

**American College of Radiology  
ACR Appropriateness Criteria®**

**Clinical Condition:** Chronic Neck Pain

**Variant 1:** Patient with chronic neck pain without or with a history of previous trauma. First study.

Radiologic Procedure	Rating	Comments	RRL*
X-ray cervical spine	9	AP and lateral (may be supplemented with swimmer's and/or open mouth views).	☼ ☼
MRI cervical spine without IV contrast	2		O
Facet injection/medial branch block cervical spine	1	Never indicated as initial study.	☼ ☼
X-ray myelography cervical spine	1	Never indicated as initial study.	☼ ☼ ☼
CT cervical spine without IV contrast	1	Never indicated as initial study.	☼ ☼ ☼
Tc-99m bone scan with SPECT neck	1	Never indicated as initial study.	☼ ☼ ☼
Myelography and post myelography CT cervical spine	1	Never indicated as initial study.	☼ ☼ ☼ ☼
MRI cervical spine without and with IV contrast	1		O
CT cervical spine with IV contrast	1		☼ ☼ ☼
CT cervical spine without and with IV contrast	1		☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 2:** Patient with chronic neck pain with history of previous malignancy. First study.

Radiologic Procedure	Rating	Comments	RRL*
X-ray cervical spine	9	AP and lateral (may be supplemented with swimmer's and/or open mouth views).	☼ ☼
MRI cervical spine without IV contrast	2		O
CT cervical spine without IV contrast	2	Only if MRI is contraindicated.	☼ ☼ ☼
Tc-99m bone scan whole body with SPECT neck	2		☼ ☼ ☼
MRI cervical spine without and with IV contrast	1		O
CT cervical spine with IV contrast	1		☼ ☼ ☼
CT cervical spine without and with IV contrast	1		☼ ☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Clinical Condition:** Chronic Neck Pain

**Variant 3:** Patient with chronic neck pain with history of previous C-spine surgery (including ACDF).  
First study.

Radiologic Procedure	Rating	Comments	RRL*
X-ray cervical spine	9	AP and lateral (may be supplemented with swimmer's and/or open mouth views).	☼☼
X-ray cervical spine flexion extension lateral views	8	To exclude pseudarthrosis.	☼☼
MRI cervical spine without IV contrast	2		○
MRI cervical spine without and with IV contrast	2		○
CT cervical spine without IV contrast	2		☼☼☼
CT cervical spine with IV contrast	2		☼☼☼
CT cervical spine without and with IV contrast	2		☼☼☼
Tc-99m bone scan with SPECT neck	2		☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 4:** Radiographs normal. No neurologic findings.

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without IV contrast	3	Persistent pain following failure of conservative management only in select cases.	○
CT cervical spine without IV contrast	2	Following conservative management if MRI contraindicated only in select cases.	☼☼☼
X-ray myelography cervical spine	1		☼☼☼
Tc-99m bone scan with SPECT neck	1		☼☼☼
Facet injection/medial branch block cervical spine	1		☼☼
Myelography and post myelography CT cervical spine	1		☼☼☼☼
MRI cervical spine without and with IV contrast	1		○
CT cervical spine with IV contrast	1		☼☼☼
CT cervical spine without and with IV contrast	1		☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Clinical Condition:** Chronic Neck Pain

**Variant 5:** Radiographs normal. Neurologic signs or symptoms present.

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without IV contrast	9		O
Myelography and post myelography CT cervical spine	5	If MRI contraindicated.	☼☼☼☼
CT cervical spine without IV contrast	5	If MRI contraindicated.	☼☼☼
Facet injection/medial branch block cervical spine	3	MBB may be used to confirm facet as specific pain generator, generally third line test following MRI or CT.	☼☼
MRI cervical spine without and with IV contrast	2		O
X-ray myelography cervical spine	2		☼☼☼
CT cervical spine with IV contrast	2		☼☼☼
CT cervical spine without and with IV contrast	2		☼☼☼
Tc-99m bone scan with SPECT neck	2		☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 6:** Radiographs show degenerative changes. No neurologic findings.

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without IV contrast	5	Persistent pain following failure of conservative management.	O
CT cervical spine without IV contrast	3	Following conservative management if MRI contraindicated.	☼☼☼
Myelography and post myelography CT cervical spine	2		☼☼☼☼
Tc-99m bone scan with SPECT neck	2		☼☼☼
Facet injection/medial branch block cervical spine	2	MBB may be used to confirm facet as specific pain generator, generally third line test following MRI or CT.	☼☼
MRI cervical spine without and with IV contrast	1		O
X-ray discography cervical spine	1		☼☼
CT cervical spine with IV contrast	1		☼☼☼
CT cervical spine without and with IV contrast	1		☼☼☼
X-ray myelography cervical spine	1	Should not be performed without CT.	☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Clinical Condition:** Chronic Neck Pain

**Variant 7:** Radiographs show degenerative changes. Neurologic signs or symptoms present.

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without IV contrast	9		O
Myelography and post myelography CT cervical spine	5	If MRI contraindicated.	☼☼☼☼
CT cervical spine without IV contrast	5	If MRI contraindicated.	☼☼☼
Facet injection/medial branch block cervical spine	3	MBB may be used to confirm facet as specific pain generator, generally third line test following MRI or CT.	☼☼
Tc-99m bone scan with SPECT neck	2		☼☼☼
X-ray myelography cervical spine	1	Should not be performed without CT.	☼☼☼
MRI cervical spine without and with IV contrast	1		O
X-ray discography cervical spine	1		☼☼
CT cervical spine with IV contrast	1		☼☼☼
CT cervical spine without and with IV contrast	1		☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 8:** Radiographs show old trauma. No neurologic findings.

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without IV contrast	5	Persistent pain following failure of conservative management.	O
CT cervical spine without IV contrast	3	Following conservative management if MRI contraindicated.	☼☼☼
X-ray myelography cervical spine	2		☼☼☼
Myelography and post myelography CT cervical spine	2		☼☼☼☼
Tc-99m bone scan with SPECT neck	2		☼☼☼
Facet injection/medial branch block cervical spine	1		☼☼
MRI cervical spine without and with IV contrast	1		O
X-ray discography cervical spine	1		☼☼
CT cervical spine with IV contrast	1		☼☼☼
CT cervical spine without and with IV contrast	1		☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Clinical Condition:** Chronic Neck Pain

**Variant 9:** Radiographs show old trauma. Neurologic signs or symptoms present.

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without IV contrast	9		O
Myelography and post myelography CT cervical spine	5		☼☼☼☼
CT cervical spine without IV contrast	5		☼☼☼
Tc-99m bone scan with SPECT neck	3	Localize pain source.	☼☼☼
Facet injection/medial branch block cervical spine	2		☼☼
X-ray myelography cervical spine	1	Should not be performed without CT.	☼☼☼
MRI cervical spine without and with IV contrast	1		O
X-ray discography cervical spine	1		☼☼
CT cervical spine with IV contrast	1		☼☼☼
CT cervical spine without and with IV contrast	1		☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

**Variant 10:** Radiographs show disc margin destruction or bone lesion suggestive of infection or malignancy.

Radiologic Procedure	Rating	Comments	RRL*
MRI cervical spine without IV contrast	9		O
MRI cervical spine without and with IV contrast	9		O
CT cervical spine with IV contrast	5	CT with contrast should be performed if MRI is unavailable or cannot be performed or when disc space infection/osteomyelitis is suspected.	☼☼☼
CT cervical spine without IV contrast	3		☼☼☼
Tc-99m bone scan with SPECT neck	2		☼☼☼
X-ray myelography cervical spine	1		☼☼☼
CT cervical spine without and with IV contrast	1		☼☼☼
Myelography and post myelography CT cervical spine	1		☼☼☼☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

**Clinical Condition:** Chronic Neck Pain

**Variant 11:** Prior C-spine surgery (including ACDF) with radiographs showing no complication. Next study.

Radiologic Procedure	Rating	Comments	RRL*
CT cervical spine without IV contrast	7	CT best examination to assess for hardware complication, extent of fusion.	☼ ☼ ☼
MRI cervical spine without IV contrast	5		O
X-ray myelography cervical spine	2		☼ ☼ ☼
Tc-99m bone scan with SPECT neck	2		☼ ☼ ☼
CT cervical spine with IV contrast	1		☼ ☼ ☼
CT cervical spine without and with IV contrast	1		☼ ☼ ☼
MRI cervical spine without and with IV contrast	1	Unless there is a concern for infection.	O
Facet injection/medial branch block cervical spine	1		☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

**Variant 12:** Radiographs show OPLL. Next study.

Radiologic Procedure	Rating	Comments	RRL*
CT cervical spine without IV contrast	8	Best for depiction of osseous masses.	☼ ☼ ☼
MRI cervical spine without IV contrast	7	Best for depiction of myelopathy, disc herniation.	O
X-ray myelography cervical spine	2		☼ ☼ ☼
CT cervical spine with IV contrast	1		☼ ☼ ☼
CT cervical spine without and with IV contrast	1		☼ ☼ ☼
MRI cervical spine without and with IV contrast	1		O
Tc-99m bone scan with SPECT neck	1		☼ ☼ ☼
Facet injection/medial branch block cervical spine	1		☼ ☼
<b>Rating Scale:</b> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			<b>*Relative Radiation Level</b>

# CHRONIC NECK PAIN

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## **Summary of Literature Review**

### **Introduction/Background**

The patient with chronic neck pain presents both diagnostic and therapeutic dilemmas for the clinician [1-4] because of considerable controversy in the literature over its etiology, as well as the role of imaging in its evaluation. The literature focuses on two general categories: post-traumatic and mechanical/degenerative, but in most cases, multiple etiological factors are present [5]. Post-traumatic etiologies include the so-called “whiplash” syndrome, defined as any injury to the cervical vertebrae and adjacent soft tissues as a result of sudden jerking. This classically includes extension-flexion mechanisms sustained in rear-end motor vehicle collisions (MVC) as well as abrupt lateral flexion mechanisms. Research in Canada and Scandinavia has identified a constellation of signs and symptoms termed whiplash-associated disorders (WAD) [6-8]. The Quebec task force provided a grading system of WAD according to severity of injury [7,8].

Mechanical/degenerative conditions include spondylosis, disc degeneration, acute disc herniation and facet joint osteoarthritis. These conditions may also result from prior acute injury. Chronic neck pain and/or neurologic symptoms may also be seen in patients with prior cervical spine surgery as well as in the setting of ossification of the posterior longitudinal ligament (OPLL) [9,10]. Finally, there are anecdotal reports in the literature about other etiologies of chronic neck pain that include carotid or vertebral artery dissection, arteriovenous malformations, and tumors.

### **Epidemiology**

For this review, 60 papers are included in the bibliography. Three early studies evaluated the largest groups of patients with chronic neck pain: Mäkelä et al (7,270 patients) [4]; the Quebec Task Force led by Spitzer et al (3,014 patients) [7]; and van der Donk et al (5,440 patients) [11]. The Quebec study focused entirely on whiplash. The other two studies focused on the etiologies of neck pain in relation to other contributing factors.

Mäkelä et al [4] studied a representative sample of Finnish adults and found the chronic neck syndrome occurring in 10% of men and 14% of women. Contributing features of symptoms included previous history of trauma and mental and physical stress at work.

The study by van der Donk et al [11] confirmed observations made by other investigators on smaller patient populations that disc disease is more likely to cause neck pain in men but not in women. In patients with spondylosis, they found that the presence of pain is related more closely to features such as personality traits and the presence of previous injury.

The Quebec Task Force on Whiplash [7] evaluated its members' experience with the disorder. It used consensus methods similar to those followed by the ACR Appropriateness Criteria<sup>®</sup> expert panels. The task force developed a flow sheet defining WAD and made recommendations for diagnosis and management.

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In a more recent series, Goode et al [12] described a prevalence of neck pain of 2.2% in North Carolina residents based on phone interviews of over 5,000 individuals. In this cohort, 79.3% of patients with neck pain had at least one provider visit for their neck problems over the prior year. This group underwent a mean of 1.58 diagnostic tests: 45.1% underwent radiographs, 24.0% computed tomography (CT), 30.2% magnetic resonance imaging (MRI) and 7.4% myelography/discography. The authors conclude that diagnostic imaging was over utilized in this population.

In another recently published report, Kaaria et al [13] evaluated risk factors for chronic neck pain among 5,277 middle aged, Finnish municipal employees by documenting the incidence of chronic neck pain developing over a 5-7 year follow-up. The incidence was 15% in females, 9% in men. Modifiable predictors of chronic neck pain included workplace bullying, sleep problems, high body mass index and workplace emotional exhaustion.

### **Whiplash Injury**

The role of prior whiplash injury in the subsequent development of chronic neck pain is of particular interest. Nolet et al [14] studied a cohort of 919 adults in Saskatchewan, Canada and found that a past history of neck injury in a MVC was associated with the development of future neck pain. The authors speculate that causation is likely multi-factorial, involving biological, psychological and social factors. While spondylosis and disc disease increase with age and are frequently asymptomatic, whiplash can accelerate these processes and lead to symptoms [15]. For these reasons, no variant specifically addressed whiplash per se.

### **Overview of Imaging Modalities**

Conventional radiographs are the mainstay in the initial imaging evaluation of patients with chronic neck pain. Prior studies cite the use of radiographs, particularly to diagnose spondylosis, degenerative disc disease, malalignment or spinal canal stenosis [7,16,17]. AP and lateral views are recommended. The addition of a swimmer's view may be necessary for improved visualization of the cervicothoracic junction [18]. A supplemental open mouth view should be considered in the setting of suspected atlantodental disease such as with a history of inflammatory arthropathy or rotatory abnormalities such as torticollis [19-21]. Based on limited supporting data in the literature and in an attempt to limit radiation dose, it is the consensus of the expert panel that oblique radiographs are no longer recommended as part of the initial radiographic evaluation of the cervical spine in the setting of chronic neck pain.

In the setting of suspected instability, supplemental flexion/extension radiographs may be considered. Flexion/extension radiographs have been shown to document atlantoaxial instability in rheumatoid arthritis and Down syndrome [22,23], as well as in the diagnosis of pseudarthrosis following anterior cervical discectomy and fusion (ACDF) [24]. Flexion/extension radiographs may also be employed in the evaluation of kinematics following cervical disc implantation and in the assessment of the integrity of posterior cervical fixation [25-27]. In the setting of degenerative disease, however, flexion/extension views appear to be of more limited clinical value [28].

Following radiography, a subset of patients with chronic neck pain may benefit from MRI or even from CT. These indications will be detailed below as will the potential role for X-ray myelography with CT and interventions such as facet injection.

### **Magnetic Resonance Imaging**

The utility of MRI in the evaluation of patients with chronic neck pain and degenerative cervical disorders is now well established [6,8,18,29-34]. Given its lack of ionizing radiation, excellent depiction of bone marrow signal, intervertebral discs, facet arthropathy and spinal stenosis, MRI has supplanted CT as the first line advanced imaging study in patients with chronic neck pain [35]. Furthermore, cervical MRI examinations frequently include the upper thoracic spine, where degenerative changes have been shown to be associated with cervical symptoms [36]. In the patient with neurologic symptoms, MRI readily depicts myelopathic changes in the cervical spinal cord [18,30,37]. The utility of flexion/extension MRI in this setting has also been demonstrated [38,39], but may be impractical in routine, daily practice [40].

In patients with neck pain, but without neurologic symptoms, the relevance of specific MRI findings in the cervical spine should be considered in light of expected changes associated with aging. In a 10-year longitudinal MRI study, Okada et al [29] showed that cervical disc degeneration progressed in 85% of patients, though symptoms developed in only 34% of patients. Most significantly, patients who developed symptoms showed more frequent progression of disc degeneration on MRI including anterior compression of disc and spinal cord and



foraminal stenosis. MRI may offer additional characterization of degenerative changes including facet disease and may reveal an unsuspected facet synovial cyst which may be amenable to image guided percutaneous treatment [41]. The presence of facet degenerative changes should be interpreted with caution, however. In a small series, Fryer et al [42] found little correlation between the presence of facet arthropathy and the side or level of symptoms in patients with acute, unilateral neck pain. Whether or not neurologic symptoms are present, there are a number of specific indications for MRI including suspected malignancy or infection (discitis, osteomyelitis); especially, when radiographs are abnormal [18]. In these instances, MRI without and with intravenous contrast should be obtained. In the setting of dialysis associated spondyloarthropathy, MRI may reveal low signal intensity within affected disc spaces on T2-weighted images, allowing differentiation from infectious spondylodiscitis [43,44]. MRI may offer specific anatomic information which is helpful in the diagnosis of atlantoaxial instability, even in the absence of dynamic imaging [40].

In the setting of whiplash associated injury there remains no consensus on the usefulness of MRI in evaluating the ligaments and membranes of the craniocervical junction [8,15,33,34,36,45-48]. While Krakenes and Kaale [34] felt that MRI could show structural changes in ligaments and membranes and concluded that there was correlation between clinical impairment and morphologic findings, Kongsted et al [33] found trauma-related MRI findings to be rare in WAD (7 of 178 patient's). In two separate reports, Myran et al [36,49] found no significant differences in the MRI findings of signal changes of the craniocervical ligaments in WAD patients relative to symptomatic and asymptomatic control groups. Caragee [45] in a commentary on the Myran paper concluded that signal changes in alar ligaments are not reliable enough to indicate that ligament damage has occurred. He reiterated the conclusions of the Task Force on Neck Pain, of which he is a member, that "The validity of high-intensity signal MRI findings in the upper cervical spine ligaments as representing acute whiplash injury had not been demonstrated" [50]. A recent study by Vetti et al [51] demonstrated that alar and transverse ligament signal within one year of injury most likely reflected normal variation.

### **Computed Tomography and CT Myelography**

Is there a role for cervical CT in patients with chronic neck pain? Certainly, advances in multidetector, helical CT scanning with high quality multiplanar reconstructions have enhanced the efficacy of CT, particularly around hardware. CT also offers superior depiction of cortical bone. CT is more sensitive than radiographs in the assessment of facet degenerative disease, including osteophyte formation, vacuum phenomenon as well as joint capsular calcification [41]. The Task Force on Neck Pain felt that cervical CT scans had better validity than radiographs in assessing high-risk and/or multi-injured blunt trauma patients [50]. There is also consensus among the members of the Musculoskeletal Imaging Expert Panel that CT myelography is a viable alternative to MRI for patients with suspected cord involvement, when MRI cannot be performed. CT myelography may be particularly advantageous in evaluating osseous lesions which contribute to canal or foraminal narrowing [30].

CT is of value in assessing patients following ACDF. The technique is useful in evaluating the extent of fusion as well as complications such as hardware failure, pseudarthrosis and in patients with post-procedural dysphagia [24,52]. In patients who have not undergone prior surgery, MRI has supplanted CT as the cross-sectional modality of choice, though some surgeons prefer CT for operative planning, by virtue of the superior osseous detail [18]. While CT (or MRI) may aid in assessing the onset of adjacent segment degeneration post-fusion, X-rays alone may be sufficient [53,54]. In the setting of OPLL, CT may aid in characterization of disease extent [55]. Finally, CT may be of value in the evaluation of the atlantoaxial joint in cases of non-traumatic torticollis [56].

### **Tc-99m Bone Scan**

The role of nuclear scintigraphy (Tc-99m bone scan) in the setting of chronic neck pain is limited, though single photon emission computed tomography (SPECT) likely offers benefit over conventional planar imaging. Some authors have advocated the use of SPECT imaging in identifying the pain source (i.e., facet disease) [57]; others have described its use in postoperative neck pain [58]. Whole body bone scanning, employed in the setting of malignancy may reveal cervical spine metastases as well as metastatic lesions elsewhere in the skeleton.

### **Discography and Diagnostic Spinal Injections**

The use of provocative injections in the cervical spine to identify a pain source is controversial. The Bone and Joint Decade 2000-2010 Task Force on Neck Pain and its Associated Disorders concluded that there was no evidence to support using cervical provocative discography or anesthetic facet or nerve blocks [50]. Provocative cervical discography is not only technically demanding, but may result in significant complications. The use of facet injection as a diagnostic maneuver is limited by frequent leakage of anesthetic into adjacent spaces resulting

in false positive results [59,60]. On the other hand, image-guided medial branch nerve blocks (MBB) may be the most efficacious way of isolating a specific facet joint as the pain generator. This may be followed by thermal ablation of the median branch under fluoroscopic guidance [41].

### **Clinical Scenarios**

Our review considered a number of clinical scenarios in which patients presented with chronic neck pain. We attempted to determine the optimal first study to be performed in patients without or with a history of remote trauma and in patients with a history of previous malignancy or previous remote surgery.

Six clinical scenarios address patients with normal radiographs, without and with degenerative changes or post-traumatic deformity and without and with neurologic symptoms. We then separately consider patients with radiographs showing signs of malignancy or infection, radiographs showing OPLL and the symptomatic patient with a remote history of neck surgery, particularly following ACDF. Whiplash was not considered as a separate entity, since patients with WAD will fit into one of the categories listed above.

### **Summary**

These guidelines apply to imaging of patients with chronic neck pain regardless of the etiology (trauma, arthritis, neoplasm):

- Patients of any age with chronic neck pain without or with a history of trauma should initially undergo AP and lateral radiographs of the cervical spine; supplemented, in select cases, by swimmer's and/or open mouth views. Oblique views are no longer recommended as a standard part of the initial radiographic evaluation.
- Patients with a history of C-spine surgery in the past should initially undergo, at minimum, AP and lateral radiographs, with consideration of additional flexion/extension views.
- Patients with a history of previous malignancy should initially undergo AP and lateral radiographs, supplemented, if necessary, by swimmer's and/or open mouth views. Radionuclide bone scanning should not be the initial procedure of choice [7].
- Flexion/extension lateral radiographs may offer supplemental diagnostic information in the setting of suspected instability or in symptomatic patients with a history of prior surgery including ACDF, cervical prosthetic disc placement or posterior instrumentation.
- Patients with normal radiographs and no neurologic signs or symptoms need no immediate further imaging.
- Patients with normal radiographs and neurologic signs or symptoms should undergo cervical MRI that includes the craniocervical junction and the upper thoracic region [6,32,38]. If there is a contraindication to the MRI examination such as a cardiac pacemaker or severe claustrophobia, CT or CT myelography with multiplanar reconstruction is recommended.
- Patients with chronic neck pain from whiplash should undergo imaging following the guidelines above.
- Many patients with radiographic evidence of degenerative changes including cervical spondylosis or of previous trauma *without* neurologic signs or symptoms need no further imaging. In other patients, particularly after failure of conservative management, MRI should be considered. In patients for whom surgery is contemplated, additional imaging with MRI or CT may be indicated for operative planning.
- Patients with radiographic evidence of cervical spondylosis or of previous trauma and neurologic signs or symptoms should undergo MRI. CT or CT myelography may also be of value, particularly if MRI is contraindicated. .
- Patients with radiographic evidence of bone or disc margin destruction should undergo MRI without and with intravenous contrast. CT with intravenous contrast is indicated only if MRI cannot be performed.
- While therapeutic injections may offer benefit, diagnostic facet injection to identify the specific level(s) producing symptoms is of more limited value. Confirmation of a specific facet joint as a pain generator may be accomplished with MBB. This can be followed by image-guided thermal ablation.
- Discography is not recommended [1,50].
- The use of additional imaging procedures should be determined in a case-by-case manner, and the evaluation of patients with chronic neck pain should follow this "tailor-made" approach.

## Relative Radiation Level Information

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

Relative Radiation Level Designations		
Relative Radiation Level*	Adult Effective Dose Estimate Range	Pediatric Effective Dose Estimate Range
O	0 mSv	0 mSv
☼	<0.1 mSv	<0.03 mSv
☼ ☼	0.1-1 mSv	0.03-0.3 mSv
☼ ☼ ☼	1-10 mSv	0.3-3 mSv
☼ ☼ ☼ ☼	10-30 mSv	3-10 mSv
☼ ☼ ☼ ☼ ☼	30-100 mSv	10-30 mSv

\*RRL assignments for some of the examinations cannot be made, because the actual patient doses in these procedures vary as a function of a number of factors (eg, region of the body exposed to ionizing radiation, the imaging guidance that is used). The RRLs for these examinations are designated as “Varies”.

## Supporting Documents

For additional information on the Appropriateness Criteria methodology and other supporting documents go to [www.acr.org/ac](http://www.acr.org/ac).

## References

1. Aprill C, Bogduk N. The prevalence of cervical zygapophyseal joint pain. A first approximation. *Spine (Phila Pa 1976)*. 1992;17(7):744-747.
2. Deans GT, Magalliard JN, Kerr M, Rutherford WH. Neck sprain--a major cause of disability following car accidents. *Injury*. 1987;18(1):10-12.
3. Gore DR, Sepic SB, Gardner GM, Murray MP. Neck pain: a long-term follow-up of 205 patients. *Spine (Phila Pa 1976)*. 1987;12(1):1-5.
4. Makela M, Heliovaara M, Sievers K, Impivaara O, Knekt P, Aromaa A. Prevalence, determinants, and consequences of chronic neck pain in Finland. *Am J Epidemiol*. 1991;134(11):1356-1367.
5. Binder AI. Cervical spondylosis and neck pain. *BMJ*. 2007;334(7592):527-531.
6. Kaale BR, Krakenes J, Albrektsen G, Wester K. Whiplash-associated disorders impairment rating: neck disability index score according to severity of MRI findings of ligaments and membranes in the upper cervical spine. *J Neurotrauma*. 2005;22(4):466-475.
7. Spitzer WO, Skovron ML, Salmi LR, et al. Scientific monograph of the Quebec Task Force on Whiplash-Associated Disorders: redefining "whiplash" and its management. *Spine (Phila Pa 1976)*. 1995;20(8 Suppl):1S-73S.
8. Vetti N, Krakenes J, Eide GE, Rorvik J, Gilhus NE, Espeland A. MRI of the alar and transverse ligaments in whiplash-associated disorders (WAD) grades 1-2: high-signal changes by age, gender, event and time since trauma. *Neuroradiology*. 2009;51(4):227-235.
9. Chen Y, Guo Y, Chen D, et al. Diagnosis and surgery of ossification of posterior longitudinal ligament associated with dural ossification in the cervical spine. *Eur Spine J*. 2009;18(10):1541-1547.

10. Choi BW, Song KJ, Chang H. Ossification of the posterior longitudinal ligament: a review of literature. *Asian Spine J.* 2011;5(4):267-276.
11. van der Donk J, Schouten JS, Passchier J, van Romunde LK, Valkenburg HA. The associations of neck pain with radiological abnormalities of the cervical spine and personality traits in a general population. *J Rheumatol.* 1991;18(12):1884-1889.
12. Goode AP, Freburger J, Carey T. Prevalence, practice patterns, and evidence for chronic neck pain. *Arthritis Care Res (Hoboken).* 2010;62(11):1594-1601.
13. Kaaria S, Laaksonen M, Rahkonen O, Lahelma E, Leino-Arjas P. Risk factors of chronic neck pain: a prospective study among middle-aged employees. *Eur J Pain.* 2012;16(6):911-920.
14. Nolet PS, Cote P, Cassidy JD, Carroll LJ. The association between a lifetime history of a neck injury in a motor vehicle collision and future neck pain: a population-based cohort study. *Eur Spine J.* 2010;19(6):972-981.
15. Ichihara D, Okada E, Chiba K, et al. Longitudinal magnetic resonance imaging study on whiplash injury patients: minimum 10-year follow-up. *J Orthop Sci.* 2009;14(5):602-610.
16. Daffner RH. Radiologic evaluation of chronic neck pain. *Am Fam Physician.* 2010;82(8):959-964.
17. Matsunaga S, Nakamura K, Seichi A, et al. Radiographic predictors for the development of myelopathy in patients with ossification of the posterior longitudinal ligament: a multicenter cohort study. *Spine (Phila Pa 1976).* 2008;33(24):2648-2650.
18. Laker SR, Concannon LG. Radiologic evaluation of the neck: a review of radiography, ultrasonography, computed tomography, magnetic resonance imaging, and other imaging modalities for neck pain. *Phys Med Rehabil Clin N Am.* 2011;22(3):411-428, vii-viii.
19. Mathers KS, Schneider M, Timko M. Occult hypermobility of the craniocervical junction: a case report and review. *J Orthop Sports Phys Ther.* 2011;41(6):444-457.
20. Richards JS, Kerr GS, Nashel DJ. Odontoid erosions in rheumatoid arthritis: utility of the open mouth view. *J Clin Rheumatol.* 2000;6(6):309-312.
21. Taniguchi D, Tokunaga D, Hase H, et al. Evaluation of lateral instability of the atlanto-axial joint in rheumatoid arthritis using dynamic open-mouth view radiographs. *Clin Rheumatol.* 2008;27(7):851-857.
22. Kauppi M, Neva MH. Sensitivity of lateral view cervical spine radiographs taken in the neutral position in atlantoaxial subluxation in rheumatic diseases. *Clin Rheumatol.* 1998;17(6):511-514.
23. Rosenbaum DM, Blumhagen JD, King HA. Atlantooccipital instability in Down syndrome. *AJR Am J Roentgenol.* 1986;146(6):1269-1272.
24. Ghiselli G, Wharton N, Hipp JA, Wong DA, Jatana S. Prospective analysis of imaging prediction of pseudarthrosis after anterior cervical discectomy and fusion: computed tomography versus flexion-extension motion analysis with intraoperative correlation. *Spine (Phila Pa 1976).* 2011;36(6):463-468.
25. Hong JT, Sung JH, Son BC, Lee SW, Park CK. Significance of laminar screw fixation in the subaxial cervical spine. *Spine (Phila Pa 1976).* 2008;33(16):1739-1743.
26. Hwang IC, Kang DH, Han JW, Park IS, Lee CH, Park SY. Clinical experiences and usefulness of cervical posterior stabilization with polyaxial screw-rod system. *J Korean Neurosurg Soc.* 2007;42(4):311-316.
27. Ryu WH, Kowalczyk I, Duggal N. Long-term kinematic analysis of cervical spine after single-level implantation of Bryan cervical disc prosthesis. *Spine J.* 2013;13(6):628-634.
28. White AP, Biswas D, Smart LR, Haims A, Grauer JN. Utility of flexion-extension radiographs in evaluating the degenerative cervical spine. *Spine (Phila Pa 1976).* 2007;32(9):975-979.
29. Okada E, Matsumoto M, Ichihara D, et al. Aging of the cervical spine in healthy volunteers: a 10-year longitudinal magnetic resonance imaging study. *Spine (Phila Pa 1976).* 2009;34(7):706-712.
30. Song KJ, Choi BW, Kim GH, Kim JR. Clinical usefulness of CT-myelogram comparing with the MRI in degenerative cervical spinal disorders: is CTM still useful for primary diagnostic tool? *J Spinal Disord Tech.* 2009;22(5):353-357.
31. Arana E, Marti-Bonmati L, Molla E, Costa S. Upper thoracic-spine disc degeneration in patients with cervical pain. *Skeletal Radiol.* 2004;33(1):29-33.
32. Boutin RD, Steinbach LS, Finnesey K. MR imaging of degenerative diseases in the cervical spine. *Magn Reson Imaging Clin N Am.* 2000;8(3):471-490.
33. Kongsted A, Sorensen JS, Andersen H, Keseler B, Jensen TS, Bendix T. Are early MRI findings correlated with long-lasting symptoms following whiplash injury? A prospective trial with 1-year follow-up. *Eur Spine J.* 2008;17(8):996-1005.

34. Krakenes J, Kaale BR. Magnetic resonance imaging assessment of craniovertebral ligaments and membranes after whiplash trauma. *Spine (Phila Pa 1976)*. 2006;31(24):2820-2826.
35. Ozawa H, Sato T, Hyodo H, et al. Clinical significance of intramedullary Gd-DTPA enhancement in cervical myelopathy. *Spinal Cord*. 2010;48(5):415-422.
36. Myran R, Kvistad KA, Nygaard OP, Andresen H, Folvik M, Zwart JA. Magnetic resonance imaging assessment of the alar ligaments in whiplash injuries: a case-control study. *Spine (Phila Pa 1976)*. 2008;33(18):2012-2016.
37. Avadhani A, Rajasekaran S, Shetty AP. Comparison of prognostic value of different MRI classifications of signal intensity change in cervical spondylotic myelopathy. *Spine J*. 2010;10(6):475-485.
38. Chen CJ, Hsu HL, Niu CC, et al. Cervical degenerative disease at flexion-extension MR imaging: prediction criteria. *Radiology*. 2003;227(1):136-142.
39. Zhang L, Zeitoun D, Rangel A, Lazennec JY, Catonne Y, Pascal-Moussellard H. Preoperative evaluation of the cervical spondylotic myelopathy with flexion-extension magnetic resonance imaging: about a prospective study of fifty patients. *Spine (Phila Pa 1976)*. 2011;36(17):E1134-1139.
40. Hung SC, Wu HM, Guo WY. Revisiting anterior atlantoaxial subluxation with overlooked information on MR images. *AJNR Am J Neuroradiol*. 2010;31(5):838-843.
41. Bykowski JL, Wong WH. Role of facet joints in spine pain and image-guided treatment: a review. *AJNR Am J Neuroradiol*. 2012;33(8):1419-1426.
42. Fryer G, Adams JH. Magnetic resonance imaging of subjects with acute unilateral neck pain and restricted motion: a prospective case series. *Spine J*. 2011;11(3):171-176.
43. Baker JC, Demertzis JL, Rhodes NG, Wessell DE, Rubin DA. Diabetic musculoskeletal complications and their imaging mimics. *Radiographics*. 2012;32(7):1959-1974.
44. Kiss E, Keusch G, Zanetti M, et al. Dialysis-related amyloidosis revisited. *AJR Am J Roentgenol*. 2005;185(6):1460-1467.
45. Carragee EJ. Continuing debate: validity and utility of magnetic resonance imaging of the upper cervical spine after whiplash exposure. *Spine J*. 2009;9(9):778-779.
46. Johansson BH. Whiplash injuries can be visible by functional magnetic resonance imaging. *Pain Res Manag*. 2006;11(3):197-199.
47. Dullerud R, Gjertsen O, Server A. Magnetic resonance imaging of ligaments and membranes in the craniocervical junction in whiplash-associated injury and in healthy control subjects. *Acta Radiol*. 2010;51(2):207-212.
48. Matsumoto M, Okada E, Ichihara D, et al. Prospective ten-year follow-up study comparing patients with whiplash-associated disorders and asymptomatic subjects using magnetic resonance imaging. *Spine (Phila Pa 1976)*. 2010;35(18):1684-1690.
49. Myran R, Zwart JA, Kvistad KA, et al. Clinical characteristics, pain, and disability in relation to alar ligament MRI findings. *Spine (Phila Pa 1976)*. 2011;36(13):E862-867.
50. Nordin M, Carragee EJ, Hogg-Johnson S, et al. Assessment of neck pain and its associated disorders: results of the Bone and Joint Decade 2000-2010 Task Force on Neck Pain and Its Associated Disorders. *Spine (Phila Pa 1976)*. 2008;33(4 Suppl):S101-122.
51. Vetti N, Krakenes J, Ask T, et al. Follow-up MR imaging of the alar and transverse ligaments after whiplash injury: a prospective controlled study. *AJNR Am J Neuroradiol*. 2011;32(10):1836-1841.
52. Stachniak JB, Diebner JD, Brunk ES, Speed SM. Analysis of prevertebral soft-tissue swelling and dysphagia in multilevel anterior cervical discectomy and fusion with recombinant human bone morphogenetic protein-2 in patients at risk for pseudarthrosis. *J Neurosurg Spine*. 2011;14(2):244-249.
53. Park JY, Kim KH, Kuh SU, Chin DK, Kim KS, Cho YE. What are the associative factors of adjacent segment degeneration after anterior cervical spine surgery? Comparative study between anterior cervical fusion and arthroplasty with 5-year follow-up MRI and CT. *Eur Spine J*. 2013;22(5):1078-1089.
54. Yi S, Lee DY, Ahn PG, Kim KN, Yoon do H, Shin HC. Radiologically documented adjacent-segment degeneration after cervical arthroplasty: characteristics and review of cases. *Surg Neurol*. 2009;72(4):325-329; discussion 329.
55. Kudo H, Yokoyama T, Tsushima E, et al. Interobserver and intraobserver reliability of the classification and diagnosis for ossification of the posterior longitudinal ligament of the cervical spine. *Eur Spine J*. 2013;22(1):205-210.
56. Haque S, Bilal Shafi BB, Kaleem M. Imaging of torticollis in children. *Radiographics*. 2012;32(2):557-571.

57. Makki D, Khazim R, Zaidan AA, Ravi K, Toma T. Single photon emission computerized tomography (SPECT) scan-positive facet joints and other spinal structures in a hospital-wide population with spinal pain. *Spine J.* 2010;10(1):58-62.
58. Cetinkal A, Kaya S, Kutlay M, et al. Can scintigraphy explain prolonged postoperative neck pain? *Turk Neurosurg.* 2011;21(4):539-544.
59. Freedman MK, Overton EA, Saulino MF, Holding MY, Kornbluth ID. Interventions in chronic pain management. 2. Diagnosis of cervical and thoracic pain syndromes. *Arch Phys Med Rehabil.* 2008;89(3 Suppl 1):S41-46.
60. Anderberg L, Annertz M, Brandt L, Saveland H. Selective diagnostic cervical nerve root block--correlation with clinical symptoms and MRI-pathology. *Acta Neurochir (Wien).* 2004;146(6):559-565; discussion 565.

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