

American College of Radiology ACR Appropriateness Criteria®

Clinical Condition: Chronic Wrist Pain

Variant 1: With or without prior injury. Best initial study.

Radiologic Procedure	Rating	Comments	RRL*
X-ray wrist	9		☢
MRI wrist without contrast	1		O
MRI wrist without and with contrast	1		O
MR arthrography wrist	1		O
CT wrist without contrast	1		☢
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
CT arthrography wrist	1		☢
US wrist	1		O
Tc-99m bone scan wrist	1		☢ ☢ ☢
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 2: Routine radiographs normal or nonspecific. Persistent symptoms. Next study.

Radiologic Procedure	Rating	Comments	RRL*
MRI wrist without contrast	9	Most of the time, further imaging is not required. If imaging is to be performed, this is the study of choice.	O
MR arthrography wrist	4		O
MRI wrist without and with contrast	1		O
CT wrist without contrast	1		☢
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
CT arthrography wrist	1		☢
US wrist	1		O
Tc-99m bone scan wrist	1		☢ ☢ ☢
<u>Rating Scale:</u> 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: Chronic Wrist Pain

Variant 3: Routine radiographs normal or nonspecific. Suspect inflammatory arthritis. Next study.

Radiologic Procedure	Rating	Comments	RRL*
MRI wrist without and with contrast	9	Further imaging is usually not required for diagnosis, but is often used to stage disease and guide therapy. See statement regarding contrast in text under “Anticipated Exceptions.”	O
MRI wrist without contrast	7		O
US wrist	5		O
CT wrist without contrast	3		☢
MR arthrography wrist	1		O
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
CT arthrography wrist	1		☢
Tc-99m bone scan wrist	1		☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 4: Radiographs normal or show nonspecific arthritis. Exclude infection. Next study.

Radiologic Procedure	Rating	Comments	RRL*
Aspiration wrist	9	Using imaging guidance if necessary.	Varies
MRI wrist without contrast	1		O
MRI wrist without and with contrast	1		O
MR arthrography wrist	1		O
CT wrist without contrast	1		☢
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
CT arthrography wrist	1		☢
US wrist	1		O
Tc-99m bone scan wrist	1		☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: Chronic Wrist Pain**Variant 5: Ulnar-sided pain; normal or nonspecific radiographs. Next study.**

Radiologic Procedure	Rating	Comments	RRL*
MRI wrist without contrast	9		O
MR arthrography wrist	7		O
CT arthrography wrist	5		☢
MRI wrist without and with contrast	4	See statement regarding contrast in text under “Anticipated Exceptions.”	O
X-ray arthrography wrist	3		☢
CT wrist without contrast	1		☢
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
US wrist	1		O
Tc-99m bone scan wrist	1		☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 6: Radial-sided pain; normal or nonspecific radiographs. Next study.

Radiologic Procedure	Rating	Comments	RRL*
MRI wrist without contrast	9		O
MR arthrography wrist	6	If scapholunate ligament tear is the primary consideration, MR arthrography is more sensitive than MRI without contrast.	O
CT arthrography wrist	6		☢
MRI wrist without and with contrast	5	See statement regarding contrast in text under “Anticipated Exceptions.”	O
US wrist	5	If extra-articular soft-tissue pathology is the primary consideration, US is helpful.	O
X-ray arthrography wrist	3		☢
CT wrist without contrast	1		☢
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
Tc-99m bone scan wrist	1		☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: Chronic Wrist Pain

Variant 7: Radiographs normal or nonspecific. Suspect Kienböck's disease. Next study.

Radiologic Procedure	Rating	Comments	RRL*
MRI wrist without contrast	9		O
CT wrist without contrast	5		☢
MRI wrist without and with contrast	3		O
Tc-99m bone scan wrist	2		☢ ☢ ☢
MR arthrography wrist	1		O
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
CT arthrography wrist	1		☢
US wrist	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 8: Kienböck's disease on radiographs. Next study.

Radiologic Procedure	Rating	Comments	RRL*
CT wrist without contrast	5	Only if needed to assess degree of collapse and associated fractures.	☢
MRI wrist without contrast	4		O
MRI wrist without and with contrast	3		O
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
CT arthrography wrist	1		☢
MR arthrography wrist	1		O
US wrist	1		O
Tc-99m bone scan wrist	1		☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: Chronic Wrist Pain

Variant 9: Palpable mass or suspected occult ganglion cyst; normal or nonspecific radiographs. Next study.

Radiologic Procedure	Rating	Comments	RRL*
MRI wrist without contrast	8	MRI and US are alternative initial examinations.	O
MRI wrist without and with contrast	8	MRI and US are alternative initial examinations. See statement regarding contrast in text under “Anticipated Exceptions.”	O
US wrist	8	MRI and US are alternative initial examinations.	O
MR arthrography wrist	1		O
CT wrist without contrast	1		☢
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
CT arthrography wrist	1		☢
Tc-99m bone scan wrist	1		☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 10: Pain for more than 3 weeks. Suspect occult fracture or stress fracture. Radiographs nondiagnostic. Next study.

Radiologic Procedure	Rating	Comments	RRL*
MRI wrist without contrast	9		O
CT wrist without contrast	7	If hook of hamate is suspected, CT is study of choice.	☢
X-ray wrist	2	Additional views (carpal tunnel or semipronational oblique) may be of value if not obtained at time of original study.	☢
MRI wrist without and with contrast	1		O
MR arthrography wrist	1		O
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
CT arthrography wrist	1		☢
US wrist	1		O
Tc-99m bone scan wrist	1		☢ ☢ ☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Clinical Condition: Chronic Wrist Pain

Variant 11: Radiographs show old scaphoid fracture. Evaluate for nonunion, malunion, osteonecrosis, and/or post-traumatic osteoarthritis. Next study.

Radiologic Procedure	Rating	Comments	RRL*
MRI wrist without contrast	9	MRI and CT are alternative examinations. Only one test needs to be performed.	O
CT wrist without contrast	9	MRI and CT are alternative examinations. Only one test needs to be performed.	☢
MRI wrist without and with contrast	5	See statement regarding contrast in text under “Anticipated Exceptions.”	O
MR arthrography wrist	1		O
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
CT arthrography wrist	1		☢
Tc-99m bone scan wrist	1		☢ ☢ ☢
US wrist	1		O
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 12: Suspect carpal tunnel syndrome.

Radiologic Procedure	Rating	Comments	RRL*
X-ray wrist	9		☢
US wrist	3		O
MRI wrist without contrast	3		O
MRI wrist without and with contrast	1		O
MR arthrography wrist	1		O
CT wrist without contrast	1		☢
CT wrist with contrast	1		☢
CT wrist without and with contrast	1		☢
CT arthrography wrist	1		☢
Tc-99m bone scan wrist	1		☢ ☢ ☢
X-ray arthrography wrist	1		☢
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

CHRONIC WRIST PAIN

Expert Panel on Musculoskeletal Imaging: David A. Rubin, MD¹; Barbara N. Weissman, MD²; Marc Appel, MD³; Erin Arnold, MD⁴; Jenny T. Bencardino, MD⁵; Ian Blair Fries, MD⁶; Curtis W. Hayes, MD⁷; Mary G. Hochman, MD⁸; Jon A. Jacobson, MD⁹; Jonathan S. Luchs, MD¹⁰; Kevin R. Math, MD¹¹; Mark D. Murphey, MD¹²; Joel S. Newman, MD¹³; Stephen C. Scharf, MD¹⁴; Kirstin M. Small, MD.¹⁵

Summary of Literature Review

Introduction/Background

In patients with chronic wrist pain, imaging studies are an important adjunct to history, physical examination, laboratory testing, and electrophysiology studies. The choice of imaging modality depends on the patient's presentation and the clinical questions being asked. There are scenarios where no imaging beyond baseline radiographs is necessary, but in other situations advanced imaging has added value for diagnostic evaluation and treatment planning.

Radiography

Imaging evaluation of the painful wrist should begin with radiographs [1-3]. This simple, relatively inexpensive study may establish a specific diagnosis in patients with arthritis, complications of injury, infection, some bone or soft-tissue tumors, impaction syndromes, or static wrist instability. The standard radiographic examination consists of posterior-anterior (PA) and lateral views, often supplemented by one or more oblique view [1,2]. The lateral view is important for demonstrating malalignments and soft-tissue swelling [4]. A variety of stress positions and maneuvers can be performed to elicit dynamic instability that is not visible on standard radiographs [5,6]. Other nonstandard projections may be indicated for specific suspected problems [7]. Additionally, radiographs are necessary for accurate measurement of ulnar variance [8].

In the past, fluoroscopic observation was used to establish the diagnosis of dynamic wrist instability, and it had been suggested that it could be cost-effective in lieu of arthrography [9]. However, in most practices fluoroscopy is used either for guidance during wrist injections or as an adjunct to arthrography. Percutaneous aspiration of the wrist—which is indicated in cases of suspected septic arthritis or to assess for intra-articular crystals—can be carried out with either fluoroscopic or ultrasound guidance if imaging is needed.

Scintigraphy

Bone scintigraphy has been used for diagnosing occult wrist fractures and also as a screening procedure in patients with wrist pain and negative radiographs. However, while it is sensitive to bone abnormalities, scintigraphy suffers from a lack of specificity [10]. Furthermore, bone scans cannot detect soft-tissue abnormalities — such as lesions of the ligaments, tendons, and cartilage — which are often responsible for chronic wrist pain.

Arthrography

Although conventional arthrography — performed with contrast injection into one or more wrist compartments — has moderate accuracy for the diagnosis of triangular fibrocartilage (TFCC) and intrinsic ligament perforations [11-13], it has largely been supplanted by computed tomography (CT) arthrography and magnetic resonance (MR) arthrography. These cross-sectional studies provide more anatomic detail about internal derangements, which is needed for treatment planning, and they often demonstrate extra-articular abnormalities responsible for pain when there is no ligament or TFCC abnormality. Furthermore, while fibrocartilage and ligament perforations are moderately associated with ulnar-sided wrist pain, there is a poor correlation between ligament lesions and radial-sided pain [14], further limiting the usefulness of conventional arthrography in this patient population.

¹Principal Author, Washington University School of Medicine, Saint Louis, Missouri. ²Panel Chair, Brigham & Women's Hospital, Boston, Massachusetts. ³Warwick Valley Orthopedic Surgery, Warwick, New York, American Academy of Orthopaedic Surgeons. ⁴Illinois Bone and Joint Institute, Morton Grove, Illinois, American College of Rheumatology. ⁵New York University Medical Center, New York, New York. ⁶Bone, Spine and Hand Surgery, Chartered, Brick, NJ, American Academy of Orthopaedic Surgeons. ⁷VCU Health System, Richmond, Virginia. ⁸Beth Israel Deaconess Medical Center, Boston, Massachusetts. ⁹University of Michigan Medical Center, Ann Arbor, Michigan. ¹⁰Metropolitan Diagnostic Imaging Group, Garden City, New York. ¹¹East Manhattan Diagnostic Imaging, Manhattan, New York. ¹²Uniformed Services University of the Health Sciences, Bethesda, Maryland. ¹³New England Baptist Hospital, Boston, Massachusetts. ¹⁴Lenox Hill Hospital, New Rochelle, New York, Society of Nuclear Medicine. ¹⁵Brigham & Women's Hospital, Boston, Massachusetts.

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Reprint requests to: Department of Quality & Safety, American College of Radiology, 1891 Preston White Drive, Reston, VA 20191-4397.

Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) of the wrist accurately depicts abnormalities of the bones and bone marrow, articular cartilage, intrinsic and extrinsic ligaments, TFCC, synovium, tendons, and neurovascular structures, making MRI a powerful study for chronic pain caused by diverse etiologies. Properly performed and interpreted, wrist MRI has a profound clinical impact. In one study, initial clinical diagnosis was changed in about half of the patients with wrist pain after they underwent MRI, and even when the suspected clinical diagnosis was confirmed, diagnostic confidence increased in another quarter of the patients imaged [15]. The same study found that the treatment plan was altered by the results of MRI in approximately half of the wrists.

A dedicated receiver coil or transmit-receive coil is necessary to provide the signal-to-noise ratio (SNR) needed for high-resolution, high-contrast MRI of the wrist [16]. MR arthrography — either with direct contrast injection into one or more wrist compartments or performed indirectly after intravenous contrast administration — can enhance the yield of the study for diagnosing internal wrist derangements, especially abnormalities of the ligaments, articular cartilage, and TFCC of the wrist. MRI performed with a 3.0-T magnet and a dedicated coil provides better SNR and better contrast compared with wrist MRI performed with 1.5-T or lower field strength systems [17,18], suggesting that a 3.0-T MRI of the wrist may be a reasonable alternative when MR arthrography is not available.

MRI has been most thoroughly investigated for diagnosing abnormalities of the intrinsic ligaments and TFCC. Accuracy is higher for tears of the scapholunate compared to the lunotriquetral ligament [19,20]. Performing indirect MR arthrography may increase the sensitivity of the examination of scapholunate ligament tears, but probably not for lunotriquetral ligament tears [19]. Direct MR arthrography (with contrast injection either into the radiocarpal joint or into all three compartments of the wrist) has higher accuracy than noncontrast-enhanced MRI for diagnosis of both scapholunate and lunotriquetral ligament tears — including incomplete tears — and interobserver agreement and diagnostic confidence are also higher with direct MR arthrography [4,21-24]. Even when compared to conventional MRI performed with a 3.0-T magnet, direct MR arthrography has higher sensitivity for intrinsic ligament lesions, although there may be more false-positive diagnoses as occasionally contrast will communicate between the radiocarpal and midcarpal compartments in wrists where ligament tears are not visible at MR arthrography or arthroscopy, presumably due to pinpoint-size lesions [25]. For the scapholunate ligament, direct MR arthrography also allows more accurate determination of which specific segments of the ligament are torn compared to conventional MRI [22], which has important biomechanical implications for wrist stability. Direct MR arthrography also has an advantage over noncontrast-enhanced MRI for diagnosing extrinsic ligament abnormalities [23].

Both traumatic and degenerative lesions of the TFCC can produce chronic, ulnar-sided wrist pain [26-28]. MRI is highly accurate for lesions involving the radial (central) zone of the disc, especially with the use of high-resolution fast spin-echo or 3D gradient-recalled pulse sequences [26-28]. There is some evidence suggesting that MRI performed with a 3.0-T system is even more accurate than MRI performed with a 1.5-T system for TFCC lesions [29], but there are no studies comparing the accuracy of the two field strengths in the same patients. The sensitivity for tears of the ulnar attachment of the disc and the peripheral attachments (the ulnocarpal ligaments) are only fair with noncontrast-enhanced wrist MRI [7,20,26-28]. Indirect MR arthrography does not improve the accuracy of the examination for diagnosing TFCC lesions, whether peripherally or centrally located [7,19]. Direct MR arthrography (performed with contrast injection of the radiocarpal or distal radioulnar compartments, alone or in combination) does result in better diagnostic accuracy for the TFCC compared with conventional MRI, especially for ulnar-sided lesions [21,23,24,30].

Unlike the case for the knee and other larger joints, MRI shows only fair sensitivity for depicting articular cartilage defects in the distal radius and carpal bones, even with the use of indirect MR arthrography or 3.0-T scanners [31-33]. The presence of focal bone marrow edema may be a clue to underlying chondral defects [31]. A single study found that direct MR arthrography was more sensitive for articular cartilage defects compared to conventional MR, but the same study showed that CT arthrography was even more sensitive [21].

MRI is highly sensitive to changes in bone marrow composition, and thus is frequently used to identify radiographically occult acute fractures throughout the skeleton, including in the wrist (see the ACR Appropriateness Criteria® topic on “[Acute Hand and Wrist Trauma](#)”). In patients with persistent symptoms thought to be due to an occult wrist fracture, MRI can be used as an alternative to presumptive casting and repeat radiographs [20,34]. MRI is also sensitive to stress fractures and stress injuries of the physes, for example, in gymnasts [35]. In patients with known chronic scaphoid fractures, the presence of nonunion, malunion,

osteonecrosis, post-traumatic osteoarthritis, or a combination of those conditions will typically influence the patient's management. Somewhat surprisingly, MRI shows only moderate sensitivity and specificity for predicting osteonecrosis of the proximal pole of scaphoid fractures, and even some scaphoid fractures with MRI evidence of osteonecrosis may still heal with treatment [36-38]. While the addition of intravenous contrast can improve the accuracy for osteonecrosis and predicting graft healing, the routine use of intravenous contrast for this indication is controversial: while nonenhancement of the proximal scaphoid pole is a reliable sign of osteonecrosis, enhancement can be seen in both viable and nonviable fracture fragments [39]. MRI does seem to be more reliable for diagnosing osteonecrosis in other carpal bones like the lunate (Kienböck's disease), and is certainly more accurate than conventional radiographs [40,41].

Fluid-filled and synovial-lined structures (including ganglia, cysts, bursa, and tendon sheaths) are well depicted with MRI. MRI is useful for diagnosing infectious and noninfectious tenosynovitis in both the flexor and extensor wrist compartments [42,43]. Occult ganglion cysts are also easily identified with MRI [44,45], but some authors recommend use of intravenous contrast to distinguish ganglia from synovitis [46].

In patients with early rheumatoid arthritis (RA) and other inflammatory arthritides, active synovitis may be more better quantified following intravenous contrast administration, especially if performed dynamically, allowing confident early diagnosis, prognostication, and treatment guidance in these patients [47-50]. Additionally, inflammatory tenosynovitis may be more conspicuous after intravenous contrast administration [51]. As is the case for any tomographic study, MRI is much more sensitive than radiographs for identifying erosions in RA [52,53], even with some small-bore, dedicated extremity scanners [54,55]. More importantly, though, the finding of enhancing bone marrow "edema" (osteitis) on MRI studies in patients with early RA is proving to be the best single predictor of future disease progression and functional deterioration, even compared to serologies and clinical measures [47,48,56-58].

Carpal tunnel syndrome is usually diagnosed by clinical signs and symptoms, combined with the results of electrodiagnostic studies [59]. The MRI findings that have been reported in wrists with carpal tunnel syndrome—including nerve enlargement, nerve flattening, and retinacular bowing—have limited usefulness in patients with clinically recognized carpal tunnel syndrome, and low predictive value in patients with nonspecific wrist pain [60-62]. There is some evidence that the length of T2 hyperintensity in the median nerve can help prognosticate the success of surgery [63], and that the size of the nerve in the distal carpal tunnel is associated with clinical severity [60], but in general MRI is not indicated in the evaluation of uncomplicated carpal tunnel syndrome. MRI may be helpful when a mass lesion is suspected in the carpal tunnel or when symptoms recur after carpal tunnel release [64].

Computed Tomography

CT of the wrist is used primarily when high-detail imaging of bone cortex or trabeculae is needed. In patients with chronic wrist pain and prior fractures, CT is typically the study of choice to evaluate fracture healing and joint congruence. When a radiographically occult fracture is suspected as the cause of a patient's chronic pain, either CT or MRI can be used [20]. Advantages of CT over MRI for the wrist include its ability to obtain high-resolution images of both wrists simultaneously, and the much shorter acquisition times for CT. These factors make CT the preferred examination for suspected distal radioulnar joint subluxation, where images of both wrists can be obtained in both supination and pronation [1,65]. Disadvantages of CT include its use of ionizing radiation and its lower sensitivity to soft-tissue abnormalities, compared with MRI.

High-resolution (typically multidetector) CT of the wrist following contrast injection into one or more wrist compartments (CT arthrography) is a powerful tool for diagnosing intra-articular abnormalities [66,67]. The intraobserver agreement on CT arthrogram images is extremely high and better than that reported for MRI [66,68]. Compared with conventional arthrography, CT arthrography has similar sensitivity and specificity for identifying intrinsic ligament tears, although CT arthrography is better at depicting the site of the torn ligament(s) [69]. The accuracy of CT arthrography for intrinsic ligament tears is higher than that for noncontrast-enhanced MRI, at least for tears of the biomechanically important dorsal fibers [68]. In addition, CT arthrography appears to be more accurate than either MRI and MR arthrography for identifying articular cartilage defects in the wrist [21], and similar to MR arthrography for the diagnosing of TFCC lesions [70].

Ultrasound

Sonography of the wrist is useful for examining extra-articular soft tissues, such as suspected ganglion cysts [71], where its accuracy is similar to that of MRI, but its cost is lower [44]. Ultrasound (US) can also be used to

diagnose abnormalities of the flexor and extensor tendons and tendon sheaths. For de Quervain's disease (stenosing tenosynovitis of the abductor pollicis longus and extensor pollicis brevis tendon compartment), preoperative identification of a septum or subcompartmentalization within the first dorsal compartment with US may affect surgical management [72,73].

Sonographic measurements of the median nerve within and proximal to the carpal tunnel correlate with the diagnosis of carpal tunnel syndrome [74-78], but similar to the situation for MRI, the clinical and electrophysiologic diagnosis rarely needs US imaging confirmation. The size of the median nerve measured sonographically does correlate with the clinical and neurophysiologic severity of the disease [79,80]. There is some evidence that the presence of vessels or hypervascularity within the carpal tunnel, demonstrated with power Doppler US, is another feature of carpal tunnel syndrome [81,82].

In patients with RA, sonography of the wrist and metacarpophalangeal joints has been used to show inflammation—a feature that predicts progression of erosions [55], and erosions themselves [52,83]. However, US is similar to radiographs in sensitivity for erosions, and both are inferior to MRI [52]. Furthermore, unlike MRI, US cannot show changes within the bone marrow, which are the strongest prognosticator for disease progression in RA [47,48,56-58].

While some investigators have tried high-resolution ultrasonography with or without arthrography for diagnosing intrinsic ligament or TFCC abnormalities [84-86], its reported sensitivity is relatively low compared with that of MRI [87], and imaging with US is largely limited to the dorsal fibers of the ligaments and TFCC [85]. Wrist US is a useful technique to guide therapeutic intra-articular and other soft-tissue injections [88].

Arthroscopy

Arthroscopy is considered the gold standard for diagnosing internal derangements in the wrist — tears of the intrinsic ligaments, abnormalities of the TFCC, and articular cartilage defects — and many of these lesions can also be treated through the arthroscope, often precluding open surgery [89,90]. Some ganglia can also be managed arthroscopically [89]. In selected patients with RA, arthroscopic synovectomy may be a useful adjunct to medical therapy or an alternative to more complex, open procedures [91]. Arthroscopy is both more invasive and more expensive than radiologic imaging techniques.

Summary and Recommendations

- Radiographs should be the initial imaging study in any patient with chronic wrist pain [1-3,8].
- Ulnar-sided wrist pain is often related to ulnocarpal impaction, TFCC lesions, and/or lunotriquetral ligament tears [1,8,14]. While diagnosis with conventional arthrography is accurate for these conditions, a positive arthrogram cannot provide the detailed anatomic information needed for treatment planning, and a negative arthrogram cannot identify extra-articular causes of ulnar-sided pain. High-resolution MRI, using an appropriate local coil, is an effective examination in these patients [27], but it has relatively low sensitivity for lesions of the distal and ulnar attachments of the TFCC [7,26,28]. Performing indirect MR arthrography does not improve diagnosis [19], but direct MR arthrography does [23,24,30]. When direct MR arthrography is not available, performing MRI with a high-field-strength (3.0-T) system is probably preferable to doing a study on a lower-field-strength system [25]. CT arthrography is at least as accurate as MR arthrography in patients with ulnar-sided pain [21,68,70] and is a good alternative. US currently does not provide a complete, accurate examination of the ulnar side of the wrist compared with these other modalities [85,87].
- In patients with radial-sided wrist pain, isolated ligament perforations do not always correspond with pain or instability [4,14], making conventional arthrography a poor choice of modality. MRI is the preferred examination in these patients because of its ability to diagnose bone, tendon, tendon sheath, and synovial abnormalities in addition to scapholunate ligament tears [19,20,43,45,46]. Performing indirect MR arthrography may increase the accuracy for diagnosis of scapholunate ligament tears [19]; direct MR arthrography is definitely more accurate than noncontrast-enhanced MRI for these tears [22,24]. If there is a strong clinical suspicion that an occult ganglion cyst or de Quervain's disease is the cause of radial-sided wrist pain, US may be a better choice than MRI as a screening imaging test, in part because of the lower cost of sonography [44,72,73].
- Most bone lesions responsible for chronic wrist pain will be evident on radiographs. For diagnosing radiographically occult fractures and complications of fractures (such as nonunion and osteonecrosis), both MRI and CT have a role in specific circumstances [20,34,37,39]; specifically, for detecting complications

after scaphoid fracture, either MRI or CT can be performed. MRI is probably the study of choice in patients without fractures who have suspected osteonecrosis [40,41]. While scintigraphy is sensitive to bone abnormalities, it has a limited role in the evaluation of chronic wrist pain because of its low specificity [10].

- Conventional MRI and indirect MR arthrography demonstrate only fair sensitivity for articular cartilage lesions in the wrist [31-33]. Direct MR arthrography and CT arthrography are more accurate [21], but arthroscopy may be necessary for patients with a high clinical suspicion of a chondral defect. Intra-articular lesions of the ligaments, TFCC, and articular cartilage may also be amenable to arthroscopic treatment [89,90].
- While both MRI and US findings correlate with the diagnosis and severity of carpal tunnel syndrome [60,63,79,80], they are rarely necessary in patients with a certain clinical and/or electrophysiologic diagnosis [59]. MRI probably has value in rare cases where a mass is thought to be responsible for median nerve dysfunction or in patients who experience recurrent symptoms following carpal tunnel release [64].
- The role of wrist imaging in patients with RA is expanding. MRI is much more sensitive than radiographs or US for identifying erosions [52-55]. Intravenous-contrast-enhanced MRI accurately depicts active synovitis and tenosynovitis, which may allow confident diagnosis of RA earlier than diagnosis relying on clinical signs and symptoms, and which correlate with disease activity [48,50,51]. Most importantly, osteitis (enhancing marrow “edema”) is a finding only demonstrable on MRI studies, and is proving to be the most important predictor of disease progression [47,56-58].
- Imaging a patient with a suspected wrist mass can be accomplished in several equally appropriate ways. If a ganglion or other cyst is most likely, US is probably the most cost-effective initial examination, recognizing that a second study (typically MRI) may be needed if the initial US is normal or shows a non-specific solid mass. MRI examination can be performed without contrast if a radiologist will be available to check the initial images and give contrast if the noncontrast images are inconclusive. Alternatively, if an MRI examination will be performed without active monitoring by a radiologist, the study may be done with intravenous contrast administration.

Anticipated Exceptions

Nephrogenic systemic fibrosis (NSF) is a disorder with a scleroderma-like presentation and a spectrum of manifestations that can range from limited clinical sequelae to fatality. It appears to be related to both underlying severe renal dysfunction and the administration of gadolinium-based contrast agents. It has occurred primarily in patients on dialysis, rarely in patients with very limited glomerular filtration rate (GFR) (ie, <30 mL/min/1.73m²), and almost never in other patients. There is growing literature regarding NSF. Although some controversy and lack of clarity remain, there is a consensus that it is advisable to avoid all gadolinium-based contrast agents in dialysis-dependent patients unless the possible benefits clearly outweigh the risk, and to limit the type and amount in patients with estimated GFR rates <30 mL/min/1.73m². For more information, please see the [ACR Manual on Contrast Media](#) [92].

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

- [ACR Appropriateness Criteria® Overview](#)
- [Procedure Information](#)
- [Evidence Table](#)

References

1. Coggins CA. Imaging of ulnar-sided wrist pain. *Clin Sports Med.* 2006;25(3):505-526, vii.
2. Forman TA, Forman SK, Rose NE. A clinical approach to diagnosing wrist pain. *Am Fam Physician.* 2005;72(9):1753-1758.
3. Wilson AJ, Mann FA, Gilula LA. Imaging the hand and wrist. *J Hand Surg Br.* 1990;15(2):153-167.
4. Theumann NH, Etehami G, Duvoisin B, et al. Association between extrinsic and intrinsic carpal ligament injuries at MR arthrography and carpal instability at radiography: initial observations. *Radiology.* 2006;238(3):950-957.
5. Lawand A, Foulkes GD. The "clenched pencil" view: a modified clenched fist scapholunate stress view. *J Hand Surg Am.* 2003;28(3):414-418; discussion 419-420.
6. Ozcelik A, Gunal I, Kose N. Stress views in the radiography of scapholunate instability. *Eur J Radiol.* 2005;56(3):358-361.
7. Haims AH, Schweitzer ME, Morrison WB, et al. Limitations of MR imaging in the diagnosis of peripheral tears of the triangular fibrocartilage of the wrist. *AJR Am J Roentgenol.* 2002;178(2):419-422.
8. Cerezal L, del Pinal F, Abascal F, Garcia-Valtuille R, Pereda T, Canga A. Imaging findings in ulnar-sided wrist impaction syndromes. *Radiographics.* 2002;22(1):105-121.
9. Braunstein EM, Vydareny KH, Louis DS, Hankin FM. Cost effectiveness of wrist fluoroscopy and arthrography in the evaluation of obscure wrist pain. *Orthopedics.* 1986;9(11):1504-1506.
10. Al-Janabi M. Imaging modalities of the painful wrist: the role of bone scintigraphy. *Rheumatology (Oxford).* 2002;41(10):1085-1087.
11. Cantor RM, Stern PJ, Wyrick JD, Michaels SE. The relevance of ligament tears or perforations in the diagnosis of wrist pain: an arthrographic study. *J Hand Surg Am.* 1994;19(6):945-953.
12. Vanden Eynde S, De Smet L, Fabry G. Diagnostic value of arthrography and arthroscopy of the radiocarpal joint. *Arthroscopy.* 1994;10(1):50-53.
13. Weiss AP, Akelman E, Lambiase R. Comparison of the findings of triple-injection cinerthrography of the wrist with those of arthroscopy. *J Bone Joint Surg Am.* 1996;78(3):348-356.
14. Manaster BJ, Mann RJ, Rubenstein S. Wrist pain: correlation of clinical and plain film findings with arthrographic results. *J Hand Surg Am.* 1989;14(3):466-473.
15. Hobby JL, Dixon AK, Bearcroft PW, et al. MR imaging of the wrist: effect on clinical diagnosis and patient care. *Radiology.* 2001;220(3):589-593.

16. Kocharian A, Adkins MC, Amrami KK, et al. Wrist: improved MR imaging with optimized transmit-receive coil design. *Radiology*. 2002;223(3):870-876.
17. Lenk S, Ludescher B, Martirosan P, Schick F, Claussen CD, Schlemmer HP. 3.0 T high-resolution MR imaging of carpal ligaments and TFCC. *Rofo*. 2004;176(5):664-667.
18. Saupe N, Prussmann KP, Luechinger R, Bosiger P, Marincek B, Weishaupt D. MR imaging of the wrist: comparison between 1.5- and 3-T MR imaging--preliminary experience. *Radiology*. 2005;234(1):256-264.
19. Haims AH, Schweitzer ME, Morrison WB, et al. Internal derangement of the wrist: indirect MR arthrography versus unenhanced MR imaging. *Radiology*. 2003;227(3):701-707.
20. Zanetti M, Saupe N, Nagy L. Role of MR imaging in chronic wrist pain. *Eur Radiol*. 2007;17(4):927-938.
21. Moser T, Dosch JC, Moussaoui A, Dietemann JL. Wrist ligament tears: evaluation of MRI and combined MDCT and MR arthrography. *AJR Am J Roentgenol*. 2007;188(5):1278-1286.
22. Scheck RJ, Kubitzek C, Hierner R, et al. The scapholunate interosseous ligament in MR arthrography of the wrist: correlation with non-enhanced MRI and wrist arthroscopy. *Skeletal Radiol*. 1997;26(5):263-271.
23. Scheck RJ, Romagnolo A, Hierner R, Pfluger T, Wilhelm K, Hahn K. The carpal ligaments in MR arthrography of the wrist: correlation with standard MRI and wrist arthroscopy. *J Magn Reson Imaging*. 1999;9(3):468-474.
24. Zanetti M, Bram J, Hodler J. Triangular fibrocartilage and intercarpal ligaments of the wrist: does MR arthrography improve standard MRI? *J Magn Reson Imaging*. 1997;7(3):590-594.
25. Magee T. Comparison of 3-T MRI and arthroscopy of intrinsic wrist ligament and TFCC tears. *AJR Am J Roentgenol*. 2009;192(1):80-85.
26. Oneson SR, Timins ME, Scales LM, Erickson SJ, Chamoy L. MR imaging diagnosis of triangular fibrocartilage pathology with arthroscopic correlation. *AJR Am J Roentgenol*. 1997;168(6):1513-1518.
27. Potter HG, Asnis-Ernberg L, Weiland AJ, Hotchkiss RN, Peterson MG, McCormack RR, Jr. The utility of high-resolution magnetic resonance imaging in the evaluation of the triangular fibrocartilage complex of the wrist. *J Bone Joint Surg Am*. 1997;79(11):1675-1684.
28. Totterman SM, Miller RJ, McCance SE, Meyers SP. Lesions of the triangular fibrocartilage complex: MR findings with a three-dimensional gradient-recalled-echo sequence. *Radiology*. 1996;199(1):227-232.
29. Anderson ML, Skinner JA, Felmlee JP, Berger RA, Amrami KK. Diagnostic comparison of 1.5 Tesla and 3.0 Tesla preoperative MRI of the wrist in patients with ulnar-sided wrist pain. *J Hand Surg Am*. 2008;33(7):1153-1159.
30. Ruegger C, Schmid MR, Pfirrmann CW, Nagy L, Gilula LA, Zanetti M. Peripheral tear of the triangular fibrocartilage: depiction with MR arthrography of the distal radioulnar joint. *AJR Am J Roentgenol*. 2007;188(1):187-192.
31. Bordalo-Rodrigues M, Schweitzer M, Bergin D, Culp R, Barakat MS. Lunate chondromalacia: evaluation of routine MRI sequences. *AJR Am J Roentgenol*. 2005;184(5):1464-1469.
32. Haims AH, Moore AE, Schweitzer ME, et al. MRI in the diagnosis of cartilage injury in the wrist. *AJR Am J Roentgenol*. 2004;182(5):1267-1270.
33. Saupe N, Pfirrmann CW, Schmid MR, Schertler T, Manestar M, Weishaupt D. MR imaging of cartilage in cadaveric wrists: comparison between imaging at 1.5 and 3.0 T and gross pathologic inspection. *Radiology*. 2007;243(1):180-187.
34. Peh WC, Gilula LA, Wilson AJ. Detection of occult wrist fractures by magnetic resonance imaging. *Clin Radiol*. 1996;51(4):285-292.
35. Dwek JR, Cardoso F, Chung CB. MR imaging of overuse injuries in the skeletally immature gymnast: spectrum of soft-tissue and osseous lesions in the hand and wrist. *Pediatr Radiol*. 2009;39(12):1310-1316.
36. Fox MG, Gaskin CM, Chhabra AB, Anderson MW. Assessment of scaphoid viability with MRI: a reassessment of findings on unenhanced MR images. *AJR Am J Roentgenol*. 2010;195(4):W281-286.
37. Morgan WJ, Breen TF, Coumas JM, Schulz LA. Role of magnetic resonance imaging in assessing factors affecting healing in scaphoid nonunions. *Clin Orthop Relat Res*. 1997(336):240-246.
38. Trumble TE. Avascular necrosis after scaphoid fracture: a correlation of magnetic resonance imaging and histology. *J Hand Surg Am*. 1990;15(4):557-564.
39. Cerezal L, Abascal F, Canga A, Garcia-Valtuille R, Bustamante M, del Pinal F. Usefulness of gadolinium-enhanced MR imaging in the evaluation of the vascularity of scaphoid nonunions. *AJR Am J Roentgenol*. 2000;174(1):141-149.
40. Sowa DT, Holder LE, Patt PG, Weiland AJ. Application of magnetic resonance imaging to ischemic necrosis of the lunate. *J Hand Surg Am*. 1989;14(6):1008-1016.

41. Trumble TE, Irving J. Histologic and magnetic resonance imaging correlations in Kienbock's disease. *J Hand Surg Am.* 1990;15(6):879-884.
42. Glajchen N, Schweitzer M. MRI features in de Quervain's tenosynovitis of the wrist. *Skeletal Radiol.* 1996;25(1):63-65.
43. Parellada AJ, Gopez AG, Morrison WB, et al. Distal intersection tenosynovitis of the wrist: a lesser-known extensor tendinopathy with characteristic MR imaging features. *Skeletal Radiol.* 2007;36(3):203-208.
44. Cardinal E, Buckwalter KA, Braunstein EM, Mih AD. Occult dorsal carpal ganglion: comparison of US and MR imaging. *Radiology.* 1994;193(1):259-262.
45. Vo P, Wright T, Hayden F, Dell P, Chidgey L. Evaluating dorsal wrist pain: MRI diagnosis of occult dorsal wrist ganglion. *J Hand Surg Am.* 1995;20(4):667-670.
46. Anderson SE, Steinbach LS, Stauffer E, Voegelin E. MRI for differentiating ganglion and synovitis in the chronic painful wrist. *AJR Am J Roentgenol.* 2006;186(3):812-818.
47. Boyesen P, Haavardsholm EA, Ostergaard M, van der Heijde D, Sesseng S, Kvien TK. MRI in early rheumatoid arthritis: synovitis and bone marrow oedema are independent predictors of subsequent radiographic progression. *Ann Rheum Dis.* 2011;70(3):428-433.
48. Navalho M, Resende C, Rodrigues AM, et al. Dynamic contrast-enhanced 3-T magnetic resonance imaging: a method for quantifying disease activity in early polyarthritis. *Skeletal Radiol.* 2012;41(1):51-59.
49. Cimmino MA, Innocenti S, Livrone F, Magnaguagno F, Silvestri E, Garlaschi G. Dynamic gadolinium-enhanced magnetic resonance imaging of the wrist in patients with rheumatoid arthritis can discriminate active from inactive disease. *Arthritis Rheum.* 2003;48(5):1207-1213.
50. Sugimoto H, Takeda A, Hyodoh K. Early-stage rheumatoid arthritis: prospective study of the effectiveness of MR imaging for diagnosis. *Radiology.* 2000;216(2):569-575.
51. Tehranzadeh J, Ashikyan O, Anavim A, Tramma S. Enhanced MR imaging of tenosynovitis of hand and wrist in inflammatory arthritis. *Skeletal Radiol.* 2006;35(11):814-822.
52. Hoving JL, Buchbinder R, Hall S, et al. A comparison of magnetic resonance imaging, sonography, and radiography of the hand in patients with early rheumatoid arthritis. *J Rheumatol.* 2004;31(4):663-675.
53. Taouli B, Zaim S, Peterfy CG, et al. Rheumatoid arthritis of the hand and wrist: comparison of three imaging techniques. *AJR Am J Roentgenol.* 2004;182(4):937-943.
54. Dohn UM, Ejbjerg BJ, Hasselquist M, et al. Detection of bone erosions in rheumatoid arthritis wrist joints with magnetic resonance imaging, computed tomography and radiography. *Arthritis Res Ther.* 2008;10(1):R25.
55. Duer-Jensen A, Ejbjerg B, Albrecht-Beste E, et al. Does low-field dedicated extremity MRI (E-MRI) reliably detect bone erosions in rheumatoid arthritis? A comparison of two different E-MRI units and conventional radiography with high-resolution CT scanning. *Ann Rheum Dis.* 2009;68(8):1296-1302.
56. Boyesen P, Haavardsholm EA, van der Heijde D, et al. Prediction of MRI erosive progression: a comparison of modern imaging modalities in early rheumatoid arthritis patients. *Ann Rheum Dis.* 2011;70(1):176-179.
57. Hetland ML, Ejbjerg B, Horslev-Petersen K, et al. MRI bone oedema is the strongest predictor of subsequent radiographic progression in early rheumatoid arthritis. Results from a 2-year randomised controlled trial (CIMESTRA). *Ann Rheum Dis.* 2009;68(3):384-390.
58. Zheng S, Robinson E, Yeoman S, et al. MRI bone oedema predicts eight year tendon function at the wrist but not the requirement for orthopaedic surgery in rheumatoid arthritis. *Ann Rheum Dis.* 2006;65(5):607-611.
59. Rempel D, Evanoff B, Amadio PC, et al. Consensus criteria for the classification of carpal tunnel syndrome in epidemiologic studies. *Am J Public Health.* 1998;88(10):1447-1451.
60. Martins RS, Siqueira MG, Simplicio H, Agapito D, Medeiros M. Magnetic resonance imaging of idiopathic carpal tunnel syndrome: correlation with clinical findings and electrophysiological investigation. *Clin Neurol Neurosurg.* 2008;110(1):38-45.
61. Monagle K, Dai G, Chu A, Burnham RS, Snyder RE. Quantitative MR imaging of carpal tunnel syndrome. *AJR Am J Roentgenol.* 1999;172(6):1581-1586.
62. Radack DM, Schweitzer ME, Taras J. Carpal tunnel syndrome: are the MR findings a result of population selection bias? *AJR Am J Roentgenol.* 1997;169(6):1649-1653.
63. Jarvik JG, Comstock BA, Heagerty PJ, et al. Magnetic resonance imaging compared with electrodiagnostic studies in patients with suspected carpal tunnel syndrome: predicting symptoms, function, and surgical benefit at 1 year. *J Neurosurg.* 2008;108(3):541-550.
64. Wu HT, Schweitzer ME, Culp RW. Potential MR signs of recurrent carpal tunnel syndrome: initial experience. *J Comput Assist Tomogr.* 2004;28(6):860-864.

65. Szabo RM. Distal radioulnar joint instability. *J Bone Joint Surg Am*. 2006;88(4):884-894.
66. De Filippo M, Pogliacomì F, Bertellini A, et al. MDCT arthrography of the wrist: diagnostic accuracy and indications. *Eur J Radiol*. 2010;74(1):221-225.
67. Moser T, Dosch JC, Moussaoui A, Buy X, Gangi A, Dietemann JL. Multidetector CT arthrography of the wrist joint: how to do it. *Radiographics*. 2008;28(3):787-800; quiz 911.
68. Schmid MR, Schertler T, Pfirrmann CW, et al. Interosseous ligament tears of the wrist: comparison of multi-detector row CT arthrography and MR imaging. *Radiology*. 2005;237(3):1008-1013.
69. Theumann N, Favarger N, Schnyder P, Meuli R. Wrist ligament injuries: value of post-arthrography computed tomography. *Skeletal Radiol*. 2001;30(2):88-93.
70. Omlor G, Jung M, Grieser T, Ludwig K. Depiction of the triangular fibro-cartilage in patients with ulnar-sided wrist pain: comparison of direct multi-slice CT arthrography and direct MR arthrography. *Eur Radiol*. 2009;19(1):147-151.
71. Teefey SA, Dahiya N, Middleton WD, Gelberman RH, Boyer MI. Ganglia of the hand and wrist: a sonographic analysis. *AJR Am J Roentgenol*. 2008;191(3):716-720.
72. Choi SJ, Ahn JH, Lee YJ, et al. de Quervain disease: US identification of anatomic variations in the first extensor compartment with an emphasis on subcompartmentalization. *Radiology*. 2011;260(2):480-486.
73. Kwon BC, Choi SJ, Koh SH, Shin DJ, Baek GH. Sonographic Identification of the intracompartmental septum in de Quervain's disease. *Clin Orthop Relat Res*. 2010;468(8):2129-2134.
74. Ashraf AR, Jali R, Moghtaderi AR, Yazdani AH. The diagnostic value of ultrasonography in patients with electrophysiologically confirmed carpal tunnel syndrome. *Electromyogr Clin Neurophysiol*. 2009;49(1):3-8.
75. Duncan I, Sullivan P, Lomas F. Sonography in the diagnosis of carpal tunnel syndrome. *AJR Am J Roentgenol*. 1999;173(3):681-684.
76. Klauser AS, Halpern EJ, De Zordo T, et al. Carpal tunnel syndrome assessment with US: value of additional cross-sectional area measurements of the median nerve in patients versus healthy volunteers. *Radiology*. 2009;250(1):171-177.
77. Sernik RA, Abicalaf CA, Pimentel BF, Braga-Baiak A, Braga L, Cerri GG. Ultrasound features of carpal tunnel syndrome: a prospective case-control study. *Skeletal Radiol*. 2008;37(1):49-53.
78. Wong SM, Griffith JF, Hui AC, Lo SK, Fu M, Wong KS. Carpal tunnel syndrome: diagnostic usefulness of sonography. *Radiology*. 2004;232(1):93-99.
79. Karadag YS, Karadag O, Cicekli E, et al. Severity of Carpal tunnel syndrome assessed with high frequency ultrasonography. *Rheumatol Int*. 2010;30(6):761-765.
80. Padua L, Pazzaglia C, Caliendo P, et al. Carpal tunnel syndrome: ultrasound, neurophysiology, clinical and patient-oriented assessment. *Clin Neurophysiol*. 2008;119(9):2064-2069.
81. Akcar N, Ozkan S, Mehmetoglu O, Calisir C, Adapinar B. Value of power Doppler and gray-scale US in the diagnosis of carpal tunnel syndrome: contribution of cross-sectional area just before the tunnel inlet as compared with the cross-sectional area at the tunnel. *Korean J Radiol*. 2010;11(6):632-639.
82. Mallouhi A, Pulzl P, Trieb T, Piza H, Bodner G. Predictors of carpal tunnel syndrome: accuracy of gray-scale and color Doppler sonography. *AJR Am J Roentgenol*. 2006;186(5):1240-1245.
83. McAlindon T, Kissin E, Nazarian L, et al. American College of Rheumatology report on reasonable use of musculoskeletal ultrasonography in rheumatology clinical practice. *Arthritis Care Res (Hoboken)*. 2012;64(11):1625-1640.
84. Keogh CF, Wong AD, Wells NJ, Barbarie JE, Cooperberg PL. High-resolution sonography of the triangular fibrocartilage: initial experience and correlation with MRI and arthroscopic findings. *AJR Am J Roentgenol*. 2004;182(2):333-336.
85. Taljanovic MS, Sheppard JE, Jones MD, Switlick DN, Hunter TB, Rogers LF. Sonography and sonoarthrography of the scapholunate and lunotriquetral ligaments and triangular fibrocartilage disk: initial experience and correlation with arthrography and magnetic resonance arthrography. *J Ultrasound Med*. 2008;27(2):179-191.
86. Taljanovic MS, Goldberg MR, Sheppard JE, Rogers LF. US of the intrinsic and extrinsic wrist ligaments and triangular fibrocartilage complex--normal anatomy and imaging technique. *Radiographics*. 2011;31(1):e44.
87. Chiou HJ, Chang CY, Chou YH, et al. Triangular fibrocartilage of wrist: presentation on high resolution ultrasonography. *J Ultrasound Med*. 1998;17(1):41-48.
88. Teh J, Vlychou M. Ultrasound-guided interventional procedures of the wrist and hand. *Eur Radiol*. 2009;19(4):1002-1010.

89. Chloros GD, Wiesler ER, Poehling GG. Current concepts in wrist arthroscopy. *Arthroscopy*. 2008;24(3):343-354.
90. Rettig ME, Amadio PC. Wrist arthroscopy. Indications and clinical applications. *J Hand Surg Br*. 1994;19(6):774-777.
91. Kim SJ, Jung KA. Arthroscopic synovectomy in rheumatoid arthritis of wrist. *Clin Med Res*. 2007;5(4):244-250.
92. American College of Radiology. *Manual on Contrast Media*. Available at: http://www.acr.org/~link.aspx?_id=29C40D1FE0EC4E5EAB6861BD213793E5&_z=z.

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.