialist, when xrays are unrevealing.

**Indication for combination studies for the initial pre-therapy staging of cancer, OR ongoing tumor/cancer surveillance OR evaluation of suspected metastases:**

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine
  - Cancer surveillance – Active monitoring for recurrence as clinically indicated.

**Other Indications for a Pelvic MRI:**

- For location or evaluation of undescended testes in adults and in children, including determination of location of testes, where ultrasound has been done previously.
- To provide an alternative to follow-up of an indeterminate pelvic CT when previous CT/Ultrasound was equivocal and needed to clarify a finding a CT could not.
- For evaluation and characterization of uterine and adnexal masses, (e.g., fibroids, ovaries, tubes and uterine ligaments), or congenital abnormality where ultrasound has been done previously.
- For evaluation of uterus prior to embolization.
- For evaluation of endometriosis.
- Prior to uterine surgery if there is abnormality suspected on prior ultrasound.
- For evaluation of known or suspected abnormality of the fetus noted on prior imaging and no prior pelvis MRI.

**ADDITIONAL INFORMATION RELATED TO PELVIC MRI:**

*Conservative Therapy - Sacroiliac Joint Dysfunction* should include a multimodality approach consisting of a combination of active and inactive components. Inactive components, such as rest, ice, heat, modified activities, medical devices, acupuncture and/or stimulators, medications, injections (epidural, facet, bursal, and/or joint, not including trigger point, and diathermy can be utilized. Active modalities may consist of physical therapy, a physician supervised home exercise program**, and/or chiropractic care.

**Home Exercise Program - (HEP)** – the following two elements are required to meet guidelines for completion of conservative therapy:

- Information provided on exercise prescription/plan AND
- Follow up with member with documentation provided regarding completion of HEP (after suitable 6 week period), or inability to complete HEP due to physical reason- i.e. increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).

**MRI Imaging** – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

**MRI and Undescended Testes** – The most common genital malformation in boys is undescended testis. The timely management of undescended testis is important to potentially minimize the risk of infertility
and less the risk of malignancy. MRI is used as a diagnostic tool in the detection of undescended testes and can reveal information for both anatomic and tissue characterization. It is noninvasive, non-ionizing, and can obtain multiplanar images.

**MRI and Adnexal Masses** – MRI is used in the evaluation of adnexal masses in pregnancy. It can identify and characterize different neoplastic and nonneoplastic abnormalities, e.g., exophytic leiomyoma, endometrioma, dermoid cyst, and ovarian edema. It is a useful adjunct when sonography is inconclusive in the evaluation of adnexal masses in pregnancy.

**MRI and Endometriosis** – MRI manifestations of endometriosis vary including endometrioma, peritoneal endometrial implant, adhesion and other rare features. The data obtained from imaging must be combined with clinical data to perform preoperative assessment of endometriosis.

**MRI and Prostate Cancer** – Although prostate cancer is the second leading cause of cancer in men, the majority of cases do not lead to a prostate cancer related death. Aggressive treatment of prostate cancer can have side effects such as incontinence, rectal injury and impotence. It is very important to do an evaluation which will assist in making decisions about therapy or treatment. MRI can non-invasively assess prostate tissue, functionally and morphologically. MRI evaluation may use a large array of techniques, e.g., T1-weighted images, T2-weighted images, and dynamic contrast enhanced T1-weighted images.

**Prostate Cancer** – For symptomatic patients and/or those with a life expectancy of greater than 5 years, a bone scan is appropriate for patients with T1 to T2 disease who also have a PSA greater than 20ng/mL or a Gleason score of 8 or higher. Patients with a T3 to T4 disease or symptomatic disease should also receive a bone scan. Pelvic computed tomography (CT) or magnetic resonance imaging (MRI) scanning is recommended if there is T3 or T4 disease, or T1 or T2 disease and a nomogram indicates that there is greater than 20% chance of lymph node involvement, although staging studies may not be cost effective until the chance of lymph node positively reaches 45%. Biopsy should be considered for further evaluation of suspicious nodal findings. For all other patients, no addition imaging is required for staging.

Men who suffer a biochemical recurrence following prostatectomy fall into two groups: (1) those whose PSA level fails to fall to undetectable levels after surgery, or (2) those who achieve an undetectable PSA after surgery with a subsequent detectable PSA level that increases on two or more laboratory determinations. Since PSA elevation alone does not necessary lead to clinical failure, the workup for both of these groups focuses on the assessment of distant metastasis. The specific tests depend on the clinical history, but potentially include a bone scan, biopsy, PSA doubling time assessment, CT/MRI or radioimmunologic scintigraphy. (i.e. ProstaScint scan). Bone scans are appropriate when patients develop symptoms or when the PSA level is increasing rapidly. In one study, the probability of a positive bone scan for a patient not on ADT after radical prostatectomy was less then 5% unless the PSA increased to 40 to 45 ng/mL.

Further work up is indicated in patients who are considered candidates for local therapy. These patients include those with original clinical stage T1-2, a life expectancy of greater than 10 years, and a current PSA of less than 10ng/mL. Work up includes a prostate biopsy, bone scan and additional tests as clinically indicated such as abdominal/pelvic CT, MRI or radioimmunologic scintigraphy. (i.e. ProstaScint scan).
A negative biopsy following post-radiation biochemical recurrence poses clinical uncertainties. Observation, ADT, or enrolling in clinical trials is viable options. Alternatively, the patients may undergo more aggressive workup, such as repeat biopsy, MR spectroscopy, and or endorectal MRI.

Fusion imaging of multi-parametric magnetic resonance imaging (MRI) and trasrectal ultrasound (TRUS) to guide prostate biopsy is not covered.

**MRI and Rectal Cancer** – MRI is used in the evaluation of rectal cancer to visualize not only the intestinal wall but also the surrounding pelvic anatomy. MRI is an excellent imaging technique due to its high soft-tissue contrast, powerful gradient system, and high resolution. It provides accurate evaluation of the topographic relationship between lateral tumor extent and the mesorectal fascia.

**REFERENCES**


CPT Codes: 72198

INTRODUCTION:

Magnetic resonance angiography (MRA) generates images of the arteries that can be evaluated for evidence of stenosis, occlusion or aneurysms. It is used to evaluate the arteries of the abdominal aorta and the renal arteries. Contrast enhanced MRA requires the injection of a contrast agent which results in very high quality images. It does not use ionizing radiation, allowing MRA to be used for follow-up evaluations.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR PELVIS MRA:

For evaluation of known or suspected pelvic vascular disease:
- For known large vessel diseases (abdominal aorta, inferior vena cava, superior/inferior mesenteric, celiac, splenic, renal or iliac arteries/veins), e.g., aneurysm, dissection, arteriovenous malformations (AVMs), and fistulas, intramural hematoma, and vasculitis.
- Evidence of vascular abnormality seen on prior imaging studies.
- For suspected pelvic extent of aortic dissection.
- Evaluation of suspected or known aneurysms limited to the pelvis or in evaluating pelvic extent of aortic aneurysm
  - Suspected or known iliac artery aneurysm (≥2.5 cm AND equivocal or indeterminate ultrasound results OR
  - Prior imaging (e.g. Ultrasound) demonstrating iliac artery aneurysm >2.5cm in diameter OR
  - Suspected complications of known aneurysm as evidenced by clinical findings such as new onset of pelvic pain.
  - Follow up of iliac artery aneurysm: Six month if between 3.0-3.5 cm and if stable follow yearly. If ≥3.5 cm, <six month follow up (and consider intervention)
- Suspected retroperitoneal hematoma or hemorrhage.
- For evaluation of suspected pelvic vascular disease when findings on ultrasound are indeterminate.
- Venous thrombosis if previous studies have not resulted in a clear diagnosis.
- Vascular invasion or displacement by tumor.
- Pelvic vein thrombosis or thrombophlebitis.

Pre-operative evaluation:
- Evaluation of interventional vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia.

Post-operative or post-procedural evaluation:
- Evaluation of endovascular/interventional vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia.
- Evaluation of post-operative complications, e.g. pseudoaneurysms, related to surgical bypass grafts, vascular stents and stent-grafts in peritoneal cavity.
• Follow-up for post-endovascular repair (EVAR) or open repair of abdominal aortic aneurysm (AAA). Routine, baseline study (post-op/intervention) is warranted within 1-3 months.
  ▪ Asymptomatic at six (6) month intervals, for two (2) years.
  ▪ Symptomatic/complications related to stent graft – more frequent imaging may be needed.
• Follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

ADDITIONAL INFORMATION RELATED TO PELVIS MRA:

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

Abdomen/Pelvis MRA & Lower Extremity MRA Runoff Requests: Two auth requests are required, one Abd MRA, CPT code 74185 and one for Lower Extremity MRA, CPT code 73725. This will provide imaging of the abdomen, pelvis and both legs.

Bruits: blowing vascular sounds heard over partially occluded blood vessels. Abdominal bruits may indicate partial obstruction of the aorta or other major arteries such as the renal, iliac, or femoral arteries. Associated risks include but are not limited to: renal artery stenosis, aortic aneurysm, atherosclerosis, AVM, or coarctation of aorta.

MRA and Chronic Mesenteric Ischemia – Contrast-enhanced MRA is used for the evaluation of chronic mesenteric ischemia including treatment follow-up. Chronic mesenteric ischemia is usually caused by severe atherosclerotic disease of the mesenteric arteries, e.g., celiac axis, superior mesenteric artery, inferior mesenteric artery. At least two of the arteries are usually affected before the occurrence of symptoms such as abdominal pain after meals and weight loss. MRA is the technique of choice for the evaluation of chronic mesenteric ischemia in patients with impaired renal function.

MRA and Abdominal Aortic Aneurysm Repair – MRA may be performed before endovascular repair of an abdominal aortic aneurysm. Endovascular repair of abdominal aortic aneurysm is a minimally invasive alternative to open surgical repair and its success depends on precise measurement of the dimensions of the aneurysm and vessels. This helps to determine selection of an appropriate stent-graft diameter and length to minimize complications such as endoleakage. MRA provides images of the aorta and branches in multiple 3D projections and may help to determine the dimensions needed for placement of an endovascular aortic stent graft. MRA is noninvasive and rapid and may be used in patients with renal impairment.

REFERENCES


INTRODUCTION:
Magnetic resonance imaging shows the soft tissues and bones. With its multiplanar capabilities, high contrast and high spatial resolution, it is an accurate diagnostic tool for conditions affecting the joint and adjacent structures. MRI has the ability to positively influence clinicians' diagnoses and management plans for patients with conditions such as primary bone cancer, fractures, and abnormalities in ligaments, tendons/cartilages, septic arthritis, and infection/inflammation.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR UPPER EXTREMITY MRI (HAND, WRIST, ARM, ELBOW or SHOULDER) (plain radiographs must precede MRI evaluation):

Evaluation of suspicious mass/tumor (unconfirmed cancer diagnosis):
• Initial evaluation of suspicious mass/tumor found on an imaging study and needing clarification, or found by physical exam and remains non-diagnostic after x-ray or ultrasound is completed.
• Suspected tumor size increase or recurrence based on a sign, symptom, imaging study or abnormal lab value.
• Surveillance: One follow-up exam if initial evaluation is indeterminate and lesion remains suspicious for cancer. No further surveillance unless tumor is specified as highly suspicious, or change was found on last imaging.

Evaluation of known cancer:
• Initial staging of known cancer in the upper extremity.
• Follow-up of known cancer of patient undergoing active treatment within the past year.
• Known cancer with suspected upper extremity metastasis based on a sign, symptom, imaging study or abnormal lab value.
• Cancer surveillance: Active monitoring for recurrence as clinically indicated

For evaluation of known or suspected infection or inflammatory disease (e.g. osteomyelitis):
• Further evaluation of an abnormality or non-diagnostic findings on prior imaging.
• With abnormal physical, laboratory, and/or imaging findings.
• Known or suspected (based upon initial workup including x-ray) of septic arthritis or osteomyelitis.

For evaluation of suspected (AVN) avascular necrosis (i.e. aseptic necrosis):
• Further evaluation of an abnormality or non-diagnostic findings on prior imaging.

For evaluation of suspected or known auto immune disease, (e.g. rheumatoid arthritis):
• Known or suspected auto immune disease and non-diagnostic findings on prior imaging.

For evaluation of known or suspected fracture and/or injury:
• Further evaluation of an abnormality or non-diagnostic findings on prior imaging.
• Suspected fracture when imaging is negative or equivocal.
• Determine position of known fracture fragments/dislocation.

For evaluation of persistent pain and initial imaging (e.g. x-ray) has been performed:
• Chronic (lasting 3 months or greater) pain and/or persistent tendonitis unresponsive to conservative treatment*, within the last 6 months which include medical therapy (may include physical therapy or chiropractic treatments) and/or physician supervised exercise** of at least four (4) weeks, OR
• With progression or worsening of symptoms during the course of conservative treatment.

Pre-operative evaluation

Post-operative/procedural evaluation:
• When imaging, physical or laboratory findings indicate joint infection, delayed or non-healing or other surgical/procedural complications.
• A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Other indications for an Upper Extremity (Hand, Wrist, Arm, Elbow, or Shoulder) MRI:
• Abnormal bone scan and x-ray is non-diagnostic or requires further evaluation.
• MR arthrogram.
• To assess status of osteochondral abnormalities including osteochondral fractures, osteochondritis dissecans, treated osteochondral defects where physical or imaging findings suggest its presence.

Additional indications for Shoulder MRI:
• For evaluation of known or suspected impingement, rotator cuff tear, or labral tear (SLAP lesion, Bankart lesion).
• Known or suspected impingement or when impingement test is positive.
• Impingement or rotator cuff tear indicated by positive Neer’s sign, Hawkin’s sign or drop sign.
• Status post prior rotator cuff repair with suspected re-tear and findings on prior imaging are indeterminate.
• For evaluation of brachial plexus dysfunction (brachial plexopathy/thoracic outlet syndrome).
• For evaluation of recurrent dislocation.

Additional indications for Wrist MRI:
• For evaluation of suspected ligament injury with evidence of wrist instability on examination or evidence of joint space widening on x-ray
• For suspected TFCC (triangular fibrocartilage complex) injury.

ADDITIONAL INFORMATION RELATED TO UPPER EXTREMITY MRI:

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O2 tanks may also be contraindicated.

*Conservative Therapy: (musculoskeletal) should include a multimodality approach consisting of a combination of active and inactive components. Inactive components such as rest, ice, heat, modified
activities, medical devices, (such as crutches, immobilizer, metal braces, orthotics, rigid stabilizer or splints, etc and not to include neoprene sleeves), medications, injections (bursal, and/or joint, not including trigger point), and diathermy, can be utilized. Active modalities may consist of physical therapy, a physician supervised home exercise program**, and/or chiropractic care. NOTE: for joint and extremity injuries, part of this combination may include the physician instructing patient to rest the area or stay off the injured part.

**Home Exercise Program - (HEP) – the following two elements are required to meet guidelines for completion of conservative therapy:

- Information provided on exercise prescription/plan AND
- Follow up with member with information provided regarding completion of HEP (after suitable 4 week period), or inability to complete HEP due to physical reason- i.e. increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).

Rotator Cuff Tears – 3.0 Tesla MRI has been found valuable for the detection of partial thickness rotator cuff tendon tears and small rotator cuff tendon tears. It is especially useful in detecting the partial tears due to increased spatial resolution. Increased spatial resolution results in precise measurements of rotator cuff tendon tears in all 3 planes and it also reduces acquisition time which reduces motion artifacts. 3.0 Tesla makes it possible to adequately evaluate tendon edges and avoid under-estimation of tears. MRI is less invasive than MR arthrography and it is faster and less expensive. MRI may be useful in the selection of patients that may benefit from arthroscopic

MRI and Occult Fractures – Magnetic resonance imaging may help to detect occult fractures of the elbow when posttraumatic elbow effusions are shown on radiographs without any findings of fracture. Effusions may be visualized on radiographs as fat pads, which can be elevated by the presence of fluid in the joint caused by an acute fracture. MRI may be useful when effusions are shown on radiographs without a visualized fracture, but there is a clinical suspicion of a lateral condylar or radial head fracture.

MRI and Avascular Necrosis – Sports such as racquetball and gymnastics may cause repeated microtrauma due to the compressive forces between the radial head and capitellum. Focal avascular necrosis and osteochondritis dissecans of the capitellum may result. MRI can be used to evaluate the extent of subchondral necrosis and chondral abnormalities. The images may also help detect intraarticular loose bodies.

MRI and Acute Osseous Trauma – Many elbow injuries result from repetitive microtrauma rather than acute trauma and the injuries are sometimes hard to diagnose. Non-displaced fractures are not always evident on plain radiographs. When fracture is suspected, MRI may improve diagnostic specificity and accuracy. T1-weighted images can delineate morphologic features of the fracture.

MRI and Brachial Plexus - MRI is the only diagnostic tool that accurately provides high resolution imaging of the brachial plexus. The brachial plexus is formed by the cervical ventral rami of the lower cervical and upper thoracic nerves which arise from the cervical spinal cord, exit the bony confines of the cervical spine, and traverse along the soft tissues of the neck, upper chest, and course into the arms.

REFERENCES


CPT Codes: 73225

INTRODUCTION:

Magnetic resonance angiography (MRA) is a noninvasive alternative to catheter angiography for evaluation of vascular structures in the upper extremity. Magnetic resonance venography (MRV) is used to image veins instead of arteries. MRA and MRV are less invasive than conventional x-ray digital subtraction angiography.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR UPPER EXTREMITY MRA/MRV:

For assessment/evaluation of known or suspected vascular disease/condition:
- For evaluation of suspected vascular disease aneurysm, arteriovenous malformation, fistula, vasculitis, or intramural hematoma.
- For evaluation of Raynaud's syndrome.
- For evaluation of vascular invasion or displacement by tumor.
- For evaluation of complications of interventional vascular procedures, e.g., pseudoaneurysms related to surgical bypass grafts, vascular stents, or stent-grafts.
- For evaluation of suspected upper extremity embolism or thrombosis.

Preoperative evaluations:
- For preoperative evaluation from known vascular disease/condition.

Postoperative/procedural evaluations:
- A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

ADDITIONAL INFORMATION RELATED TO UPPER EXTREMITY MRA/MRV:

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

Bruits - blowing vascular sounds heard over partially occluded blood vessels. Abdominal bruits may indicate partial obstruction of the aorta or other major arteries such as the renal, iliac, or femoral arteries. Associated risks include but are not limited to: renal artery stenosis, aortic aneurysm, atherosclerosis, AVM, Coarctation of aorta.

MRA/MRV and Raynaud’s Syndrome – Raynaud’s syndrome is evidenced by episodic waxy pallor or cyanosis of the fingers caused by vasoconstriction of small arteries or arterioles in the fingers. It usually
occurs due to a response to cold or to emotional stimuli. CTA may be used in the evaluation of Raynaud’s syndrome.

**MRA/MRV and Stenosis or Occlusion** – MRA of the central veins of the chest is used for the detection of central venous stenoses and occlusions. High-spatial resolution MRA characterizes the general morphology and degree of stenosis. Enlarged and well-developed collateral veins in combination with the non-visualization of a central vein may be indicative of chronic occlusion, whereas less-developed or absent collateral veins are suggestive of acute occlusions. A hemodynamically significant stenosis may be indicated by the presence of luminal narrowing with local collaterals.

**REFERENCES**


CPT Codes: 73718, 73719, 73720, 73721, 73722, 73723

INTRODUCTION:

Magnetic resonance imaging shows the soft tissues and bones. With its multiplanar capabilities, high contrast and high spatial resolution, it is an accurate diagnostic tool for conditions affecting the joint and adjacent structures. MRI has the ability to positively influence clinicians’ diagnoses and management plans for patients with conditions such as primary bone cancer, fractures, and abnormalities in ligaments, tendons/cartilages, septic arthritis, and infection/inflammation.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR LOWER EXTREMITY MRI (FOOT, ANKLE, KNEE, LEG or HIP) (plain radiographs must precede MRI evaluation):

Evaluation of suspicious mass/tumor (unconfirmed cancer diagnosis):
- Initial evaluation of suspicious mass/tumor found on an imaging study, and needing clarification, or found by physical exam and remains non-diagnostic after x-ray or ultrasound is completed.
- Suspected tumor size increase or recurrence based on a sign, symptom, imaging study or abnormal lab value.
- Surveillance: One follow-up exam if initial evaluation is indeterminant and lesion remains suspicious for cancer. No further surveillance unless tumor is specified as highly suspicious, or change was found on last imaging.

Evaluation of known cancer:
- Initial staging of known cancer in the lower extremity.
- Follow-up of known cancer of patient undergoing active treatment within the past year.
- Known cancer with suspected lower extremity metastasis based on a sign, symptom, imaging study or abnormal lab value.
- Cancer surveillance: Active monitoring for recurrence as clinically indicated.

For evaluation of known or suspected infection or inflammatory disease (e.g. osteomyelitis):
- Further evaluation of an abnormality or non-diagnostic findings on prior imaging.
- With abnormal physical, laboratory, and/or imaging findings.
- Known or suspected (based upon initial workup including x-ray) of septic arthritis or osteomyelitis.

For evaluation of suspected (AVN) avascular necrosis (i.e. aseptic necrosis, Legg-Calve-Perthes disease in children):
- Further evaluation of an abnormality or non-diagnostic findings on prior imaging.

For evaluation of suspected or known auto immune disease, (e.g. rheumatoid arthritis):
- Known or suspected auto immune disease and non-diagnostic findings on prior imaging.

For evaluation of known or suspected fracture and/or injury:
• Further evaluation of an abnormality or non-diagnostic findings on prior imaging.
• Suspected fracture when imaging is negative or equivocal.
• Determine position of known fracture fragments/dislocation.

For evaluation of persistent pain and initial imaging (e.g. x-ray) has been performed:
• Chronic (lasting 3 months or greater) pain and/or persistent tendonitis unresponsive to conservative treatment*, within the last 6 months which include medical therapy (may include physical therapy or chiropractic treatments) and/or physician supervised exercise** of at least four (4) weeks, OR
• With progression or worsening of symptoms during the course of conservative treatment.

Pre-operative evaluation.

Post-operative/procedural evaluation:
• When imaging, physical or laboratory findings indicate joint infection, delayed or non-healing or other surgical/procedural complications.
• A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

Other indications for a Lower Extremity (Foot, Ankle, Knee, Leg or Hip) MRI:
• Abnormal bone scan and x-ray is non-diagnostic or requires further evaluation.
• MR arthrogram.
• To assess status of osteochondral abnormalities including osteochondral fractures, osteochondritis dissecans, treated osteochondral defects where physical or imaging findings suggest its presence.

Additional indication specific for FOOT or ANKLE MRI
• Chronic (lasting 3 months or greater) pain in a child or adolescent with painful rigid flat foot where imaging is unremarkable or equivocal or on clinician’s decision to evaluate for known or suspected tarsal coalition. Do not add 6 mnts to this; don’t mention conservative care here.
• Accompanied by physical findings of ligament damage such as an abnormal drawer test of the ankle or significant laxity on valgus or varus stress testing and/or joint space widening on x-rays.

Additional indications specific for KNEE MRI:
• Accompanied by blood in the joint (hemarthrosis) demonstrated by aspiration.
• Presence of a joint effusion.
• For evaluation of suspected Baker’s cyst or posterior knee swelling with ultrasound requiring further evaluation.
• Accompanied by physical findings of a meniscal injury determined by physical examination tests (McMurray’s, Apley’s) or significant laxity on varus or valgus stress tests.
• Accompanied by physical findings of anterior cruciate ligament (ACL) or posterior cruciate ligament (PCL) ligamental injury determined by the drawer test or the Lachman test.

Additional indications specific for HIP MRI:
• For evaluation of suspected slipped capital femoral epiphysis with non-diagnostic imaging.
• For any evaluation of patient with hip prosthesis or other implanted metallic hardware where prosthetic loosening or dysfunction is suspected on physical examination or imaging.
• Suspected labral tear of the hip with signs of clicking and pain with hip motion especially with hip flexion, internal rotation and adduction which can also be associated with locking and giving way sensations of the hip on ambulation.

ADDITIONAL INFORMATION RELATED TO A LOWER EXTREMITY MRI:

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

*Conservative Therapy: (musculoskeletal) should include a multimodality approach consisting of a combination of active and inactive components. Inactive components such as rest, ice, heat, modified activities, medical devices, (such as crutches, immobilizer, metal braces, orthotics, rigid stabilizer or splints, etc and not to include neoprene sleeves), medications, injections (bursal, and/or joint, not including trigger point), and diathermy, can be utilized. Active modalities may consist of physical therapy, a physician supervised home exercise program**, and/or chiropractic care. NOTE: for joint and extremity injuries, part of this combination may include the physician instructing patient to rest the area or stay off the injured part.

**Home Exercise Program - (HEP) – the following two elements are required to meet guidelines for completion of conservative therapy:
• Information provided on exercise prescription/plan AND
• Follow up with member with information provided regarding completion of HEP (after suitable 4 week period), or inability to complete HEP due to physical reason- i.e. increased pain, inability to physically perform exercises. (Patient inconvenience or noncompliance without explanation does not constitute “inability to complete” HEP).

MRI and Knee Trauma - MRI is an effective means of evaluating internal derangements of the knee with a very high accuracy for detection of meniscal injury. On MRI of the knee, meniscal injury may appear “free-floating”, corresponding to a meniscal avulsion or detachment from the tibial plateau. The floating meniscus seen on MRI is a result of significant trauma. It may also be associated with significant ligamentous injury. The results of the MRI are valuable to the surgeon as he plans to reattach the meniscus to the tibial plateau.

MRI and Osteonecrosis – Osteonecrosis is a complication of knee surgery which may be accompanied by new or persistent pain after meniscal surgery. It can be detected by MRI with subcortical low signal intensity of T1-weighted images with or without central high signal intensity on T2-weighted images. Osteonecrosis can result in collapse of the articular surface.

MRI and Legg-Calve-Perthes Disease (LPD) –This childhood condition is associated with an insufficient blood supply to the femoral head which is then at risk for osteonecrosis. Clinical signs of LPD include a limp with groin, thigh or knee pain. Flexion and adduction contractures may develop as the disease progresses and eventually movement may only occur in the flexion-extension plane. This condition is staged based on plain radiographic findings. MRI is used in identifying the early stage of LPD when normal plain films are normal. It is also used in preoperative planning to diagnose “hinge abduction” (lateral side of the femoral head contacts the acetabular margin and femoral head does not slide as it should). However, MRI is not used as a standard diagnostic tool.
MRI and Septic Arthritis – Young children and older adults are the most likely to develop septic arthritis in the hip joint. Early symptoms include pain in the hip, groin, or thigh along with a limping gait and fever. It is sometimes hard to differentiate this condition from transient synovitis, a less serious condition with no known long-term sequelae. MRI may help in the differential diagnosis of these two conditions. Coronal T1-weighted MRI, performed immediately after contrast administration, can evaluate blood perfusion at the femoral epiphysis.

MRI and Slipped Capital Femoral Epiphysis – This condition, where the femoral head is displaced in relation to the femoral neck, is the most common hip disorder in adolescents and it is more common in obese children. Its symptoms include a limping gait, groin pain, thigh pain and knee pain. Most cases are stable and the prognosis is good with early diagnosis and treatment. Unstable slipped capital femoral epiphysis may lead to avascular necrosis. MRI is used for diagnosis of slipped capital femoral epiphysis. Its image can be oriented to a plane orthogonal to the plane of the physic to detect edema in the area of the physic.

MRI and Tarsal Coalition – This is a congenital condition in which two or more bones in the midfoot or hindfoot are joined. It usually presents during late childhood or late adolescence and is associated with repetitive ankle sprains. Mild pain, deep in the subtalar joint and limited range of motion is clinical symptoms. Tarsal coalition is detectable on oblique radiographs, but these are not routinely obtained at many institutions. Clinical diagnosis is not simple; it requires the expertise of skilled examiners. MRI is valuable in diagnosing tarsal coalition because it allows differentiation of osseous from non-osseous coalitions and also depicts the extent of joint involvement as well as degenerative changes. It may also detect overgrowth of the medial aspect of the talus that may be associated with talocalcaneal coalitions.

MRI and Ankle Fractures – One of the most frequently injured areas of the skeleton is the ankle. These injuries may include ligament sprains as well as fractures. A suspected fracture is first imaged with conventional radiographs in anteroposterior, internal oblique and lateral projections. MRI is normally not used in the initial imaging of suspected ankle fractures: MRI is more specific for ligamentous injuries. MRI may identify ankle ligament injuries associated with problematic subsets of ankle fracture.

REFERENCES


CPT Code: 73725

INTRODUCTION:
MRA is used for imaging arterial obstructive disease in the lower extremity. It is noninvasive and has little risk. It can image tibia and pedal arteries and can evaluate symptoms that occur after angiography.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR LOWER EXTREMITY MRA/MRV:

For assessment/evaluation of suspected or known vascular disease/condition:
- Significant ischemia in the presence of ulcers/gangrene.
- Large vessel diseases, e.g., aneurysm, dissection, arteriovenous malformations (AVMs), and fistulas, intramural hematoma, and vasculitis.
- Arterial entrapment syndrome e.g. peripheral artery disease (PAD).
- Venous thrombosis if previous studies have not resulted in a clear diagnosis.
- Vascular invasion or displacement by tumor.
- Pelvic vein thrombosis or thrombophlebitis
- Abnormal preliminary testing (ankle/brachial index, ultrasound/doppler arterial evaluation) associated with significant symptoms of claudication with exercise.

Pre-operative evaluation:
- Evaluation of known peripheral vascular disease of the leg and ultrasound indicates significant disease and an indeterminate conclusion about whether the condition would be amenable to surgery.

Post-operative / procedural evaluation:
- Post-operative or interventional vascular procedure for luminal patency versus re-stenosis (due to atherosclerosis, thromboembolism, intimal hyperplasia and other causes) as well as complications such as pseudoaneurysms related to surgical bypass grafts and vascular stents and stent-grafts
- A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

ADDITIONAL INFORMATION RELATED TO LOWER EXTREMITY MRA/MRV:

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.
MRA of Foot – Fast contrast-enhanced time-resolved 3D MR angiography is used in evaluating the arterial supply of the foot. It does not require the use of ionizing radiation and iodinated contrast medium and it is minimally invasive, safe, fast and accurate. Dorsalis pedis bypass surgery is an option for preserving a foot in a patient with arterial occlusive disease and MRA may be used in the preoperative evaluation. It can discriminate arteries from veins and can provide other key information, e.g., patency of the pedal arch, presence of collateral pathways, and depiction of target vessel suitable for surgical bypass. Time-resolved gadolinium enhanced MRA can identify injured fat pads in the foot before they have become ulcerated.

MRA and arterial obstructive disease – Catheter angiography is the standard of reference for assessing arterial disease but MRA with contrast enhanced media has gained acceptance and can image the entire vascular system. Contrast agents such as high dose gadolinium have been associated with the development of nephrogenic systemic fibrosis in patients with chronic renal insufficiency. Gadolinium dosage may be decreased without compromising image quality in high-spatial-resolution contrast-enhanced MRA of the lower extremity.

Bruit – blowing vascular sounds heard over partially occluded blood vessels. Abdominal bruits may indicate partial obstruction of the aorta or other major arteries such as the renal, iliac, or femoral arteries. Associated risks include but are not limited to: renal artery stenosis, aortic aneurysm, atherosclerosis, AVM, Coarctation of aorta.

REFERENCES


CPT Codes: 74181, 74182, 74183

INTRODUCTION:

Abdominal magnetic resonance imaging (MRI) is a proven and useful tool for the diagnosis, evaluation, assessment of severity and follow-up of diseases of the abdomen. It is more expensive than computed tomography (CT) but it avoids exposing the patient to ionizing radiation. MRI may be the best imaging procedure for patients with allergy to radiographic contrast material or renal failure. It may also be the procedure of choice for suspected lesions that require a technique to detect subtle soft-tissue contrast and provide a three dimensional depiction of a lesion. Abdominal MRI studies are usually targeted for further evaluation of indeterminate or questionable findings, identified on more standard imaging exams such as Ultrasound (US) and CT.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR ABDOMEN MRI:

Evaluation of suspicious known mass/tumors (unconfirmed diagnosis of cancer) for further evaluation of indeterminate or questionable findings:
- Initial evaluation of suspicious abdomen masses/tumors found only in the abdomen by physical exam or imaging study, such as Ultrasound (US).
- Surveillance: One follow-up exam to ensure no suspicious change has occurred in a tumor in the abdomen. No further surveillance unless tumor(s) are specified as highly suspicious, or change was found on last follow-up.

of known cancer for further evaluation of indeterminate or questionable findings, identified by physical examination or imaging exams such as Ultrasound (US) and CT:
- Initial staging of known cancer
  - All cancers, excluding the following:
    - Basal Cell Carcinoma of the skin,
    - Melanoma without symptoms or signs of metastasis.
- Three (3) month follow-up of known abdominal cancer undergoing active treatment within the past year.
- Six (6) month follow-up of known abdominal cancer undergoing active treatment within the past year.
- Follow-up of known cancer of patient undergoing active treatment within the past year.
- Known cancer with suspected abdominal metastasis based on a sign, symptom or an abnormal lab value.
- Cancer surveillance: Active monitoring for recurrence as clinically indicated

For evaluation of suspected infection or inflammatory disease:
- Suspected acute appendicitis (or severe acute diverticulitis) if abdominal pain and tenderness to palpation is present, with at LEAST one of the following:
  - WBC elevated
  - Fever
  - Anorexia or
Nausea and vomiting.

- Suspected peritonitis (from any cause) if abdominal pain and tenderness to palpation is present, and at least one of the following:
  - Rebound, rigid abdomen, or
  - Severe tenderness to palpation present over entire abdomen.
- Suspected pancreatitis.
- Suspected inflammatory bowel disease (Crohn’s or ulcerative colitis) with abdominal pain, and persistent diarrhea, or bloody diarrhea.
- Suspected cholecystitis or retained gallstones with recent equivocal ultrasound.
- Suspected infection in the abdomen.

For evaluation of known infection or inflammatory disease follow up:

- Complications of diverticulitis with severe abdominal pain or severe tenderness or mass, not responding to antibiotic treatment, (prior imaging study is not required for diverticulitis diagnosis).
- Pancreatitis by history, (including pancreatic pseudocyst) with abdominal pain suspicious for worsening, or re-exacerbation.
- Known inflammatory bowel disease, (Crohn’s or ulcerative colitis) with recurrence or worsening signs/symptoms requiring re-evaluation.
- Any known infection that is clinically suspected to have created an abscess in the abdomen.
- Any history of fistula limited to the abdomen that requires re-evaluation, or is suspected to have recurred.
- Abnormal fluid collection seen on prior imaging that needs follow-up evaluation.
- Hepatitis C/hepatoma evaluation with elevated alpha-fetoprotein (AFP) and equivocal ultrasound results.
- Known infection in the abdomen.

Pre-operative evaluation:

- For abdominal surgery or procedure.

Post-operative/procedural evaluation:

- Follow-up of suspected or known post-operative complication involving only the abdomen.
- A follow-up study to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed.

Indication for combination studies for the initial pre-therapy staging of cancer, OR ongoing tumor/cancer surveillance OR evaluation of suspected metastases:

- ≤ 5 concurrent studies to include CT or MRI of any of the following areas as appropriate depending on the cancer: Neck, Abdomen, Pelvis, Chest, Brain, Cervical Spine, Thoracic Spine or Lumbar Spine.
  - Cancer surveillance – Active monitoring for recurrence as clinically indicated.

Other Indications for an Abdominal MRI:

- To provide an alternative to abdominal CT when CT would be limited due to allergy to radiographic contrast material.
- To provide an alternative to follow-up of an indeterminate abdomen CT when previous CT/Ultrasound was equivocal.
- Suspected adrenal mass or pheochromocytoma based on diagnostic testing/imaging results, and/or a suspicious clinical presentation.

ADDITIONAL INFORMATION RELATED TO ABDOMINAL MRI:
MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

MRI of the liver – The liver is a common site of metastatic spread. Patients with a history of known or suspected malignancy, especially tumors from the colon, lung, pancreas and stomach, are at risk for developing hepatocellular carcinoma. Patients with chronic liver disease are also at risk for developing liver cancer and undergo periodic liver screening for focal liver lesion detection, usually with ultrasonography (US). Extra-cellular gadolinium chelate contrast-enhanced MRI is used for evaluating patients with an abnormal US. Patients with hepatic metastases being considered for metastasectomy undergo contrast-enhanced MRI using tissue-specific contrast agents.

MRI of the adrenal glands – The adrenal glands are susceptible for metastases from various tumors, especially of lung or breast. Adrenal lesions may also represent primary tumors of the adrenal cortex of medulla, both benign and malignant. MRI may be done to distinguish between benign and malignant lesions. Metastases are predominantly hypointense on T1-weighted images and hyperintense on T2-weighted images. Benign lesions, which have high lipid content, exhibit clear suppression of the signals.

MRI of the pancreas – The most common pancreatic endocrine tumors, accounting for up to 50% of all cases, are insulinomas, which are usually benign. The next most common is gastrinomas. Patients with gastrinomas generally present with recurrent, multiple or ‘ectopic’ peptic ulceration, the Zollinger-Ellison syndrome. After a diagnosis of gastrinomas has been confirmed, imaging should be done to localize and stage the disease. Other pancreatic endocrine tumors are rare and often associated with genetic disorders such as the multiple endocrine neoplasia type 1 (MEN 1). MRI is the preferred imaging for follow-up in patients with MEN 1 where repeated imaging may be required to assess the response to therapy.

MRI of the kidney – MRI in renal imaging has been used to differentiate benign lesions versus malignant lesions in patients unable to undergo CT scanning with contrast media or in cases where the CT findings were questionable. Initial evaluation of renal lesions is often undertaken with ultrasound. MRI can have additional diagnostic value in the evaluation of lesions with minimal amounts of fat or with intracellular fat. MRI may have a higher accuracy than CT in the evaluation of early lymph node spread. Although MRI of the kidney has not yet found broad clinical application, it may have an increasing role in the management of patients with renal disease.

MRI of the spleen – Among some radiologists, the spleen is considered a ‘forgotten organ’ although it is included and demonstrated on every abdominal CT and MRI. Malignant tumors of the spleen are rare: malignant lymphomas are the most common and are usually a manifestation of generalized lymphoma. Splenic metastases are predominantly hypointense on T1-weighted images and hyperintense on T2-weighted images and MRI is used for the detection of necrotic or hemorrhagic metastases.

MRI to diagnose abdominal aortic aneurysm – MRI can be useful in the diagnosis of aortic aneurysms in patients with chronic aortic disease. The advantages include: safety, noninvasive nature (except for intravenous contrast), wide field of view, multi-planar imaging and 3D relationship viewing. MRI, unlike CT, does not require large volumes of iodinated contrast. ECG-gated spin-echo MRI is the basis for many MRI imaging algorithms for diagnosing abdominal aortic disease. A rapid breath holds MRI, a more recent development, allows more comprehensive examination of the aorta and defines many types of aortic pathology.
MRI for the evaluation of vascular abnormalities such as renal artery stenosis and celiac/superior mesenteric artery stenosis (in chronic mesenteric ischemia) - Doppler Ultrasound, MRA or CTA should be considered as the preferred imaging modalities.

REFERENCES


CPT Codes: 74185

INTRODUCTION:

Magnetic resonance angiography (MRA) generates images of the arteries that can be evaluated for evidence of stenosis, occlusion or aneurysms. It is used to evaluate the arteries of the abdominal aorta and the renal arteries. Contrast enhanced MRA requires the injection of a contrast agent which results in very high quality images. MRA does not use ionizing radiation, allowing MRA to be used for follow-up evaluations. MRA is not used as a screening tool, e.g. evaluation of asymptomatic patients without a previous diagnosis.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR ABDOMEN MRA:

For evaluation of known or suspected abdominal vascular disease:
• For known large vessel diseases (abdominal aorta, inferior vena cava, superior/inferior mesenteric, celiac, splenic, renal or iliac arteries/veins), e.g., aneurysm, dissection, arteriovenous malformations (AVMs), and fistulas, intramural hematoma, and vasculitis.
• Evidence of vascular abnormality seen on prior imaging studies.
• Evaluation of suspected or known aortic aneurysm**:
  o Suspected or known aneurysm > 2.5 cm AND equivocal or indeterminate ultrasound results OR
  o Prior imaging (e.g. ultrasound) demonstrating aneurysm >2.5cm cm in diameter OR
  o Suspected complications of known aneurysm as evidenced by signs/symptoms such as new onset of abdominal or pelvic pain.
• Suspected retroperitoneal hematoma or hemorrhage.
• Suspected renal vein thrombosis in patient with known renal mass.
• For evaluation of mesenteric ischemia/ischemic colitis.
• Venous thrombosis if previous studies have not resulted in a clear diagnosis.
• Vascular invasion or displacement by tumor.
• For evaluation of hepatic blood vessel abnormalities (aneurysm, hepatic vein thrombosis, stenosis post transplant).
• For evaluation of splenic artery aneurysm.
• Kidney failure or renal insufficiency if initial evaluation performed with Ultrasound is inconclusive.
• For evaluation of known or suspected renal artery stenosis or resistant hypertension demonstrated by any of the following:
  o Unsuccessful control after treatment with three (3) or more anti-hypertensive medication at optimal dosing.
  o Acute elevation of creatinine after initiation of an angiotension converting enzyme inhibitor, (ACE inhibitor) or Angiotension receptor blocker, (ARB).
  o Asymmetric kidney size noted on ultrasound.
  o Onset of hypertension in a person younger than age 30 without any other risk factors or family history of hypertension.
New onset of hypertension after age 55 (>160/100).
- Acute rise in blood pressure in a person with previously stable blood pressures.
- Flash pulmonary edema without identifiable causes.
- Malignant hypertension.

Pre-operative evaluation:
- Evaluation of interventional vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia.
- For pretransplantation of either liver or kidney.

Post-operative or post-procedural evaluation:
- Evaluation of endovascular/interventional abdominal vascular procedures for luminal patency versus restenosis due to conditions such as atherosclerosis, thromboembolism, and intimal hyperplasia.
- Evaluation of post-operative complications, e.g. pseudoaneurysms, related to surgical bypass grafts, vascular stents and stent-grafts in the peritoneal cavity.
- Follow-up for post-endovascular repair (EVAR) or open repair of abdominal aortic aneurysm (AAA).
  - Routine, baseline study (post-op/intervention) is warranted within 1-3 months.
    - Asymptomatic at six (6) month intervals, for two (2) years.
    - Symptomatic/complications related to stent graft – more frequent imaging may be needed.
- Follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

ADDITIONAL INFORMATION RELATED TO ABDOMEN MRA:

MRI imaging – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

MRI Follow-up for post-endovascular repair (EVAR) - CT is generally the study of choice in this evaluation due to improved spatial resolution and less artifact from components of the stent graft.

Abd/Pelvis MRA & Lower Extremity MRA Runoff Requests: Two (2) auth requests are required, one Abd MRA, CPT code 74185 and one for Lower Extremity MRA, CPT code 73725. This will provide imaging of the abdomen, pelvis and both legs.

MRA and Abdominal Aortic Aneurysm – Endovascular repair is an alternative to open surgical repair of an abdominal aortic aneurysm. It has lower morbidity and mortality rates and is minimally invasive. In order to be successful, it depends on precise measurement of the aneurysm and involved vessels. MRA with gadolinium allows visualization of the aorta and major branches and is effective and reliable for use in planning the placement of the endovascular aortic stent graft. MRA is also used for the detection of postoperative complications of endovascular repair.

**Abdominal Aneurysms and general Guidelines for follow-up:**
The normal diameter of the suprarenal abdominal aorta is 3.0 cm and that of the infrarenal is 2.0 cm. Aneurysmal dilatation of the infrarenal aorta is defined as diameter >= 3.0 cm or dilatation of the aorta >= 1.5 the normal diameter¹. Initial evaluation of AAA is accurately made by ultrasound. Ultrasound can detect and size AAA, with the advantage of being relatively inexpensive, noninvasive and not require
iodinate contrast. The limitations are that overlying bowel gas can obscure findings and the technique is operator dependent.

**Recommended intervals for initial follow-up imaging of ectatic aortas and Abdominal aortas (follow up intervals may vary depending on comorbidities and the growth rate of the aneurysm):**

- 2.5-2.9 cm: ............5yr
- 3.0-3.4 cm: ............3yr
- 3.5-3.9 cm: ............2yr
- 4.0-4.4 cm: ............1yr
- 4.5-4.9 cm: ............6 mo
- 5.0-5.5 cm: ............3-6 mo

**MRA and Renal Artery Stenosis** – Renal artery stenosis is the major cause of secondary hypertension. It may also cause renal insufficiency and end-stage renal disease. Atherosclerosis is one of the common causes of this condition, especially in older patients with multiple cardiovascular risk factors and worsening hypertension or deterioration of renal function. Navigator-gated MR angiography is used to evaluate the renal arteries and detect renal artery stenosis.

**MRA and Renal Vein Thrombosis** – Renal vein thrombosis is a common complication of nephritic syndrome and often occurs with membranous glomerulonephritis. Gadolinium-enhanced MRA can demonstrate both the venous anatomy and the arterial anatomy and find filling defects within renal veins. The test can be used for follow-up purposes as it does not use ionizing radiation.

**REFERENCES**


**CPT Codes:** 75557, 75559, 75561, 75563 +75565

**INTRODUCTION:**

Cardiac magnetic resonance imaging (MRI) is an imaging modality utilized in the assessment and monitoring of cardiovascular disease. It has a role in the diagnosis and evaluation of both acquired and congenital cardiac disease. MRI is a noninvasive technique using no ionizing radiation resulting in high quality images of the body in any plane, unlimited anatomic visualization and potential for tissue characterization.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

**ACCF/ASNC/ACR/AHA/ASE/SCCT/SCMR/SNM 2010 APPROPRIATE USE CRITERIA for Heart MRI:**

| Heart MRI (Appropriate ACCF et al. Criteria # with Use Score) A= Appropriate (7-9) U=Uncertain (4-6) | INDICATIONS (*Refer to Additional Information section) |
| Detection of CAD: Symptomatic | |
| Evaluation of Chest Pain Syndrome, Including Low Risk Unstable Angina (Use of Vasodilator Perfusion CMR or Dobutamine Stress Function CMR) | |
| 2 U(4) | • Intermediate pre-test probability of CAD* 
| | • ECG interpretable AND able to exercise |
| 3 A(7) | • Intermediate pre-test probability of CAD* 
<p>| | • ECG uninterpretable OR unable to exercise |
| 4 A(7-9) | • High pre-test probability of CAD* |
| Followup of Known Ischemic CAD | |
| Asymptomatic or Stable Symptoms | |
| | • ROUTINE FOLLOW-UP when last invasive or non-invasive assessment of coronary artery disease showed HEMODYNAMICALLY SIGNIFICANT CAD (ischemia on stress test or FFR &lt;= 0.80 for a major vessel or stenosis &gt;=70% of a major vessel) over two years ago, without supervening coronary revascularization, is an appropriate indication for stress CMR in patients with high risk clinical scenarios, such as left ventricular dysfunction (ejection fraction less than 50%) or severe un-revascularized multivessel CAD (if it will alter management), OR in patients with HIGH RISK OCCUPATIONS (e.g. associated with public safety, airline and boat pilots, bus and train drivers, bridge and tunnel workers/toll |</p>
<table>
<thead>
<tr>
<th>Heart MRI (Appropriate ACCF et al. Criteria # with Use Score)</th>
<th>INDICATIONS (*Refer to Additional Information section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A= Appropriate (7-9)</td>
<td>collectors, police officers, and firefighters) or a HIGH PERSONAL RISK (e.g. scuba divers, etc).</td>
</tr>
<tr>
<td>U=Uncertain (4-6)</td>
<td></td>
</tr>
<tr>
<td><strong>New, recurrent, or worsening (progressive) symptoms in patients with known ischemic CAD</strong></td>
<td></td>
</tr>
<tr>
<td>A(7-9)</td>
<td>PRIOR LOW RISK CORONARY EVALUATION AT LEAST TWO YEARS EARLIER (e.g. limited extent of CORONARY ARTERY DISEASE, &lt;5% myocardium at risk), AND NOW WITH NEW STABLE (or low risk unstable), RECURRENT, OR SLOWLY WORSENING (PROGRESSIVE) SYMPTOMS of coronary ischemia, is an appropriate indication for stress CMR in this patient group. However, regardless of timing of prior non-invasive assessment, clinical documentation of continued problematic symptoms or moderate to highly likely acute coronary syndrome (Table 6) of even low mortality risk (Table 7) is often better assessed with invasive coronary arteriography, particularly when stress testing in the last 2 years and current clinical findings are at odds. This category is very documentation-sensitive and requires judgment. Note: INVASIVE CORONARY ARTERIOGRAPHY IS GENERALLY PREFERABLE in those patients, who have a PRIOR MODERATE OR HIGH RISK STRESS TEST RESULT (especially if NOT previously evaluated by invasive coronary arteriography) or a current diagnosis of moderate to high risk UNSTABLE ANGINA, and inappropriate for repeat stress CMR unless supervening reasons to prefer a non-invasive approach are documented in the record (e.g. very unclear symptoms, CKD, dye allergy, etc.), and it could alter management.</td>
</tr>
<tr>
<td><strong>New or Worsening Symptoms without Known CAD</strong></td>
<td></td>
</tr>
<tr>
<td>A(7—9)</td>
<td>One of the following, when invasive coronary arteriography is not clearly indicated or appropriate (e.g.data are equivocal, symptoms not clear, CKD, dye allergy, other etiologies suspect, etc.): o Normal exercise EKG o CCTA, invasive coronary arteriography, or stress imaging did not show obstructive CAD</td>
</tr>
<tr>
<td>U(4-6)</td>
<td>Abnormal prior stress imaging study, when invasive coronary arteriography is not clearly indicated or appropriate (e.g.data are equivocal, symptoms not clear, CKD, dye allergy, other etiologies suspect, etc.): o Post Coronary Revascularization</td>
</tr>
<tr>
<td>A(7-9)</td>
<td>Symptomatic or ischemic equivalent that is well documented</td>
</tr>
</tbody>
</table>
### Heart MRI (Appropriate ACCF et al. Criteria # with Use Score)

| A(7-9) | **INDICATIONS**
|--------|---------------------------------------------
|        | • Asymptomatic
|        | Minimum of 2 YEARS post coronary artery bypass grafting or 2 YEARS post percutaneous coronary intervention (whichever was the latter) is appropriate only for patients with high direct CORONARY-related risk, such as incomplete coronary revascularization with feasible additional revascularization of residual severe multivessel disease, need for otherwise unevaulated follow up of stenting of unprotected left main coronary artery (LM) disease or left ventricular dysfunction (ejection fraction less than 50%), OR for patients with HIGH OCCUPATIONAL RISK (e.g. associated with public safety, airline and boat pilots, bus and train drivers, bridge and tunnel workers/toll collectors, police officers, and firefighters) or HIGH PERSONAL RISK (e.g. scuba divers, etc.).
|        | • Evaluation of Asymptomatic Patient

| U(4-6) | **INDICATIONS**
|--------|---------------------------------------------
|        | • High Global Risk CAD
|        | • Regardless of EKG interpretability or ability to exercise >2 years from last assessment

### Evaluation of Intra-Cardiac Structures (Use of MR Coronary Angiography)

| 8 A(8) | **INDICATIONS**
|--------|---------------------------------------------
|        | • Evaluation of suspected coronary anomalies or coronary aneurysms

| 9 U(6) | **INDICATIONS**
|--------|---------------------------------------------
|        | • With history of intermediate pre-test probability of CAD
|        | • No ECG changes and serial cardiac enzymes negative

### Risk Assessment With Prior Test Results (Use of Vasodilator Perfusion CMR or Dobutamine Stress Function CMR)

| 12 U(6) | **INDICATIONS**
|---------|---------------------------------------------
|        | • Intermediate Global Risk
|        | • Equivocal stress imaging test (exercise, stress SPECT, or stress echo)

| 13 A(7) | **INDICATIONS**
|---------|---------------------------------------------
|        | • Coronary angiography (catheterization or CCTA)
|        | • Stenosis of unclear significance

| A(7-9) | **INDICATIONS**
|--------|---------------------------------------------
|        | • Prior Exercise EKG stress test or CCTA
|        | • Equivocal result

| A(7-9) | **INDICATIONS**
|--------|---------------------------------------------
|        | • One of the following:
|        | o High concern for ischemic EKG with intermediate to high global risk EKG, and indication for invasive coronary arteriography is not clear
|        | o Abnormal prior exercise EKG with preference to avoid invasive evaluation (e.g. unclear symptoms, mildly abnormal stress EKG, dye allergy, CKD, etc.)

(Refer to Additional Information section)
<table>
<thead>
<tr>
<th>Heart MRI (Appropriate ACCF et al. Criteria # with Use Score)</th>
<th>INDICATIONS (*Refer to Additional Information section)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A= Appropriate (7-9)</td>
<td>Obstructive CAD on prior CCTA, and either physiologic evaluation for ischemia is required, or there are new or worsening symptoms.</td>
</tr>
<tr>
<td>U=Uncertain (4-6)</td>
<td>Obstructive CAD on invasive coronary angiography, and physiologic evaluation for ischemia is required</td>
</tr>
<tr>
<td></td>
<td>LEFT BUNDLE BRANCH BLOCK, when the history (intermediate to high global risk), physical examination, and/or noninvasive ejection fraction together support further evaluation, and invasive coronary arteriography is not already indicated, is an indication for stress CMR</td>
</tr>
<tr>
<td></td>
<td>One of the following:</td>
</tr>
<tr>
<td></td>
<td>High concern for ischemic EKG, but only low global risk CORONARY ARTERY DISEASE, and indication for invasive coronary arteriography is not clear</td>
</tr>
<tr>
<td></td>
<td>Abnormal prior stress imaging study, and indication for invasive coronary arteriography is not clear</td>
</tr>
<tr>
<td></td>
<td>LEFT BUNDLE BRANCH BLOCK, when the history (low global risk), physical examination, and/or noninvasive ejection fraction together support further evaluation, and invasive coronary arteriography is not already indicated, is an indication for stress CMR</td>
</tr>
</tbody>
</table>

Risk Assessment: Preoperative Evaluation for Non-Cardiac Surgery – Intermediate or High Risk Surgery (Use of Vasodilator Perfusion CMR or Dobutamine Stress Function CMR)

15 A(7-9)

- If all the following apply:
  - Coronary evaluation before thoracoabdominal aortic surgery
  - Patient has less than a 4 MET functional capacity
  - Patient has one peri-operative risk factor
  - No coronary evaluation (invasive or non-invasive) within the past year
  - If invasive coronary arteriography is preferable, then stress CMR is not appropriate
  - Alternatively, without the need for the above criteria, patient would be a candidate for stress CMR at the time of a preoperative evaluation if indications unrelated to the surgery were well documented in the clinical record

Other Cardiovascular Conditions

A(7-9)

- One of the following:
  - Newly diagnosed systolic heart failure
  - Newly diagnosed diastolic heart failure
  - Sustained VT
  - VF
  - Exercise Induced VT or nonsustained VT
<table>
<thead>
<tr>
<th>INDICATIONS <em>Refer to Additional Information section</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>- Prior to initiation of antiarrhythmic therapy in high CAD global risk patients</td>
</tr>
<tr>
<td>- One of the following:</td>
</tr>
<tr>
<td>- Frequent PVCs (&gt;30/min)</td>
</tr>
<tr>
<td>- Intermediate or high Global Risk CAD</td>
</tr>
</tbody>
</table>

**Structure and Function**

**Evaluation of Ventricular and Valvular Function**

<table>
<thead>
<tr>
<th>Procedures may include LV/RV mass and volumes, MR angiography, quantification of valvular disease, and delayed contrast enhancement, when echocardiogram is inadequate</th>
</tr>
</thead>
<tbody>
<tr>
<td>18 <strong>A(9)</strong> • Assessment of complex congenital heart disease including anomalies of coronary circulation, great vessels, and cardiac chambers and valves</td>
</tr>
<tr>
<td>• Procedures may include LV/RV mass and volumes, MR angiography, quantification of valvular disease, and contrast enhancement</td>
</tr>
<tr>
<td>19 <strong>U(6)</strong> • Evaluation of LV function following myocardial infarction OR in heart failure patients</td>
</tr>
<tr>
<td>20 <strong>A(8)</strong> • Evaluation of LV function following myocardial infarction OR in heart failure patients</td>
</tr>
<tr>
<td>• Patients with technically limited images from echocardiogram</td>
</tr>
<tr>
<td>21 <strong>A(8)</strong> • Quantification of LV function</td>
</tr>
<tr>
<td>• Discordant information that is clinically significant from prior tests</td>
</tr>
<tr>
<td>22 <strong>A(8)</strong> • Evaluation of specific cardiomyopathies (infiltrative [amyloidosis, sarcoidosis, hemochromatosis,], noncompaction, HCM, acute viral myocarditis or due to cardiotoxic therapies), if echocardiography is inadequate and the information might alter management</td>
</tr>
<tr>
<td>• Use of delayed enhancement</td>
</tr>
<tr>
<td>23 <strong>A(8)</strong> • Characterization of native and prosthetic cardiac valves—including morphology of a bicuspid aortic valve’s ascending aorta, hemodynamics, planimetry of stenotic disease, quantification of regurgitant disease, preoperative/preinterventional evaluation of septal defects, and valve/inflow/outflow/conduit dimensions, necessary evaluation of congenital heart disease (e.g. anomalous pulmonary venous return, tetralogy of Fallot, etc.)</td>
</tr>
<tr>
<td>• Patients with technically limited images from echocardiogram, transesophageal echocardiogram, or cardiac CT</td>
</tr>
<tr>
<td>24 <strong>A9</strong> • Evaluation for arrhythmogenic right ventricular cardiomyopathy (ARVC)</td>
</tr>
<tr>
<td>• Patients presenting with syncope or ventricular arrhythmia</td>
</tr>
<tr>
<td>25 <strong>A8</strong> • Evaluation of myocarditis or myocardial infarction with normal coronary arteries</td>
</tr>
<tr>
<td>• Positive cardiac enzymes without obstructive atherosclerosis on angiography</td>
</tr>
<tr>
<td>Heart MRI (Appropriate ACCF et al. Criteria # with Use Score)</td>
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<tr>
<td>-------------------------------------------------------------</td>
</tr>
<tr>
<td>A= Appropriate (7-9)</td>
</tr>
<tr>
<td>U= Uncertain (4-6)</td>
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<tr>
<td>26 A(9)</td>
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<tr>
<td>27 A(8)</td>
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<td>28 A(8)</td>
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<td>30 A(7)</td>
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<td>31 U(4)</td>
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<td>32 A(9)</td>
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<tr>
<td>33 A(9)</td>
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</table>

INDICATIONS FOR HEART MRI:

- Where Stress Echocardiography (SE) is noted as an appropriate substitute for a Cardiac MRI indication (#’s 2, 3, 4, 12, and 13) then at least one of the following contraindications to SE must be demonstrated:
  - Stress echocardiography is not indicated: OR
  - Stress echocardiography has been performed however findings were inadequate, there were technical difficulties with interpretation, or results were discordant with previous clinical data: OR
  - Heart MRI is preferential to stress echocardiography including but not limited to following conditions:
    - Ventricular paced rhythm
    - Evidence of ventricular tachycardia
    - Severe aortic valve dysfunction
    - Severe Chronic Obstructive Pulmonary Disease, (COPD) as defined as FEV1 < 30% predicted or FEV1 < 50% predicted plus respiratory failure or clinical signs of right heart failure. (GOLD classification of COPD access: http://www.pulmonaryreviews.com/jul01/pr_jul01_copd.html)
    - Congestive Heart Failure (CHF) with current Ejection Fraction (EF) < 40%
    - Inability to get an echo window for imaging
- Prior thoracotomy, (CABG, other surgery)
- Obesity BMI>40
- Poorly controlled hypertension [generally above 180 mm Hg systolic (both physical stress and dobutamine stress may exacerbate hypertension during stress echo)]
- Poorly controlled atrial fibrillation (Resting heart rate > 100 bpm on medication)
- Inability to exercise requiring pharmacological stress test
- Segmental wall motion abnormalities at rest (e.g. due to cardiomyopathy, recent MI, or pulmonary hypertension)

OR

- Arrhythmias with Stress Echocardiography ◆ any patient on a type 1C anti-arrhythmic drug (i.e. Flecainide or Propafenone) or considered for treatment with a type 1C anti-arrhythmic drug.

For all other requests, the patient must meet ACCF/ASNC Appropriateness criteria for indications (score 4-9) above.

**INDICATIONS IN ACC GUIDELINES WITH “INAPPROPRIATE” DESIGNATION:**

Patient meets ACCF/ASNC Appropriateness criteria for indications (score 1-3) noted below OR meets any one of the following:
- For any combination imaging study
- For same imaging tests less than six weeks part unless specific guideline criteria states otherwise.
- For different imaging tests, such as CTA and MRA, of same anatomical structure less than six weeks apart without high level review to evaluate for medical necessity.
- For re-imaging of repeat or poor quality study

**ACCF/ASNC/ACR/AHA/ASE/SCCT/SCMR/SNM 2006 APPROPRIATE USE CRITERIA for Heart MRI:**

<table>
<thead>
<tr>
<th>Heart MRI (Appropriate ACCF et al. Criteria # with Use Score)</th>
<th>INDICATIONS (*Refer to Additional Information section)</th>
<th>PROPRIATE USE SCORE (1-3); I= Inappropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Detection of CAD: Symptomatic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Evaluation of Chest Pain Syndrome (Use of Vasodilator Perfusion CMR or Dobutamine Stress Function CMR)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| 1 | • Low pre-test probability of CAD  
  • ECG interpretable AND able to exercise | I(2) |
| **Evaluation of Chest Pain Syndrome (Use of MR Coronary Angiography)** | | |
| 5 | • Intermediate pre-test probability of CAD  
  • ECG interpretable AND able to exercise | I(2) |
| 6 | • Intermediate pre-test probability of CAD  
  • ECG uninterpretable OR unable to exercise | I(2) |
| 7 | • High pre-test probability of CAD | I(1) |
## Heart MRI (Appropriate ACCF et al. Criteria # with Use Score)

<table>
<thead>
<tr>
<th>INDICATIONS</th>
<th>APPROPRIATE USE SCORE (1-3); I= Inappropriate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acute Chest Pain (Use of Vasodilator Perfusion CMR or Dobutamine Stress Function CMR)</td>
<td></td>
</tr>
</tbody>
</table>
| 10 | - With history of high pre-test probability of CAD  
- ECG - ST segment elevation and/or positive cardiac enzymes | I(1) |
| Risk Assessment With Prior Test Results (Use of Vasodilator Perfusion CMR or Dobutamine Stress Function CMR) |  |
| 11 | - Normal prior stress test (exercise, nuclear, echo, MRI)  
- High CHD risk (Framingham)  
- Within 1 year of prior stress test | I(2) |
| Risk Assessment: Preoperative Evaluation for Non-Cardiac Surgery – Low Risk Surgery (Use of Vasodilator Perfusion CMR or Dobutamine Stress Function CMR) |  |
| 14 | - Intermediate perioperative risk predictor | I(2) |
| Detection of CAD: Post-Revascularization (PCI or CABG) |  |
| Evaluation of Chest Pain Syndrome (Use of MR Coronary Angiography) |  |
| 16 | - Evaluation of bypass grafts | I(2) |
| 17 | - History of percutaneous revascularization with stents | I(1) |

## ADDITIONAL INFORMATION RELATED TO HEART MRI:

### Abbreviations

- ACS = acute coronary syndrome
- CABG = coronary artery bypass grafting surgery
- CAD = coronary artery disease
- CCTA = coronary CT angiography
- CHD = coronary heart disease
- CHF = congestive heart failure
- CT = computed tomography
- CTA = computed tomographic angiography
- ECG = electrocardiogram
- ERNA = equilibrium radionuclide angiography
- FP = First Pass
- HF = heart failure
- LBBB = left bundle-branch block
- LV = left ventricular
- MET = estimated metabolic equivalent of exercise
- MI = myocardial infarction
- MPI = myocardial perfusion imaging
- MRI = magnetic resonance imaging
- PCI = percutaneous coronary intervention
- PET = positron emission tomography
RNA = radionuclide angiography  
SE = stress echocardiography  
SPECT = single positron emission CT (see MPI)

**What is a valid anginal or ischemic equivalent?**

Development of an anginal equivalent (e.g., shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons to suspect that symptoms other than chest discomfort are not due to other organ systems (e.g. dyspnea due to lung disease, fatigue due to anemia, etc.), by presentation of clinical data such as respiratory rate, oximetry, lung exam, etc. (as well as d-dimer, chest CT(A), and/or PFTs, when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Syncope by itself is generally not considered an anginal equivalent, and is handled under a separate category in this guideline.

**Exercise Treadmill Testing** - Exercise Treadmill Testing (ETT) is the appropriate first line test in most patients with suspected CAD. In appropriately selected patients the test provides adequate sensitivity and specificity with regard to diagnosis and prognostication. There are patients in whom the test is not the best choice, for example those with resting ECG abnormalities, inability to exercise and perhaps diabetes. Also of note from an operational standpoint the test does not require pre-authorization.

An uninterpretable baseline EKG includes:

- Abnormalities of ST segment depression of 0.1 mV (1 mm with conventional calibration) or more
- Ischemic looking T wave inversions of at least 0.25 mV (2.5 mm with conventional calibration)
- EKG findings of probable or definite LVH, WPW, a ventricular paced rhythm, or left bundle branch block
- Digitalis use or hypokalemia
- Resting HR under 50 bpm on a beta blocker and an anticipated suboptimal workload (e.g. rate-pressure product less than 20-25K)
- Prior false positive stress EKG

*Pretest Probability of CAD for Symptomatic (Ischemic Equivalent) Patients:*

**Typical Angina (Definite):** Defined as 1) substernal chest pain or discomfort that is 2) provoked by exertion or emotional stress and 3) relieved by rest and/or nitroglycerin.

**Atypical Angina (Probable):** Chest pain or discomfort that lacks 1 of the characteristics of definite or typical angina.

**Nonanginal Chest Pain:** Chest pain or discomfort that meets 1 or none of the typical angina characteristics.

Once the presence of symptoms (Typical Angina/Atypical Angina/Non angina chest pain/Asymptomatic) is determined, the probabilities of CAD can be calculated from the risk algorithms as follows:

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Gender</th>
<th>Typical / Definite Angina Pectoris</th>
<th>Atypical / Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
<th>Asymptomatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40–49</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
</tbody>
</table>
**Coronary Heart Disease (CHD) Risk**

- **CHD Risk—Low**
  - Defined by the age-specific risk level that is below average. In general, low risk will correlate with a 10-year absolute CHD risk less than 10%.

- **CHD Risk—Moderate**
  - Defined by the age-specific risk level that is average or above average. In general, moderate risk will correlate with a 10-year absolute CHD risk between 10% and 20%.

- **CHD Risk—High**
  - Defined as the presence of diabetes mellitus or the 10-year absolute CHD risk of greater than 20%.

**Definition of Peripheral Arterial Disease/Cerebrovascular Disease:**

Non-coronary arterial narrowing causing symptoms (claudication, related tissue demise, threatened limb loss), asymptomatic 70% or more narrowing by non-invasive or invasive evaluation, atherosclerotic arterial aneurysm by non-invasive or invasive evaluation, or aortic atheroma of at least 4 mm thickness. As a subset of peripheral arterial disease, cerebrovascular disease is also defined as a history of stroke or TIA.

**Global CAD Risk:**

It is assumed that clinicians will use current standard methods of global risk assessment in the asymptomatic patient for primary prevention, based upon Framingham-ATP IV, Reynolds, Pooled Cohort Equation (includes cerebrovascular risk), ACC/AHA Risk Calculator, MESA Risk Calculator (includes calcium score), or very similar risk calculator) CAD risk refers to 10-year risk for any hard cardiac event (e.g., myocardial infarction or CAD death).

- **Low global CAD risk**
  - Defined by the age-specific risk level that is below average. In general, low risk will correlate with a 10-year absolute CAD risk <10%. However, in women and younger men, low risk may correlate with 10-year absolute CAD risk <6%.

- **Intermediate global CAD risk**
  - Defined by the age-specific risk level that is average. In general, moderate risk will correlate with a 10-year absolute CAD risk range of 10% to 20%. Among women and younger age men, an expanded intermediate risk range of 6% to 20% may be appropriate.

- **High global CAD risk**
  - Defined by the age-specific risk level that is above average. In general, high risk will correlate with a 10-year absolute CAD risk of >20%. CAD equivalents (e.g., peripheral arterial disease (defined in additional information), cerebrovascular disease (history of stroke or TIA), or multiple simultaneous anti-rejection medications (e.g. cyclosporine, tacrolimus, mycophenolate mofetil,
azathioprine, long term supraphysiologic doses of glucocorticoids, but not everolimus or sirolimus/rapamycin), peripheral arterial disease) can also define high risk. High global risk can be further defined by **COMPELLING NON-INVASIVE DATA**, such as clearly pathologic Q waves on the EKG, marked ST-segment and/or T wave abnormalities of myocardial ischemia without symptoms, clear regional wall motion abnormalities of the left ventricle, or reduced ejection fraction below 50%.

### Peri-Operative Cardiac Risk Factors

These are specifically: ischemic coronary artery disease (by study more than two years ago with lesions, which are: >=70% or ischemia producing on prior stress testing or with FFR <=0.80), cerebrovascular disease, insulin-requiring diabetes mellitus, history of congestive heart failure or ejection fraction less than 40%, or CKD with creatinine >= 2 mg/dl.

#### ***Duke Treadmill Score***

The equation for calculating the Duke treadmill score (DTS) is,

\[
DTS = \text{exercise time} - (5 \times \text{ST deviation}) - (4 \times \text{exercise angina}),
\]

with 0 = none, 1 = non limiting, and 2 = exercise-limiting.

The score typically ranges from -25 to +15. These values correspond to low-risk (with a score of >= +5), intermediate risk (with scores ranging from -10 to +4), and high-risk (with a score of <= -11) categories. The Duke Score provides an annual mortality estimate: <1% for low risk, 1-3% for intermediate risk, and >3% for high risk.

### Determinants of a 4 MET functional capacity:

Examples of activities:

<4 METs:
- Slow ballroom dancing, golfing with a cart, playing a musical instrument, and walking at approximately 2 mph to 3 mph

>4 METs:
- Climbing a flight of stairs or walking up a hill, walking on level ground at 4 mph, and performing heavy work around the house

### Tools for Characterization of Unstable Angina:

Risk Stratification in Acute Coronary Syndrome from 2007 ACC/AHA Guidelines

Three Principal Presentations of Unstable Angina (as defined within a two week time frame) (Braunwald)

<table>
<thead>
<tr>
<th>Class</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest angina*</td>
<td>Angina occurring at rest and prolonged, usually greater than 20 min</td>
</tr>
<tr>
<td>Now-onset angina</td>
<td>New-onset angina of at least CCS class III severity</td>
</tr>
<tr>
<td>Increasing angina</td>
<td>Previously diagnosed angina that has become distinctly more frequent, longer in duration, or lower in threshold (i.e., increased by 1 or more CCS class to at least CCS class III severity)</td>
</tr>
</tbody>
</table>

Table 6: Likelihood that Symptoms Represent an Acute Coronary Syndrome
Table 7: Short Term Risk of Death or Nonfatal MI in Acute Coronary Syndrome

<table>
<thead>
<tr>
<th>Feature</th>
<th>High Risk</th>
<th>Intermediate Risk</th>
<th>Low Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>Accelerating tempo of ischemic symptoms in preceding 48 h</td>
<td>Prior MI, peripheral or cerebrovascular disease, or CABG, prior aspirin use</td>
<td>Increased angina frequency, severity, or duration</td>
</tr>
<tr>
<td>Character of pain</td>
<td>Prolonged ongoing (greater than 20 min) rest pain</td>
<td>Prolonged (greater than 20 min) rest angina, new ischemia, with moderate or high likelihood of CAD</td>
<td>New onset angina with onset 2 weeks to</td>
</tr>
<tr>
<td></td>
<td>Age greater than 70 years</td>
<td>Rest angina (greater than 20 min) or relieved with rest or sublingual NTG</td>
<td>2 months prior to presentation</td>
</tr>
<tr>
<td>Clinical findings</td>
<td>Pulmonary edema, most likely due to ischemia</td>
<td>New or worsening MR murmur</td>
<td>Increased angina frequency, severity, or duration</td>
</tr>
<tr>
<td></td>
<td>Systolic blood pressure &gt; 100 mmHg</td>
<td>Hypertension, bradycardia, tachycardia</td>
<td>New onset angina with onset 2 weeks to</td>
</tr>
<tr>
<td></td>
<td>Age greater than 70 years</td>
<td>Angina provoked at a lower threshold</td>
<td>2 months prior to presentation</td>
</tr>
<tr>
<td>EOG</td>
<td>Angina at rest with transient ST-segment depression &lt; 0.5 mm</td>
<td>T-wave changes less than 1 mm in multiple lead groups (anterior, inferior, lateral)</td>
<td>Normal or unchanged ECG</td>
</tr>
<tr>
<td>Cardiac biomarkers</td>
<td>Slightly elevated cardiac TnT, Tnl, or CK-MB (e.g., TnT or Tnl greater than 0.5 ng/mL)</td>
<td>Slightly elevated cardiac TnT, Tnl, or CK-MB (e.g., TnT greater than 0.01 but less than 0.1 ng/mL)</td>
<td>Normal</td>
</tr>
</tbody>
</table>

The **TIMI Risk Score** is determined by the sum of the presence of 7 variables at admission: 1 point is given for each of the following variables: age ≥65 years, at least 3 risk factors for CAD, prior coronary stenosis of ≥50%, ST-segment deviation on ECG presentation, at least 2 anginal events in prior 24 hours, use of aspirin in prior 7 days, and elevated serum cardiac biomarkers

**Low-Risk TIMI Score**: TIMI score <2; **High-Risk TIMI Score**: TIMI score ≥2. A low risk TIMI score might still warrant invasive coronary arteriography, when other features, such as symptoms, are compelling.

**Request for a follow-up study** - A follow-up study may be needed to help evaluate a patient's progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.
Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O2 tanks may also be contraindicated.

Cardiomyopathy – Cardiac MRI is used to diagnose and differentiate cardiomyopathies in the same study. Very small morphological and functional changes in different types of cardiomyopathy may be detected and may be used to evaluate the chance of functional recovery after surgical revascularization.

Cardiac Tumors – MRI is the modality of choice to evaluate cardiac tumors due to its high contrast resolution and multiplanar capability which allows for optimal evaluation of myocardial infiltration, pericardial involvement and extracardiac vascular structures within and beyond the thorax. It is also useful in the differentiation of benign and malignant cardiac tumors and in differentiating thrombi from cardiac tumors.

Pericardial abnormalities – Complicated pericardial diseases may cause significant morbidity and mortality without therapeutic interventions. MRI imaging has an important role in the evaluation of pericardial abnormalities: the pericardium is well visualized on MRI due to its superb contrast resolution and multiplanar capability.

REFERENCES


INTRODUCTION:
Magnetic resonance imaging (MRI) of the breast is a useful tool for the detection and characterization of breast disease, assessment of local extent of disease, evaluation of treatment response, and guidance for biopsy and localization. Breast MRI should be bilateral except for those with a history of mastectomy or when the MRI is being performed expressly to further evaluate or follow findings in one breast. MRI findings should be correlated with clinical history, physical examination results, and the results of mammography and any other prior breast imaging.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR BREAST MRI:

Silicone Implants:
- Confirmation of silicone gel-filled breast implant ruptures, when this diagnosis cannot be confirmed by mammography or breast ultrasound.
- For postoperative evaluation of silicone breast implant complications.

No History of Known Breast Cancer

For screening examination to detect breast cancer in any of the following situations:
- Inconclusive screening mammogram due to breast characteristics limiting the sensitivity of mammography (e.g., extremely or heterogeneously dense breasts, implants).
- A Breast Cancer Risk Assessment (by the Gail risk or other validated breast cancer risk assessment models) that identifies the patient as having a lifetime risk of 20% or greater of developing breast cancer (Approve annually).
- Two or more first degree relatives (parents, siblings, and children) have history of breast cancer.
- Patients with histories of extensive chest irradiation (usually as treatment for Hodgkin’s or other lymphoma.) Approve annually starting at age 30.
- Patients with known BRCA mutation. Approve annually starting at age 30.
- Patients not yet tested for BRCA gene, but with known BRCA mutation in first degree relative. Approve annually starting at age 30.

For evaluation of identified lesion, mass or abnormality in breast in any of the following situations:
- Two or more first degree relatives (parents, siblings, and children) have history of breast cancer.
- Evaluation of suspected breast cancer when other imaging examinations, such as ultrasound and mammography, and physical examination are inconclusive for the presence of breast cancer, and biopsy could not be performed (e.g. seen only in single view mammogram without ultrasound correlation).
- Previous positive breast biopsy within the previous four (4) months and no intervening previous breast MRI.
• Inconclusive screening mammogram due to breast characteristics limiting the sensitivity of mammography (e.g., extremely or heterogeneously dense breasts, implants).
• Evaluation of palpable lesion on physical examination and not visualized on ultrasound or mammogram and MRI guided biopsy considered.
• For evaluation of axillary node metastasis or adenocarcinoma with normal physical examination and normal breast mammogram.
• Patients diagnosed with biopsy-proven lobular neoplasia or ADH (atypical ductal hyperplasia).
• Personal history of or first-degree relative with Le-Fraumeni syndrome (TP53 mutation), Cowden syndrome (PTEN) or Bannayan-Riley-Ruvalcaba syndrome (BRRS).

**History of Known Breast Cancer**

**For screening examination to detect breast cancer in any of the following situations:**
• Patients with a known history of Breast Cancer: Approve initial staging, with treatment [within three (3) months], and yearly surveillance for detection of recurrence or a new cancer.

**For evaluation of identified lesion, mass or abnormality in breast in any of the following situations:**
• For evaluation of breast lesion, identifying whether single or multi-focal, in patient with diagnosed breast cancer.
• For evaluation of suspicious mass, lesion, distortion or abnormality of breast in patient with history of breast cancer.

**Pre-operative:**
• For preoperative evaluation for known breast cancer when surgery planned within thirty (30) days.
• Evaluation of more than two (2) lesions to optimize surgical planning when requested by surgeon or primary care provider on behalf of surgeon who has seen the patient.

**ADDITIONAL INFORMATION RELATED TO BREAST MRI:**

**CAD Breast MRI:** There are no proven indications for use of CAD with/without an approved Breast MRI.

**Request for a follow-up study** - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

**MRI imaging** – Metal devices or foreign body fragments within the body, such as indwelling pacemakers and intracranial aneurysm surgical clips that are not compatible with the use of MRI, may be contraindicated. Other implanted metal devices in the patient as well as external devices such as portable O₂ tanks may also be contraindicated.

**MRI as First-Line Screening Modality** – Only recently has the use of MRI for screening been encouraged. It is now used for screening in patients with increased risk for breast cancer due to certain factors, e.g., history of mediastinal irradiation for Hodgkin disease, mutation in a breast cancer susceptibility gene, and familial clustering of breast cancer. Certain mutations, including BRCA1 and BRCA2 genes confer significantly elevated risk of breast cancer. Even when a patient tests negative for BRCA mutations, this patient may still be at risk for breast cancer if the patient has first degree relatives with a history of breast cancer or positive BRCA mutations.

**MRI in Patient with Normal Physical Examination and Normal Mammogram but with Clinical Signs of Breast Cancer** – Metastatic spread in the axillary lymph nodes suggest the breast as the site of the
primary cancer even when the results of a mammogram are normal. MRI is useful in detecting primary breast malignancies in these cases. A negative MRI may also be used to prevent an unnecessary mastectomy.

**MRI during or after Neoadjuvant Chemotherapy** – Dynamic contrast material-enhanced MRI may be used to monitor response of a tumor to neoadjuvant chemotherapy used to shrink the tumor before surgery. This is very important in clinical decision making as alternative therapies may be selected based upon the results obtained from the MRI. It may also be used to depict residual disease after neoadjuvant chemotherapy.

**MRI and Breast Implants** – MRI may be used in patients with breast implants to evaluate breast implant integrity. It may also detect cancers arising behind an implant that may not be diagnosed with mammography.

**MRI and Invasive Lobular Carcinoma** – Invasive lobular carcinoma (ILC) is not the most common type of breast carcinoma but it is second to invasive ductal carcinoma. MRI is used in the evaluation of ILC and can measure the extent of the disease with high reliability.

**REFERENCES**


**Breast MRI for the Early Detection of Breast Cancer: Approved by the Cancer.Net Editorial Board, 03/2014**


Federal Register – Final Rule: Section 1557 of the Affordable Care Act (ACA) May 18, 2016, Nondiscrimination in Health Programs and Activities: §92.206 Equal Program Access on the Basis of Sex. [https://federalregister.gov/a/2016-11458](https://federalregister.gov/a/2016-11458)


Saslow et al American Cancer Society Guidelines for Breast Screening with MRI as an Adjunct to Mammography CA Cancer J Clin 2007;57:75–89


CPT Code: 78466, 78468, 78469, 78481, 78483, 78499

INTRODUCTION: This guideline is organized around seven clinical scenarios:

I. Suspected Coronary Artery Disease (CAD)
II. Incompletely Evaluated CAD
III. Follow-up of Known Ischemic CAD
IV. CAD in Presence of Other New Cardiac Concerns
V. Prior to Noncardiac Surgery
VI. Prior to Cardiac Rehabilitation or Exercise Program
VII. Post Cardiac Transplantation

This guideline is for stress imaging, specifically myocardial perfusion imaging (MPI), with appropriate preference for suitable alternatives, such as stress echocardiography (stress echo) or stress EKG alone, when more suitable, using the following stream of logic:

- A stress EKG alone is often appropriate. A baseline EKG which does not allow interpretation of ischemic findings with exercise will sometimes, but not always, require the addition of stress imaging.

- When stress imaging is appropriate, as an addition to stress EKG alone, stress echo is preferred when the patient is able to exercise, MPI when the patient cannot exercise. This document does not endorse dobutamine echocardiography for pragmatic reasons.

- When stress echo is precluded by specific imaging difficulties (e.g. poor quality image despite contrast medium, uncontrolled atrial fibrillation, ventricular paced rhythm, baseline wall motion abnormalities, etc., as listed in the Additional Information section), then MPI is preferable.

Compelling indications (e.g. ACC Class I or IIA or Appropriate Use Criteria ‘A’) for stress imaging (MPI and echo) are the foundation, and the less compelling indications (IIB or ‘M’) have been selected as appropriate for those scenarios in which the clinical presentation incurs high risk. If a patient fits two or more clinical scenarios, the scenario which endorses stress imaging (MPI or echo) supersedes any category which does not.

Issues such as pretest probability, global risk of coronary or cardiovascular disease, anginal equivalent, aspects of different types of stress testing, etc. are discussed in the Additional Information section at the end of this document, and the reader is encouraged to refer to that section, in order to optimally utilize this guideline.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.
INDICATIONS FOR STRESS IMAGING (MPI or ECHO) BY CLINICAL SCENARIO

I. SUSPECTED (CAD):
   High Global Risk asymptomatic OR
   Stable symptomatic OR
   Low risk “unstable” symptomatic (Tables 6 & 7)

   • SYMPTOMATIC: LOW PRETEST PROBABILITY patients should undergo a treadmill exercise stress EKG alone, with stress imaging (MPI or echo) reserved only for those unable to exercise OR with an uninterpretable EKG.

   • SYMPTOMATIC: INTERMEDIATE OR HIGH PRETEST PROBABILITY patients are appropriate for stress imaging (MPI or echo).

   • REPEAT STRESS TESTING FOR SIMILAR SYMPTOMS AND SAME PRETEST PROBABILITY should not be performed for at least 5 years following prior stress testing or invasive coronary arteriography, unless there has been a change in clinical presentation.

   • ASYMPTOMATIC HIGH GLOBAL RISK (>20% coronary or vascular event rate over ensuing 10 years) based upon a COMPELLING HISTORY, such as patients with peripheral arterial disease (defined in additional information), cerebrovascular disease (history of stroke or TIA), or multiple simultaneous anti-rejection medications (e.g. cyclosporine, tacrolimus, mycophenolate mofetil, azathioprine, long term supraphysiologic doses of glucocorticoids, but not everolimus or sirolimus/rapamycin), should be assessed with EKG STRESS TEST alone, with stress imaging (MPI or echo) reserved only for those unable to exercise OR with an uninterpretable EKG.

   • ASYMPTOMATIC HIGH GLOBAL RISK (>20% coronary or vascular event rate over ensuing 10 years, based upon Framingham-ATP IV, Reynolds, Pooled Cohort Equation (includes cerebrovascular risk), ACC/AHA Risk Calculator, MESA Risk Calculator (includes calcium score), or very similar risk calculator) or based upon COMPELLING NON-INVASIVE DATA, such as clearly pathologic Q waves on the EKG, marked ST-segment and/or T wave abnormalities of myocardial ischemia without symptoms, clear regional wall motion abnormalities of the left ventricle, or reduced ejection fraction below 50%, should be assessed with EKG STRESS TEST alone, with stress imaging (MPI or echo) reserved only for those unable to exercise OR with an uninterpretable EKG. (Patients with ejection fraction < 50%, with contraindication to invasive coronary arteriography, are reasonable candidates for stress imaging (MPI or echo).

   • REPEAT EKG STRESS TEST ALONE OF ASYMPTOMATIC HIGH GLOBAL RISK patients (as described in the 2 bullets immediately above), whose last invasive or non-invasive test was over two years ago and was negative for hemodynamically significant obstructive coronary artery disease (i.e. no ischemia on stress testing, no Fractional Flow Reserve (FFR) <= 0.80 for a major vessel, or no angiographic stenosis >70% for a major vessel), is reasonable.

   • HIGH OCCUPATIONAL RISK patients (e.g. associated with public safety, airline and boat pilots, bus and train drivers, bridge and tunnel workers/toll collectors, police officers, and firefighters) or HIGH PERSONAL RISK patients (e.g. scuba divers, etc.), should be assessed with EKG STRESS TEST alone, with stress imaging (MPI or echo) reserved only for those unable to exercise OR with an uninterpretable EKG. Determinations for screening of asymptomatic patients (without known
coronary artery disease) in high-risk occupations should be deferred to those agencies that manage such non-medical necessity.

II. INCOMPLETELY EVALUATED CAD:
Requires further evaluation within 2 years of a prior coronary evaluation for CLARIFICATION OF DIAGNOSIS OR DISEASE SEVERITY

- **NORMAL EXERCISE STRESS TEST EKG** within the past 2 years and currently compelling coronary history or symptoms should be considered appropriate indication for a repeat stress test with imaging (MPI or echocardiogram), particularly if there are reasons to avoid cardiac catheterization (CKD, dye allergy, etc.), unless invasive coronary arteriography is strongly indicated (e.g. compelling presentation of moderate or high risk unstable angina).

- **ABNORMAL OR INDETERMINATE EXERCISE STRESS EKG or CCTA** (coronary computed tomographic angiography) within the past 2 years, for whom a noninvasive approach is preferable to proceeding to invasive coronary arteriography (unclear nature of symptoms, mildly abnormal or borderline EKG stress test or CCTA, CKD, dye allergy, etc.), is an appropriate indication for stress imaging (MPI or echo).

- **A WELL DOCUMENTED MYOCARDIAL INFARCTION OR moderate to high risk ACUTE CORONARY SYNDROME WITHIN THE PAST 2 YEARS**, when stable, without subsequent stress imaging of invasive coronary arteriography, can be appropriate for stress imaging, especially when a non-invasive approach is documented to be preferable to invasive coronary arteriography.

- **SEVERITY/EXTENT OF ISCHEMIA ASSESSMENT**, in order to assist with the management strategy, in patients with recent invasive coronary arteriography AND suspected residual ischemia post incomplete coronary revascularization, is an appropriate indication for stress imaging (MPI or echo), if it will affect management.

III. FOLLOW-UP of KNOWN ISCHEMIC CAD:

A. In need of FOLLOW-UP TESTING for known ischemic coronary artery disease, either ASYMPTOMATIC OR WITH STABLE symptoms

**ROUTINE FOLLOW-UP** when last invasive or non-invasive assessment of coronary artery disease showed HEMODYNAMICALLY SIGNIFICANT CAD (ischemia on stress test or FFR <= 0.80 for a major vessel or stenosis >=70% of a major vessel) over two years ago, without supervening coronary revascularization, is an appropriate indication for stress imaging (MPI or echo) in patients with high risk clinical scenarios, such as left ventricular dysfunction (ejection fraction less than 50%) or severe un-revascularized multivessel CAD (if it will alter management), OR in patients with HIGH RISK OCCUPATIONS (e.g. associated with public safety, airline and boat pilots, bus and train drivers, bridge and tunnel workers/toll collectors, police officers, and firefighters) or a HIGH PERSONAL RISK (e.g. scuba divers, etc.).

- **SEVERITY/EXTENT OF ISCHEMIA ASSESSMENT**, in order to assist with the management strategy, in patients with recent invasive coronary arteriography AND suspected residual ischemia post incomplete coronary revascularization, is an appropriate indication for stress imaging (MPI or echo), if it will affect management.
• MYOCARDIAL VIABILITY TESTING BY REST MYOCARDIAL PERFUSION IMAGING prior to coronary revascularization is reasonable in patients with ejection fraction less than or equal to 50%, if it could significantly alter the revascularization strategy.

B. NEW, RECURRENT, OR WORSENING (PROGRESSIVE) SYMPTOMS in patients with known ischemic CAD (ischemia on stress testing, lesion stenosis >=70%, or FFR <=0.80), which has not been revascularized.

• PRIOR LOW RISK CORONARY EVALUATION AT LEAST TWO YEARS EARLIER (e.g. limited extent of CORONARY ARTERY DISEASE, <5% myocardium at risk), AND NOW WITH NEW STABLE (or low risk unstable), RECURRENT, OR SLOWLY WORSENING (PROGRESSIVE) SYMPTOMS of coronary ischemia, is an appropriate indication for stress imaging (MPI or echo) in this patient group. However, regardless of timing of prior non-invasive assessment, clinical documentation of continued problematic symptoms or moderate to highly likely acute coronary syndrome (Table 6) of even low mortality risk (Table7) is often better assessed with invasive coronary arteriography, particularly when stress testing in the last 2 years and current clinical findings are at odds. This category is very documentation-sensitive and requires judgment.

• INVASIVE CORONARY ARTERIOGRAPHY IS GENERALLY PREFERABLE in those patients, who have a PRIOR MODERATE OR HIGH RISK STRESS TEST RESULT (especially if NOT previously evaluated by invasive coronary arteriography) or a current diagnosis of moderate to high risk UNSTABLE ANGINA, and inappropriate for repeat stress imaging (MPI or echo), unless supervening reasons to prefer a non-invasive approach are documented in the record (e.g. very unclear symptoms, CKD, dye allergy, etc.), and it could alter management.

C. FOLLOW-UP OF PATIENTS POST CORONARY REVASCULARIZATION

• ASYMPTOMATIC, ROUTINE FOLLOW-UP, STRESS IMAGING (MPI OR ECHO) at a minimum of 2 YEARS post coronary artery bypass grafting or 2 YEARS post percutaneous coronary intervention (whichever was the latter) is appropriate only for patients with high direct CORONARY-related risk, such as incomplete coronary revascularization with feasible additional revascularization of residual severe multivessel disease, need for otherwise unevaluated follow up of stenting of unprotected left main coronary artery (LM) disease or left ventricular dysfunction (ejection fraction less than 50%), OR for patients with HIGH OCCUPATIONAL RISK (e.g. associated with public safety, airline and boat pilots, bus and train drivers, bridge and tunnel workers/toll collectors, police officers, and firefighters) or HIGH PERSONAL RISK (e.g. scuba divers, etc.),

• NEW, RECURRENT, OR WORSENING SYMPTOMS POST CORONARY REVASCULARIZATION, with good documentation, are an indication for stress imaging (MPI or echo) if it could affect management.

IV. CAD IN PRESENCE OF OTHER NEW CARDIAC CONCERNS

• NON-CORONARY CARDIAC DIAGNOSES support use of stress imaging (MPI or echo) in newly diagnosed systolic or diastolic heart failure, sustained VT (> 100 bpm), VF, exercise induced VT or nonsustained VT, frequent PVCs (over 30 per hour), and/or required initiation of antiarrhythmic drug (AAD) therapy when invasive coronary arteriography is not necessarily indicated.
NEW ONSET ATRIAL FIBRILLATION, in patients with coronary artery disease and/or moderate or high global risk, are candidates for stress imaging if there has been no coronary evaluation by stress imaging or invasive coronary arteriography within the preceding two years.

SYNCOPE (specifically, transient loss of consciousness due to global cerebral hypoperfusion characterized by rapid onset, short duration and spontaneous complete recovery, not just any light headedness or dizziness alone) with otherwise intermediate or high global risk of coronary artery disease warrants stress imaging (MPI or echo). Documentation supporting classic vasovagal syncope does not warrant stress testing.

LEFT BUNDLE BRANCH BLOCK, when the history, physical examination, and/or noninvasive ejection fraction together support further evaluation, and invasive coronary arteriography is not already indicated, is an indication for stress imaging (MPI or echo).

EKG STRESS TESTING without imaging is reasonable for EVALUATION OF EXERCISE-INDUCED ARRHYTHMIA (or long QT interval evaluation when the resting QTc is normal), when coronary artery disease is not suspected.

EXERCISE HEMODYNAMICS can be obtained with Stress echocardiography with Doppler when it will affect management.

KAWASAKI DISEASE long-term surveillance is better performed with CCTA, which includes aneurysm assessment.

V. Prior to NONCARDIAC SURGERY

THORACOABDOMINAL AORTIC VASCULAR SURGERY is an indication for PREOPERATIVE STRESS IMAGING (MPI or echo) if the patient has less than a 4 MET (see Additional Information section) exercise functionality, AND that patient has at least one OPERATIVE clinical risk factor from the list: ischemic coronary artery disease (by study more than two years ago with lesions, which are: >=70% or ischemia producing on prior stress testing or with FFR <=0.80), cerebrovascular disease, insulin-requiring diabetes mellitus, history of congestive heart failure or ejection fraction less than 40%, or CKD with creatinine >= 2 mg/dl. (Such stress imaging is restricted to patients who have not had either stress imaging or invasive coronary arteriography within the past year.) If invasive coronary arteriography is preferable, then preoperative stress imaging is not appropriate.

UNRELATED TO THE PLANNED SURGICAL PROCEDURE, stress imaging might be indicated for other reasons at the time patients are seen for preoperative cardiac risk evaluation. When such indications for stress imaging are unrelated to the need for the intended non-cardiac surgery, then the record must document those reasons in order to support proceeding with appropriate stress imaging (MPI or echo).

BARIATRIC SURGERY is not considered an indication for preoperative stress testing.

SOLID ORGAN TRANSPLANTATION is an indication for preoperative stress imaging (MPI or echo) if invasive coronary arteriography is not intended as the initial preoperative evaluation of choice, AND there has not been an adequate coronary evaluation within the past year.
VI. Prior to CARDIAC REHABILITATION or EXERCISE PROGRAM

- CARDIAC REHABILITATION ENTRY or DETERMINATION OF EXERCISE CAPACITY is an indication for stress testing with EKG alone, when performed as part of the cardiac rehabilitation program or for purposes of exercise prescription.

VII. Post CARDIAC TRANSPLANTATION

- During the first five years post cardiac transplantation, patients with glomerular filtration rates less than 40 mL/min/1.73 sq M, or who otherwise should not undergo invasive coronary arteriography every 1-2 years, are appropriate for stress imaging (MPI or echo) every 1-2 years.

- After the first five years post cardiac transplantation, in lieu of invasive coronary arteriography:
  1) patients considered at low risk for transplant vasculopathy (i.e., with normal invasive coronary arteriography) can have annual stress imaging (MPI or echo), and
  2) patients with transplant coronary vasculopathy can have annual stress imaging (MPI or echo), if the risk of annual invasive coronary arteriography is not acceptable (i.e., high risk of contrast nephropathy).

ADDITIONAL INFORMATION:

Definitions of Coronary Artery Disease:

1. Percentage stenosis refers to diameter stenosis when angiography is the method and refers to cross sectional narrowing when IVUS (intravascular ultrasound) is the method of determination.
2. Coronary artery calcification is a marker of risk, as measured by Agatston score on coronary artery calcium imaging. It is not a diagnostic tool so much as it is a risk stratification tool (similar to an ankle brachia index, family history of coronary artery disease, or high sensitivity C-reactive protein). Its incorporation into Global Risk can be achieved by using the MESA risk calculator.
3. Stenoses less than 50% are considered nonobstructive coronary artery disease, while stenoses of 50% or more are considered obstructive coronary artery disease. However, the contents of this Guideline are very clear about specifying that ischemic heart disease requires one of three possible determinants:
   i. Percentage stenosis of at least 70% - by angiography or IVUS (intravascular ultrasound), as described above, for a major vessel
   ii. FFR (fractional flow reserve) of 0.80 or less for a major vessel
   iii. Demonstrable ischemic findings on stress testing (acceptable EKG or imaging), that are at least mild in degree
4. A major vessel would be a coronary vessel that would typically be substantial enough for revascularization, if it were indicated. Lesser forms of coronary artery disease would be labeled as “limited.” (i.e. A 50% lesion in a tiny septal would be limited obstructive coronary artery disease.)
5. Microvascular ischemic coronary artery disease, as might be described by a normal FFR (fractional flow reserve) above 0.80 with a reduced CFR (coronary flow reserve less than 2.5), has not otherwise been addressed in this manuscript, because it is very rarely an issue in compliance determinations. However, it would constitute a form of ischemic heart disease.
6. FFR (fractional flow reserve) is the distal to proximal pressure ratio across a coronary lesion during maximal hyperemia induced by either intravenous or intracoronary adenosine. Less than or equal to 0.80 is considered a reduction in coronary flow.

Definition of Peripheral Arterial Disease/Cerebrovascular Disease:
Non-coronary arterial narrowing causing symptoms (claudication, related tissue demise, threatened limb loss), asymptomatic 70% or more narrowing by non-invasive or invasive evaluation, atherosclerotic arterial aneurysm by non-invasive or invasive evaluation, or aortic atheroma of at least 4 mm thickness. As a subset of peripheral arterial disease, cerebrovascular disease is also defined as a history of stroke or TIA.

**What is a valid anginal equivalent?**

Development of an anginal equivalent (e.g. shortness of breath, fatigue, or weakness) either with or without prior coronary revascularization should be based upon the documentation of reasons to suspect that symptoms other than chest discomfort are not due to other organ systems (e.g. dyspnea due to lung disease, fatigue due to anemia, etc.), by presentation of clinical data such as respiratory rate, oximetry, lung exam, etc. (as well as d-dimer, chest CT(A), and/or PFTs, when appropriate), and then incorporated into the evaluation of coronary artery disease as would chest discomfort. Syncope by itself is generally not considered an anginal equivalent, and is handled under a separate category in this guideline.

**Pretest Probability of CAD for Symptomatic Patients:**

Pretest probability is a reference to symptoms that need evaluation as potentially coronary in origin.

- **Typical Angina (Definite):** Defined as 1) substernal chest pain or discomfort that is 2) provoked by exertion or emotional stress and 3) relieved by rest and/or nitroglycerin.
- **Atypical Angina (Probable):** Chest pain or discomfort that lacks 1 of the characteristics of definite or typical angina.
- **Nonanginal Chest Pain:** Chest pain or discomfort that meets 1 or none of the typical angina characteristics.

Once the presence of symptoms (Typical Angina/Atypical Angina/Non angina chest pain/Asymptomatic) is determined, the probabilities of CAD can be calculated from the risk algorithms as follows:

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Gender</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
<th>Asymptomatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40–49</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>50–59</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>&gt;60</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
</tbody>
</table>

- **Very low:** Less than 5% pretest probability of CAD
- **Low:** Less than 10% pretest probability of CAD
- **Intermediate:** Between 10% and 90% pretest probability of CAD
- **High:** Greater than 90% pretest probability of CAD

**Global Risk of CAD or Vascular Disease**

**Global risk** of CAD is defined as the probability of developing CAD, including myocardial infarction or CAD death over a given time period and refers to asymptomatic patients without known coronary artery
disease. It should be determined by the Framingham Risk Score (ATP IV risk tool), the Reynolds Risk Index, or the Pooled Cohort Equation (which includes cerebrovascular risk). A high risk is considered greater than a 20% risk of a coronary or major vascular event over the ensuing 10 years.

- **CAD Risk—Low**
  Defined by the age-specific risk level that is below average. In general, low risk will correlate with a 10-year absolute CAD risk less than 10%.

- **CAD Risk—Moderate**
  Defined by the age-specific risk level that is average or above average. In general, moderate risk will correlate with a 10-year absolute CAD risk between 10% and 20%.

- **CAD Risk—High**
  Defined as the presence of peripheral arterial disease, cerebrovascular disease, or a 10-year absolute CAD risk of greater than 20%.

**Duke Treadmill Score**

The equation for calculating the Duke treadmill score (DTS) is,

\[ DTS = \text{exercise time in minutes} - (5 \times \text{ST deviation in mm or 0.1 mV increments}) - (4 \times \text{exercise angina score}) \]

with angina score being 0 = none, 1 = non limiting, and 2 = exercise-limiting.

The score typically ranges from -25 to +15. These values correspond to low-risk (with a score of \( \geq +5 \)), intermediate risk (with scores ranging from -10 to +4), and high-risk (with a score of \( \leq -11 \)) categories.

**What Type of Stress Test is Appropriate?**

**EKG Stress Test versus Stress Echocardiography versus Stress Myocardial Perfusion Imaging**

Appropriate resource utilization, cost effectiveness, and radiation exposure limitation dictate choices in stress testing options.

Five prominent scenarios for an EKG stress test WITHOUT imaging (i.e. exercise treadmill EKG test) are endorsed by the guidelines presented above, often (but not always) requiring that the patient can exercise for at least 3 minutes of Bruce protocol with achievement of near maximal heart rate AND has an interpretable EKG for ischemia during exercise:

- The (symptomatic) low pretest probability patient who is able to exercise and has an interpretable EKG
- The (asymptomatic) high global risk patient who is able to exercise and has an interpretable EKG
- The patient who is under evaluation for exercise induced arrhythmia (or long QT interval evaluation when the resting QTc is normal), and coronary artery disease is not suspected
- The patient who requires an entrance stress test EKG for a cardiac rehab program or for an exercise prescription

An uninterpretable baseline EKG includes:

- Abnormalities of ST segment depression of 0.1 mV (1 mm with conventional calibration) or more
- Ischemic looking T wave inversions of at least 0.25 mV (2.5 mm with conventional calibration)
- EKG findings of probable or definite LVH, WPW, a ventricular paced rhythm, or left bundle branch block
- Digitalis use or hypokalemia
- Resting HR under 50 bpm on a beta blocker and an anticipated suboptimal workload (e.g. rate-pressure product less than 20-25K)
Prior false positive stress EKG

Exercise remains a valid stressor:

- In patients who can exercise to near maximal heart rate
- For entrance to cardiac rehabilitation or determination of an exercise prescription
- For exercise induced arrhythmia evaluation
- Even with an uninterpretable EKG if stress imaging is appropriate and EKG un-interpretablility is acknowledged

Scenarios for choosing stress echocardiography over myocardial perfusion imaging:

The patient can exercise to near maximal heart rate for at least 3 minutes of Bruce protocol and has an interpretable echocardiogram, with usage of contrast medium if necessary to enable quality imaging

AND

There is normal baseline systolic function, without moderately severe or severe valvular disease. Stress echocardiography with Doppler is appropriate in the patient for whom determination of exercise hemodynamics is required.

Exercise Doppler with hemodynamics is the main reason for stress testing.

**When is Myocardial Perfusion Imaging Preferred Over Stress Echocardiography?**

There are circumstances in which myocardial perfusion imaging is generally preferable to stress echocardiography:

- BMI \(\geq 40\)
- Ventricular paced rhythm, LBBB, WPW
- Frequent PVCs interfering with wall motion assessment
- Prior coronary artery bypass grafting with resultant paradoxical septal motion
- Currently in poorly controlled atrial fibrillation
- Poor cardiac window on echo (documented on echo report as technically limited or difficult, without likely benefit of contrast medium)
- Documented regional wall motion abnormality: dyskinesia, akinesia, or hypokinesia
- Unable to perform ADL’s with documented extent of limitations
- Functional capacity <4 METS or < 3’ Bruce protocol
- Arthritis with documented limitations
- Leg/foot amputation
- Active foot wound/ulcer
- Ambulation requires cane or walker
- Confinement to a wheelchair
- Severe chronic obstructive pulmonary disease (based upon PFT findings), severe dyspnea on exertion, or requirement for home oxygen use
- Systolic congestive heart failure with ejection fraction <40%
- Recent orthopedic surgery limiting use of a lower extremity
Determinants of a 4 MET functional capacity:

Examples of activities:

<4 METs: Slow ballroom dancing, golfing with a cart, playing a musical instrument, and walking at approximately 2 mph to 3 mph

>4 METs: Climbing a flight of stairs or walking up a hill, walking on level ground at 4 mph, and performing heavy work around the house

Tools for Characterization of Unstable Angina:

Risk Stratification in Acute Coronary Syndrome from 2007 ACC/AHA Guidelines

Three Principal Presentations of Unstable Angina (as defined within a two week time frame) (Braunwald)

<table>
<thead>
<tr>
<th>Class</th>
<th>Presentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rest angina</td>
<td>Angina occurring at rest and prolonged, usually greater than 20 min</td>
</tr>
<tr>
<td>New-onset angina</td>
<td>New-onset angina of at least CCS class III severity</td>
</tr>
<tr>
<td>Increasing angina</td>
<td>Previously diagnosed angina that has become distinctly more frequent, longer in duration, or lower in threshold (i.e., increased by 1 or more CCS class to at least CCS class III severity)</td>
</tr>
</tbody>
</table>

Table 6: Likelihood that Symptoms Represent an Acute Coronary Syndrome

<table>
<thead>
<tr>
<th>Feature</th>
<th>High Likelihood Any of the following:</th>
<th>Intermediate Likelihood Absence of high-likelihood features and presence of any of the following:</th>
<th>Low Likelihood Absence of high- or intermediate-likelihood features but may have:</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>Chest or left arm pain or discomfort as chief symptom reproducing prior documented angina</td>
<td>Chest or left arm pain or discomfort as chief symptom Age greater than 70 years Male sex Diabetes mellitus</td>
<td>Probable ischemic symptoms in absence of any of the intermediate likelihood characteristics Recent cocaine use</td>
</tr>
<tr>
<td>Examination</td>
<td>Transient MR murmur, hypotension, diaphoresis, pulmonary edema, or rales</td>
<td>Extracardiac vascular disease</td>
<td>Chest discomfort reproduced by palpation</td>
</tr>
<tr>
<td>ECG</td>
<td>New, or presumably new, transient ST-segment deviation (5 mm or greater) or T-wave inversion in multiple precordial leads</td>
<td>ST depression 0.5 to 1 mm or T-wave inversion greater than 1 mm</td>
<td>T-wave flattening or inversion less than 1 mm in leads with dominant R waves Normal EGG</td>
</tr>
<tr>
<td>Cardiac markers</td>
<td>Elevated cardiac TnI, TnT, or CK-MB</td>
<td>Normal</td>
<td>Normal</td>
</tr>
</tbody>
</table>


ACD = acute coronary syndrome; CAD = coronary artery disease; CK-MB = MB fraction of creatine kinase; ECG = electrocardiogram; MI = myocardial infarction; MR = mitral regurgitation; TnI = troponin I; TnT = troponin T.
Table 7: Short Term Risk of Death or Nonfatal MI in Acute Coronary Syndrome

<table>
<thead>
<tr>
<th>Feature</th>
<th>High Risk</th>
<th>Intermediate Risk</th>
<th>Low Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>History</td>
<td>Accelerating tempo of ischemic symptoms in preceding 48 h</td>
<td>Prior MI, peripheral or cerebrovascular disease, or CAD; prior aspirin use</td>
<td>Increased angina frequency, severity, or duration</td>
</tr>
<tr>
<td>Character of pain</td>
<td>Prolonged ongoing (greater than 20 min) rest pain</td>
<td>Prolonged (greater than 20 min) rest angina, now resolved, with moderate or high likelihood of CAD</td>
<td>Angina provoked at a lower threshold</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Rest angina (greater than 20 min) or relieved with rest or sublingual NTG</td>
<td>New onset angina with onset 2 weeks to 2 months prior to presentation</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Nocturnal angina</td>
<td></td>
</tr>
</tbody>
</table>

**Clinical findings**

- Pulmonary edema, most likely due to ischemia
- New or worsening MR murmur
- S₂ or new/worsening d-pulmonic
- Hypotension, bradycardia, tachycardia
- Age greater than 75 years
- Age greater than 70 years

**ECG**

- Angiographic ST-segment changes greater than 0.5 mm
- New or previously new Bundle-branch block
- Sustained ventricular tachycardia
- T-wave changes less than 1 mm in multiple lead groups (anterior, inferior, lateral)
- Normal or unchanged ECG

**Cardiac markers**

- Elevated cardiac TnT, TnI, or CK-MB (e.g., TnT or TnI greater than 0.01 u/kg/ml)
- Slightly elevated cardiac TnT, TnI, or CK-MB (e.g., TnT greater than 0.01 but less than 0.1 ug/ml)
- Normal

*The TIMI Risk Score* is determined by the sum of the presence of 7 variables at admission: 1 point is given for each of the following variables: age ≥65 years, at least 3 risk factors for CAD, prior coronary stenosis of ≥50%, ST-segment deviation on ECG presentation, at least 2 anginal events in prior 24 hours, use of aspirin in prior 7 days, and elevated serum cardiac biomarkers.

**Low-Risk TIMI Score**: TIMI score <2; **High-Risk TIMI Score**: TIMI score ≥2. A low risk TIMI score might still warrant invasive coronary arteriography, when other features, such as symptoms, are compelling.

**Abbreviations**:

- AAD: antiarrhythmic drug
- ADLs: activities of daily living
- CAD: coronary artery disease
- CCS: Canadian Cardiovascular Society
- CKD: chronic kidney disease
- EKG: electrocardiogram
- FFR: fractional flow reserve
- LBBB: left bundle-branch block
- LVH: left ventricular hypertrophy
- MI: myocardial infarction
- MET: estimated metabolic equivalent of exercise
- PFT: pulmonary function test
- PVCs: premature ventricular contractions
- TIMI: Thrombolysis in Myocardial Infarction (Study Group)
REFERENCES

General References


References for cardiovascular risk:
(Also see links to Online Calculators at end of Reference Section)


NIH Estimate of 10 Year coronary artery disease risk from Framingham Risk Score:

**References for High Occupational Risk**


**Reference for peri-operative risk**


**Reference for unstable angina risk**

http://dx.doi.org/10.1161/CIRCULATIONAHA.107.181940

**Reference for indications for cardiac catheterization/ invasive coronary arteriography:**


Reference for bariatric surgery risk


Reference for number of PVCs


Reference for syncope


Reference for left bundle branch block


Reference for right bundle branch block


Reference for police, fireman, pilots, etc.


Reference for Arrhythmias and Long QT Syndrome

http://electrophysiology.onlinejacc.org/article.aspx?articleid=2506118&resultClick=3#tab1

http://circ.ahajournals.org/content/124/20/2181.full


Reference for Cardiac Transplantation Patients

Gustafsson F. (2016) Diagnosis and prognosis of cardiac allograft vasculopathy. UpToDate.

Reference for Microvascular Coronary Disease


Reference for Kawasaki Disease


Reference for Anti-rejection Medication and Vascular Disease

http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2810018/

Links to Cardiac/Vascular Risk Online Calculators:

Framingham-ATP IV:
http://cvdrisk.nhlbi.nih.gov/

Reynolds Risk Score:
http://www.reynoldsriskscore.org/

Pooled Cohort Equation (includes cardiac and cerebrovascular risk):
http://clincalc.com/Cardiology/ASCVD/PooledCohort.aspx?example
ACC/AHA Risk Calculator (includes cardiac and cerebrovascular risk):
http://tools.acc.org/ASCVD-Risk-Estimator/

MESA Risk Calculator with addition of Coronary Artery Calcium Score:
https://www.mesa-nhlbi.org/MESACHDRisk/MesaRiskScore/RiskScore.aspx
CPT Codes: 78459, 78491, 78492

INTRODUCTION:

Cardiac PET has two major clinical uses. First, it can characterize myocardial blood flow (perfusion scan). The FDA has approved both rubidium-82 (Rb-82) and nitrogen-13(N-13) radiotracers for this purpose. Second, PET can identify regions of myocardial viability that appear scarred (dead) on standard rest or stress SPECT/MPI imaging. The FDA has approved use of fluorine 18 (F-18) fluorodeoxyglucose for this purpose.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR CARDIAC PET SCAN WITH APPROVED FDA RADIOISOTOPES:

• Evaluation of myocardial viability prior to possible percutaneous or surgical revascularization if:
  o Previous SPECT/MPI imaging for viability is inadequate; AND
  o Patient has severe left ventricular dysfunction (LVEF ≤ 35%).
• Evaluation in patient with suspected or known Coronary Artery Disease.
  o To qualify for PET perfusion scan done either at rest or with pharmacologic stress, the patient must meet criteria for indicated nuclear cardiac imaging/myocardial perfusion study AND is likely to experience attenuation artifact with SPECT imaging due to factors such as morbid obesity, large breasts, breast implants, previous mastectomy, chest wall deformity, pleural/pericardial effusion; OR
  o Patient had a previous inadequate SPECT/MPI imaging due to inadequate findings, technical difficulties with interpretation, or discordant results with previous clinical data.
• For the diagnosis of suspected cardiac involvement in patients with sarcoidosis as evidenced by reduced heart function on transthoracic echocardiogram or heart block on baseline electrocardiogram
  o For patients who have a contraindication to MRI or who have had an MRI of the heart with results equivocal for sarcoid involvement.
  o Examples of patients who are unable to undergo MRI include, but are not limited to, patients with a pacemaker, automatic implanted cardioverter-defibrillator (AICDs), or other metal implant.

◊ ACCF/ASNC/ACR/AHA/ASE/SCCT/SCMR/SNM 2009 APPROPRIATE USE CRITERIA for Nuclear Cardiac Imaging / Myocardial Perfusion Study:

<table>
<thead>
<tr>
<th>ACCF et al. Criteria # MPI / Stress Echo</th>
<th>INDICATIONS</th>
<th>APPROPRIATE USE SCORE (4-9):</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(*Refer to Additional Information section)</td>
<td>A= Appropriate;</td>
</tr>
<tr>
<td></td>
<td>□ Not subject to Stress Echocardiogram contraindications as noted in section “Indications for a Nuclear Cardiac Imaging / Myocardial Perfusion Study”. Please see explanation in Introduction, paragraph “6”</td>
<td>U=Uncertain (MPI / Stress Echo)</td>
</tr>
</tbody>
</table>

Detection of CAD/Risk Assessment: Symptomatic
### ACCF et al. Criteria # MPI / Stress Echo

<table>
<thead>
<tr>
<th>INDICATIONS</th>
<th>APPROPRIATE USE SCORE (4-9):</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>(Refer to Additional Information section)</em></td>
<td>A= Appropriate; U=Uncertain (MPI / Stress Echo)</td>
</tr>
</tbody>
</table>

- □ Not subject to Stress Echocardiogram contraindications as noted in section “Indications for a Nuclear Cardiac Imaging / Myocardial Perfusion Study”. Please see explanation in Introduction, paragraph “6”

#### Evaluation of Ischemic Equivalent (Non-Acute)

<table>
<thead>
<tr>
<th>#</th>
<th>Evaluation</th>
<th>Appropriate Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 / 115</td>
<td>Low pretest probability of CAD*&lt;br&gt;ECG uninterpretable OR unable to exercise</td>
<td>A(7) / A(7)</td>
</tr>
<tr>
<td>3 / 116</td>
<td>Intermediate pretest probability of CAD*&lt;br&gt;ECG interpretable AND able to exercise</td>
<td>A(7) / A(7)</td>
</tr>
<tr>
<td>4 / 117</td>
<td>Intermediate pretest probability of CAD*&lt;br&gt;ECG uninterpretable OR unable to exercise</td>
<td>A(9) / A(9)</td>
</tr>
<tr>
<td>5 / 118</td>
<td>High pretest probability of CAD*&lt;br&gt;Regardless of ECG interpretability and ability to exercise</td>
<td>A(8) / A(7)</td>
</tr>
</tbody>
</table>

#### Detection of CAD: Asymptomatic (Without Ischemic Equivalent)

<table>
<thead>
<tr>
<th>#</th>
<th>Evaluation</th>
<th>Appropriate Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>14 / 126</td>
<td>Intermediate CHD risk (ATP III risk criteria)***&lt;br&gt;ECG uninterpretable</td>
<td>U(5) / U(5)</td>
</tr>
<tr>
<td>15/127</td>
<td>High CHD risk (ATP III risk criteria)*** ✓</td>
<td>A(8) / U(5) ✓</td>
</tr>
</tbody>
</table>

#### New-Onset or Newly Diagnosed Heart Failure With LV Systolic Dysfunction Without Ischemic Equivalent

<table>
<thead>
<tr>
<th>#</th>
<th>Evaluation</th>
<th>Appropriate Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>16 / 128</td>
<td>No prior CAD evaluation AND no planned coronary angiography</td>
<td>A(8) / A(7)</td>
</tr>
</tbody>
</table>

#### New-Onset Atrial Fibrillation ♦

<table>
<thead>
<tr>
<th>#</th>
<th>Evaluation</th>
<th>Appropriate Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>17 / 132</td>
<td>Part of evaluation when etiology unclear</td>
<td>U(6) / U(6)</td>
</tr>
</tbody>
</table>

#### Ventricular Tachycardia ♦

<table>
<thead>
<tr>
<th>#</th>
<th>Evaluation</th>
<th>Appropriate Use Score</th>
</tr>
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<tbody>
<tr>
<td>18 / NA</td>
<td>Low CHD risk (ATP III risk criteria)***</td>
<td>A(7) / NA</td>
</tr>
<tr>
<td>19 / NA</td>
<td>Intermediate or high CHD risk (ATP III risk criteria)***</td>
<td>A(8) / NA</td>
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</tbody>
</table>

#### Syncope

<table>
<thead>
<tr>
<th>#</th>
<th>Evaluation</th>
<th>Appropriate Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>21 / 134</td>
<td>Intermediate or high CHD risk (ATP III risk criteria)***</td>
<td>A(7) / A(7)</td>
</tr>
</tbody>
</table>

#### Elevated Troponin

<table>
<thead>
<tr>
<th>#</th>
<th>Evaluation</th>
<th>Appropriate Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>22 / 135</td>
<td>Troponin elevation without additional evidence of acute coronary syndrome (with ischemia is not subject to Stress Echocardiogram contraindications) ✓</td>
<td>A(7) / A(7) ✓</td>
</tr>
</tbody>
</table>

#### Risk Assessment With Prior Test Results and/or Known Chronic Stable CAD

- Asymptomatic OR Stable Symptoms Normal Prior Stress Imaging Study

<table>
<thead>
<tr>
<th>#</th>
<th>Evaluation</th>
<th>Appropriate Use Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>26 / 145</td>
<td>Intermediate to high CHD risk (ATP III risk criteria)*** ✓</td>
<td>U(6) / U(4) ✓</td>
</tr>
<tr>
<td>ACCF et al. Criteria # MPI / Stress Echo</td>
<td>INDICATIONS</td>
<td>APPROPRIATE USE SCORE (4-9);</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------</td>
<td>-----------------------------</td>
</tr>
<tr>
<td>□ Not subject to Stress Echocardiogram contraindications as noted in section &quot;Indications for a Nuclear Cardiac Imaging / Myocardial Perfusion Study&quot;. Please see explanation in Introduction, paragraph “6”</td>
<td>(*Refer to Additional Information section)</td>
<td>A= Appropriate; U=Uncertain (MPI / Stress Echo)</td>
</tr>
<tr>
<td>• Last stress imaging study done more than or equal to 2 years ago</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• If known CAD, not subject to Stress Echo contraindications</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Asymptomatic OR Stable Symptoms Abnormal Coronary Angiography OR Abnormal Prior Stress Imaging Study, No Prior Revascularization</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>28 / 147</td>
<td>• Known CAD on coronary angiography OR prior abnormal stress imaging study</td>
<td>U(5) / U(5)</td>
</tr>
<tr>
<td></td>
<td>• Last stress imaging study done more than or equal to 2 years ago</td>
<td></td>
</tr>
<tr>
<td><strong>Prior Noninvasive Evaluation</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>29 / 153</td>
<td>• Equivocal, borderline, or discordant stress testing where obstructive CAD remains a concern</td>
<td>A(8) / A(8)</td>
</tr>
<tr>
<td><strong>New or Worsening Symptoms</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30 / 151</td>
<td>• Abnormal coronary angiography OR abnormal prior stress imaging study</td>
<td>A(9) / A(7)</td>
</tr>
<tr>
<td>31 / 152</td>
<td>• Normal coronary angiography OR normal prior stress imaging study</td>
<td>U(6) / U(5)</td>
</tr>
<tr>
<td><strong>Coronary Angiography (Invasive or Noninvasive)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>32 / 141</td>
<td>• Coronary stenosis or anatomic abnormality of uncertain significance</td>
<td>A(9) / A(8)</td>
</tr>
<tr>
<td><strong>Asymptomatic Prior Coronary Calcium Agatston Score</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>34 / 137</td>
<td>• Low to intermediate CHD risk***</td>
<td>U(5) / U(5)</td>
</tr>
<tr>
<td></td>
<td>• Agatston score between 100 and 400</td>
<td></td>
</tr>
<tr>
<td>35 / 138</td>
<td>• High CHD risk***✓</td>
<td>A(7) / U(6) ✓</td>
</tr>
<tr>
<td></td>
<td>• Agatston score between 100 and 400</td>
<td></td>
</tr>
<tr>
<td>36 / 139</td>
<td>• Agatston score greater than 400</td>
<td>A(7) / A(7)</td>
</tr>
<tr>
<td><strong>Duke Treadmill Score</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>38 / 149</td>
<td>• Intermediate-risk Duke treadmill score****</td>
<td>A(7) / A(7)</td>
</tr>
<tr>
<td>39 / 150</td>
<td>• High-risk Duke treadmill score****</td>
<td>A(8) / A(7)</td>
</tr>
<tr>
<td><strong>Risk Assessment: Preoperative Evaluation for Noncardiac Surgery Without Active Cardiac Conditions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Intermediate-Risk Surgery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>43 / 157</td>
<td>• Greater than or equal to 1 clinical risk factor✓</td>
<td>A(7) / U(6) ✓</td>
</tr>
<tr>
<td></td>
<td>• Poor or unknown functional capacity (less than 4 METs)</td>
<td></td>
</tr>
<tr>
<td>ACCF et al. Criteria # MPI / Stress Echo</td>
<td>INDICATIONS</td>
<td>APPROPRIATE USE SCORE (4-9); A= Appropriate; U=Uncertain (MPI / Stress Echo)</td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------------</td>
<td>-----------------------------------------------------------------------------</td>
</tr>
<tr>
<td><strong>Vascular Surgery</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>47 / 161</td>
<td>• Greater than or equal to 1 clinical risk factor</td>
<td>A(8) / A(7)</td>
</tr>
<tr>
<td></td>
<td>• Poor or unknown functional capacity (less than 4 METS)</td>
<td></td>
</tr>
<tr>
<td><strong>Risk Assessment: Within 3 Months of an Acute Coronary Syndrome</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>STEMI</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>50 / 164</td>
<td>• Hemodynamically stable, no recurrent chest pain symptoms or no signs of HF</td>
<td>A(8) / A(7)</td>
</tr>
<tr>
<td></td>
<td>• To evaluate for inducible ischemia</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No prior coronary angiography</td>
<td></td>
</tr>
<tr>
<td><strong>UA/NSTEMI</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>52 / 166</td>
<td>• Minor perioperative risk predictor</td>
<td>A(9) / A(8)</td>
</tr>
<tr>
<td></td>
<td>• Normal exercise tolerance (greater than or equal to 4 METS) Hemodynamically stable, no recurrent chest pain symptoms or no signs of HF</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• To evaluate for inducible ischemia</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• No prior coronary angiography</td>
<td></td>
</tr>
<tr>
<td><strong>Risk Assessment: Postrevascularization (Percutaneous Coronary Intervention or Coronary Artery Bypass Graft)</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Symptomatic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>55 / 169</td>
<td>• Evaluation of ischemic equivalent</td>
<td>A(8) / A(8)</td>
</tr>
<tr>
<td><strong>Asymptomatic</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>56 / 170</td>
<td>• Incomplete revascularization</td>
<td>A(7) / A(7)</td>
</tr>
<tr>
<td></td>
<td>• Additional revascularization feasible</td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>• Less than 5 years after CABG</td>
<td>U(5) ✓</td>
</tr>
<tr>
<td>58 / 172</td>
<td>• Greater than or equal to 5 years after CABG</td>
<td>A(7) / U(6)</td>
</tr>
<tr>
<td>60 / 174</td>
<td>• Greater than or equal to 2 years after PCI</td>
<td>U(6) / U(5)</td>
</tr>
<tr>
<td><strong>Assessment of Viability/Ischemia</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Ischemic Cardiomyopathy/Assessment of Viability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>62 / 176</td>
<td>• Known severe LV dysfunction</td>
<td>A(9) / A(8)</td>
</tr>
<tr>
<td></td>
<td>• Patient eligible for revascularization</td>
<td></td>
</tr>
</tbody>
</table>

◊ INDICATIONS FOR A NUCLEAR CARDIAC IMAGING/MYOCARDIAL PERFUSION STUDY:

- To qualify for SPECT/MPI, the patient must meet ACCF/ASNC Appropriateness criteria for appropriate indications above and meets any one of the following conditions:
  
  o Stress echocardiography is not indicated; OR
Stress echocardiography has been performed however findings were inadequate, there were technical difficulties with interpretation, or results were discordant with previous clinical data; OR MPI is preferential to stress echocardiography including but not limited to following conditions:

- Ventricular paced rhythm
- Evidence of ventricular tachycardia
- Severe aortic valve dysfunction
- Severe Chronic Obstructive Pulmonary Disease, (COPD) as defined as FEV1 < 30% predicted or FEV1 < 50% predicted plus respiratory failure or clinical signs of right heart failure. (GOLD classification of COPD access http://www.pulmonaryreviews.com/jul01/pr_jul01_copd.html)
- Congestive Heart Failure (CHF) with current Ejection Fraction (EF) < 40%
- Inability to get an echo window for imaging
- Prior thoracotomy, (CABG, other surgery)
- Obesity BMI>40
- Poorly controlled hypertension [generally above 180 mm Hg systolic (both physical stress and dobutamine stress may exacerbate hypertension during stress echo)]
- Poorly controlled atrial fibrillation (Resting heart rate > 100 bpm on medication to control rate)
- Inability to exercise requiring pharmacological stress test
- Segmental wall motion abnormalities at rest (e.g. due to cardiomyopathy, recent MI, or pulmonary hypertension)

OR

Arrhythmias with Stress Echocardiography - any patient on a type 1C anti-arrhythmic drug (i.e. Flecainide or Propafenone) or considered for treatment with a type 1C anti-arrhythmic drug.

For all other requests, the patient must meet ACCF/ASNC Appropriateness criteria for indications with Appropriate Use Scores 4-9, as noted above.

ADDITIONAL INFORMATION:

The applications for Cardiac Viability Imaging with FDG PET are:
- The identification of patients with partial loss of heart muscle movement or hibernating myocardium is important in selecting candidates with compromised ventricular function to determine appropriateness for revascularization.
- Distinguish between dysfunctional but viable myocardial tissue and scar tissue in order to affect management decisions in patients with ischemic cardiomyopathy and left ventricular dysfunction.

♦ Use of class IC antiarrhythmic agents:
Flecainide (Tambocor) and propafenone (Rythmol) are class IC anti arrhythmic agents. They are used to treat ventricular and supraventricular tachyarrhythmias. They are contraindicated in patients with structural heart disease due to the risk of precipitating life-threatening ventricular arrhythmias. These drugs can depress systolic function. They can suppress the sinus node in patients with sick sinus syndrome and impair AV and infra nodal conduction in patients with conduction disease. Propafenone has beta adrenergic receptor blocking effect.

*Pretest Probability of CAD for Symptomatic (Ischemic Equivalent) Patients:
- Typical Angina (Definite): Defined as 1) substernal chest pain or discomfort that is 2) provoked by exertion or emotional stress and 3) relieved by rest and/or nitroglycerin.
- Atypical Angina (Probable): Chest pain or discomfort that lacks 1 of the characteristics of definite or typical angina.
- Nonanginal Chest Pain: Chest pain or discomfort that meets 1 or none of the typical
angina characteristics.

Once the presence of symptoms (Typical Angina/Atypical Angina/Non angina chest pain/Asymptomatic) is determined, the probabilities of CAD can be calculated from the risk algorithms as follows:

<table>
<thead>
<tr>
<th>Age (Years)</th>
<th>Gender</th>
<th>Typical/Definite Angina Pectoris</th>
<th>Atypical/Probable Angina Pectoris</th>
<th>Nonanginal Chest Pain</th>
<th>Asymptomatic</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;39</td>
<td>Men</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Very low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>40–49</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
<td>Very low</td>
</tr>
<tr>
<td>50–59</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
<td>Very low</td>
</tr>
<tr>
<td>&gt;60</td>
<td>Men</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
<tr>
<td></td>
<td>Women</td>
<td>High</td>
<td>Intermediate</td>
<td>Intermediate</td>
<td>Low</td>
</tr>
</tbody>
</table>

- **Very low**: Less than 5% pretest probability of CAD
- **Low**: Less than 10% pretest probability of CAD
- **Intermediate**: Between 10% and 90% pretest probability of CAD
- **High**: Greater than 90% pretest probability of CAD

**REFERENCES:**


CPT Codes: 78472, 78473, 78494, +78496

INTRODUCTION:

Multiple-gated acquisition (MUGA) scanning is a radionuclide ventriculography technique to evaluate the pumping function of the ventricles of the heart. During this noninvasive nuclear test, radioactive tracer is injected into a vein and a gamma camera detects the radiation released by the tracer, providing moving images of the heart. From these images, the health of the heart’s pumping chamber, the left ventricle, can be assessed. It is used to evaluate the left ventricular ejection fraction (LVEF), a measure of overall cardiac function. It may also detect areas of poor contractility following an ischemic episode and it is used to evaluate left ventricular hypertrophy.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

INDICATIONS FOR MULTIPLE-GATED ACQUISITION (MUGA) SCAN:

- To evaluate left ventricular (LV) function at baseline before chemotherapy or cardiotoxic therapy; may be repeated prior to subsequent chemotherapy cycles until a total cardiotoxic dose has been reached.
- To evaluate ejection fraction in a patient with congestive heart failure (CHF), when prior cardiac imaging has proven inadequate for an accurate determination of ejection fraction.
- To evaluate patient, who is obese or who has chronic obstructive pulmonary disease (COPD), for coronary artery disease (CAD).
- As an alternative form of stress imaging instead of echocardiography or myocardial perfusion imaging, based upon similar necessity criteria for the evaluation of coronary or valvular heart disease.

COMBINATION OF STUDIES WITH MUGA:

Abdomen CT/Pelvis CT/Chest CT/Neck MRI/Neck CT with MUGA – known tumor/cancer for initial staging or evaluation before starting chemotherapy or radiation treatment.

ADDITIONAL INFORMATION RELATED TO MUGA:

Request for a follow-up study - A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) requested.

MUGA Scan Monitoring during Chemotherapy – Chemotherapeutic drugs that are used in cancer treatment may be toxic to the heart muscle. To minimize the risk of damaging the heart muscle with these drugs, the patient’s cardiac function may be monitored with the MUGA scan before and during administration of the drug. Before the first dose of the drug, a MUGA scan may be performed to establish a baseline left ventricle ejection fraction (LVEF). It may then be repeated after cumulative doses. If the LVEF begins to decrease, cardio toxicity risk must be considered if continuing the treatment.
REFERENCES


CPT Codes: 78608, 78609

Positron Emission Tomography (PET) scanning is useful in brain tumor imaging and in the preoperative evaluation of refractory epilepsy. It is useful in the identification of epileptic foci in the brain as an adjunct to surgical planning and is useful for follow-up of brain tumor surgery or treatment. It helps in the evaluation of known brain tumor with new signs or symptoms indicative of a recurrence of cancer.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

**INDICATIONS FOR BRAIN PET SCAN:**

**For evaluation of known brain tumor or cancer:**
- Known brain tumor or cancer with new signs or symptoms indicative of a reoccurrence of cancer.
- Brain tumor follow-up after surgery and/or after treatment recently completed.

**For pre-operative evaluation:**
- Pre-surgical evaluation for refractory epilepsy.

**Post-operative/procedural evaluation:**
- A follow-up study may be needed to help evaluate a patient’s progress after treatment, procedure, intervention or surgery. Documentation requires a medical reason that clearly indicates why additional imaging is needed for the type and area(s) of requested imaging.

**For evaluation of Dementia:**
- A scan is reasonable and necessary in patients (who meet all of the following) with:
  1. Documented cognitive decline of at least six months (request date of onset of symptoms).
  2. Recent assessment done of patient’s mental status - documented by neuro-diagnostic testing, such as:
     a. Change in mental status with a mental status score of either MMSE or MoCA of less than 26 or other similar mental status exams showing at least mild cognitive impairment AND a completed basic metabolic workup (such as thyroid function testing, liver function testing, complete blood count, etc).
  3. Appropriate baseline work-up for other treatable causes

**ADDITIONAL INFORMATION RELATED TO BRAIN PET:**

**Information applicable to Dementia/Alzheimer's:**
- Cognition is the act or process of thinking, perceiving, and learning.
- Symptoms develop when the underlying condition affects areas of the brain involved with learning, memory, decision-making, and language.
- Memory impairment is often the first symptom to be noticed. Someone with dementia may be unable to remember ordinary information, such as their birth date and address, and may be unable to recognize friends and family members.
- There is progressive decline in these cognitive functions as well:
  - Decision making
  - Judgment
Orientation in time and space
Problem solving
Verbal communication

Behavioral changes may include the following:
- Eating, dressing, toileting (e.g., unable to dress without help; becomes incontinent)
- Interests (e.g., abandons hobbies)
- Routine activities (e.g., unable to perform household tasks)
- Personality (e.g., inappropriate responses, lack of emotional control).

Frontotemporal dementia diagnostic criteria:
- Behavioral symptoms that should be recorded include apathy, aspontaneity, or, oppositely, disinhibition.
- Executive function should also be assessed—patients would show impairment in ability to perform skills that require complex planning or sequencing (multi-step commands, drawing the face of a clock).
- Primitive reflexes showing frontal release should be assessed including palmomental reflex, rooting reflex and palmar grasp.

Alzheimer’s criteria:
- Memory impairment (assessed as part of mini-mental status exam MMSE)
- Cognitive disturbance (one or more) evidenced by
  - Aphasia (language disturbance)
  - Apraxia (impaired ability to carry out motor activities despite intact motor function)
  - Agnosia - failure to recognize or identify objects despite intact sensory (vision, touch, etc) function
- Disturbance in executive function—patients would show impairment in ability to perform skills that require complex planning or sequencing (multi-step commands, drawing the face of a clock).

Metabolic testing (in addition to neurologic examination, MMSE):
- Urinalysis (to r/o urinary tract infection as a cause of dementia)
- CBC (to r/o infection or anemia as a cause of impaired mental function)
- Serum electrolytes, including magnesium
- Serum chemistries, including liver function testing
- Thyroid function tests (TSH or super sensitive (ss) TSH)
- Vitamin B12
- Erythrocyte Sedimentation Rate (ESR, “Sed Rate”, etc)
- Serologic test for syphilis (to r/o tertiary syphilis)
- Possibly toxicology tests to r/o poisoning or overdose—salicylates, alcohol, other

Medicines that may be causing cognitive impairment:
- Anti-diarrheals
- Anti-epileptic medications
- Antihistamines, cold and flu medications
- Lithium
- Sleeping pills
- Tricyclic antidepressants
- Opiates
- Salicylates

**PET in Seizure Disorders** — Refractory epilepsy is defined as epilepsy that does not respond to medical treatment. These patients struggle with recurrent seizures even while undergoing treatment with antiepileptic drugs (AEDs). However, the definition is unclear as some of these patients will partially respond to treatment or will worsen when AEDs are discontinued. PET is helpful in locating the area of
the brain causing seizures and is used in the preoperative evaluation of patients who have failed to respond to conventional medical treatment of epilepsy.

**PET and Known Brain Tumor/Cancer** – Studies have shown that PET is useful in patients who have undergone surgery. PET, a biochemical and physiologic technology, provides precise information about brain tumors which helps to distinguish between brain tumors and other anatomic structures or surgical scars. It is useful in identifying tumors in the brain after surgery, radiation or chemotherapy. With the sensitivity and specificity of the radiotracer 18-F FDG, PET is able to evaluate recurrent tumor and treatment-induced changes.

**REFERENCES**


TOC

78813 – PET Scan

78811 - Limited area e.g. Chest, head/neck
78812 - Skull base to mid thigh
78813 - Whole Body
78814 - With CT attenuation (Limited area e.g. Chest, head/neck)
78815 - With CT attenuation (Skull base to mid thigh)
78816 - With CT attenuation (Whole Body)
G0219 - PET imaging whole body, melanoma for non-covered indications
G0235 - PET imaging, any site, not otherwise specified
G0252 - PET imaging, initial diagnosis of breast cancer and/or surgical planning for breast cancer

INTRODUCTION:

Positron emission tomography (PET) is a rapidly developing technology that is able to detect biochemical processes, most often glucose uptake and utilization, within body tissues. A radioactive tracer is used during the procedure. Though multiple PET radiotracers are FDA approved, the most commonly used PET radiotracer is 18F Fluorodeoxyglucose (FDG). Unlike other nuclear medicine examinations, FDG PET measures metabolic activity of the cells of body tissues, providing information about the functionality and structure of the particular organ or tissue examined. PET may detect biochemical changes that help to evaluate malignant tumors and other lesions.

The degree of radioactive tracer uptake may indicate increased metabolism in the cells of body tissues. Cancer cells tend to show increased radioactive tracer accumulation relative to tissue not involved with tumor. Radioactive tracer uptake is generally higher in fast-growing tumors; FDG PET is not as sensitive for slow growing tumors.

Radioactive tracer uptake may occur in various types of active inflammation and is not specific for cancer. Thus it is generally not used for the initial specific diagnosis of cancer, but is more useful in monitoring cancer cell viability and for the diagnosis and detection of recurrence of cancer. FDG PET is also useful for monitoring the response to treatment of various cancers. Finally FDG PET is useful in the management of indeterminate pulmonary nodules/masses that are, for both anatomic and clinical reasons, difficult to biopsy.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

The following guidelines are for FDG PET imaging in oncology.

IMPORTANT NOTE:
- The following are noncovered for all other indications including (but not limited to):
  - **Breast Cancer** – Initial Treatment Strategy (formerly diagnosis and initial staging) of axillary lymph nodes.
  - **Melanoma** – Initial Treatment Strategy (formerly Evaluation) of regional lymph nodes.
  - **Prostate Cancer** – Initial Treatment Strategy (formerly Diagnosis and initial staging.)
  - **Infection and/or Inflammation** - PET for chronic osteomyelitis, infection of hip arthroplasty, and fever of unknown origin.
INDICATIONS FOR AN ONCOLOGICAL FDG PET SCAN:

Initial Treatment Strategy

All solid tumors, including myeloma, with biopsy proven cancer or strongly suspected based on other diagnostic testing:

Including

- CLL – chronic lymphocytic leukemia (PET/CT is generally not useful in CLL/SLL but may be necessary to direct nodal tissue sampling when high-grade histologic transformation is suspected)
- SPN – solitary (or clearly dominant) indeterminate pulmonary nodule ≥ to 8mm in size without existing tissue diagnosis (note: patient may have other non-suspicious nodules in the lung, such as granulomas and hamartomas.)

Excluding

- ALL – acute lymphoblastic leukemia
- AML – acute myelogenous leukemia
- BCC – basal cell carcinoma (of the skin)
- Prostate cancer
- To determine the anatomic extent of tumor when the recommended anti-tumor treatment reasonably depends on the extent of the tumor, or
- To determine if patient is an appropriate candidate for an invasive diagnostic or therapeutic procedure, or
- To determine the optimal anatomic location for an invasive procedure.

Subsequent Treatment Strategy

Restaging or monitoring response to active treatment, and/or a single evaluation after completion/cessation of therapy not to be performed within 4 weeks of completion of therapy (ideally FDG PET is delayed 2-3months after surgical therapy, 2-3 months after radiation therapy if locoregional assessment is the imaging goal), and/or evaluation for suspicion of recurrence due to new or changing signs/symptoms. (Asymptomatic surveillance is not approvable.)

- Breast cancer (female and males)
- Cervical cancer
- Colorectal cancer (including colon, rectal, appendiceal or anal cancer)
- Esophageal cancer
- Head and neck cancer (not including Brain cancer/tumor; thyroid noted below)
- Lung cancer - Non-small cell
- Lymphoma
- Melanoma
- Myeloma
- Ovarian cancer

Subsequent PET Scans may be performed only if other imaging (US, CT, MRI, NM) is inconclusive in determining a treatment plan or unable to be performed:

- Brain cancer: (with metastasis to non-head areas)
- Refer to Brain PET Scan Guidelines to image the brain
- Lung cancer - Small cell
- Neuroendocrine cancer (e.g. carcinoid, pheochromocytoma, etc)
- Pancreatic cancer
- Prostate cancer
- Soft tissue sarcoma
- Testicular cancer
- Tumors of unknown origin

**Thyroid cancer:**
- Subsequent treatment strategy for recurrence or distant metastasis for thyroid cancer of Papillary, Follicular, or Hurthle cell origin AND patient has the following:
  - A thyroidectomy and radioiodine ablation initially, *and*
  - Current serum thyroglobulin > 10ng/mL, *and*
  - Current whole body I-131 scan is negative.
  - Medullary thyroid cancer when calcitonin levels are elevated post-operatively.

**Surveillance/Remission**

Surveillance/remission PET scan testing to assess for possible changes in status with no signs or symptoms of active cancer changes and not on any active treatment. Unless otherwise specified above, PET scan is not indicated for surveillance/remission.

**ADDITIONAL INFORMATION RELATED TO PET SCANS:**

**Initial Treatment Strategy** - “Initial Anti-tumor Treatment Strategy” or “Initial Treatment Strategy” is replacing “diagnosis and initial staging”.

**Subsequent Treatment Strategy** - “Subsequent Anti-tumor Treatment Strategy” or “Subsequent Treatment Strategy” is replacing “restaging and monitoring response to treatment”.

**PET in the setting of immunotherapy** - Be aware that cancer immunotherapy with cytokines, immune-modulating antibodies, and cancer vaccines, is changing the landscape of imaging evaluation of cancer treatment response. Early experience with these therapies has demonstrated a delayed imaging response to therapy as compared to traditional chemotherapy. Transient enlargement and intensification of radiotraer activity in tumors, nodal and metastatic disease is well documented. This “pseudoprogression” may necessitate additional PET/CT surveillance. Literature currently supports repeat interval PET/CT after such a transient worsening on imaging so as to determine whether the changes seen are true progression or merely brisk immune response.

**PET/CT or PET with CT Attenuation Correction** – In contrast to the simple PET scan which requires a complex process of evaluation of body habitus to adjust for tissue density, modern scanners have the capacity to obtain a preliminary, general assessment of a patient’s habitus through the use of CT technology. Automatic adjustments to the PET data (based on tissue attenuation) are made. This is one study, not a combination study. This is interchangeably referred to as a PET/CT or PET/CT fusion examination. These provide the anatomical detail of a CT with PET’s ability to measure tissue metabolic activity. The ability to view both the morphology and metabolic activity simultaneously helps to evaluate tumors with speed and clarity. PET alone is normally not the standard of care and is significantly less accurate than PET/CT. The combination of PET and computed tomography (PET/CT) has advantages
over PET alone because areas of tracer uptake are better localized and the image acquisition time is reduced.

**PET and Breast Cancer** - PET provides important qualitative and quantitative metabolic information that is important in the initial staging and re-staging of breast cancer.

**PET and Cervical Cancer** – Studies have shown that PET may be useful for the pre-treatment detection of retroperitoneal nodal metastasis in cervical cancer.

**PET and Colorectal Cancer** – PET is useful in the detection of recurrent disease, the localization of recurrence in patients with a rise of carcinoembryonic antigen (CEA), the assessment of residual masses after treatment, and in staging patients before surgery.

**PET and Esophageal Cancer** – The most common use of PET in esophageal cancer is to detect distant metastases and distant lymph node disease. It may also be used to assess therapy response and evaluate for esophageal tumor recurrence after treatment. PET findings do not specify each separate type of lesion. It is very helpful in detecting distant spread from invasive thymic carcinomas.

**PET and Head and Neck Cancer** – PET is used to evaluate cancer/tumor in the head and neck region, e.g., face, orbit, temporal, neck and is useful to rule out head and/or neck cancer/tumor as the “primary” when there is evidence of tumor elsewhere in the body and clinical examination or conventional imaging has failed to localize the lesion. It is also used to distinguish a benign tumor from a malignant tumor.

**PET and Lung Cancer** – The most common cause of death from cancer in western countries is lung cancer. PET is helpful in the evaluation of patients diagnosed with early-stage non small lung cancer. It is valuable in picking up otherwise occult metastasis. PET identifies areas of hypermetabolism such as neoplasia or inflammation and reveals occult metastases. The detection of hidden or unsuspected metastasis prevents unnecessary surgery or treatments.

**PET and Lymphoma** – PET is used in the early assessment of response to chemotherapy in Hodgkin lymphoma (HL) as well as in aggressive non-Hodgkin lymphoma (NHL). Soon after the initiation of therapy, changes in radioactive tracer uptake may occur and these changes precede changes in tumor volume. This information may be used to guide treatment for patients with HL and NHL. However, PET/CT scan at early/interim restaging can lead to increased false positives and should be carefully considered in select cases.

**PET and Melanoma** – PET is not used in the diagnosis of melanoma. It may be used in the evaluation of stage III melanoma for detection of distant metastases and to identify candidates for further treatment or surgery.

**PET and Pancreatic Cancer** – In difficult cases, the presence of diffuse uptake of radioactive tracer by the pancreas or concomitant extrapancreatic uptake by the salivary glands on PET/CT can be used to aid in differentiation of autoimmune pancreatitis and pancreatic cancer.

**PET and Solitary Pulmonary Nodule** – PET may be used in the evaluation of patients with a single solitary nodule. It measures glucose metabolism which is different between benign and malignant nodules. FDG-PET is accurate in evaluation of the nodule. However, it may provide false positive results in patients who have inflammatory disease or active infections.
PET and Thyroid Cancer – The differentiated thyroid carcinoma (DTC) represents the most common type of thyroid cancer. It can be cured with surgical treatment and adjunctive therapy, but tumor recurrence is associated with significant morbidity and mortality. PET is used to evaluate DTC patients with negative radiiodine scans and elevated thyroglobulin (Tg) levels to detect recurrent or metastatic DTC. When thyroid carcinoma is differentiated it tends to retain the ability to accumulate iodine and iodine-based imaging is therefore the most appropriate imaging exam. When thyroid carcinoma becomes dedifferentiated, it tends to lose the ability to accumulate iodine and instead begins to act like other aggressive carcinomas.

PET in pediatric age group – While radiation dose and stochastic effects of radiation are of greater concern in the pediatric age group as compared to the adult age group, there are no PET/CT-specific radiation safety precautions. Prudence with all forms of imaging requiring ionizing radiation is recommended.

REFERENCES


