

**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	<u>RRL*</u>
X-ray wrist	9		☼
MRI wrist with or without contrast	1		O
CT wrist without contrast	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 nondiagnostic. Persistent symptoms. Next study.

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
MRI wrist without contrast	9	Most of the time, imaging is not required. If imaging is to be performed, this is the study of choice.	O
CT wrist without contrast	1		☼
US wrist	1		O
Tc-99m bone scan wrist	1		☼ ☼ ☼
Biopsy/aspiration wrist	1		NS
<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 3:

Routine radiographs normal or nondiagnostic. Suspect arthritis. Next study.

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
MRI wrist without and with contrast	9	Most of the time, imaging is not required. If imaging is to be performed, this is the study of choice. See statement regarding contrast in text under “Anticipated Exceptions.”	O
US wrist	5	Dependent on expertise.	O
CT wrist without contrast	3		☼
Tc-99m bone scan wrist	1		☼ ☼ ☼
Biopsy/aspiration wrist	1		NS
<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 4:****Nonspecific arthritis on radiographs. Exclude infection. Next study.**

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
Aspiration wrist	9		NS
MRI wrist with or without contrast	1		O
CT wrist 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 5:**Pain on ulnar side, suspect triangular fibrocartilage or lunotriquetral ligament tear. Radiographs normal. Next study.**

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
MR arthrography wrist	9	Either MR arthrogram or routine MRI is appropriate. Depends on availability and institutional preference. See statement regarding contrast in text under “Anticipated Exceptions.”	O
MRI wrist without contrast	9	Either MR arthrogram or routine MRI is appropriate. Depends on availability and institutional preference.	O
CT arthrography wrist	8	If MRI is not available or is contraindicated.	☼
X-ray arthrography wrist	7	CT or MR arthrography may add osseous or soft-tissue detail.	☼
US wrist	3	Dependent on expertise.	O
Biopsy/aspiration wrist	1		NS
CT wrist without 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 6:****Radiographs show positive ulnar variance and irregularity in proximal lunate articular surface. Next study.**

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
MRI wrist without contrast	8	Either MR arthrogram or routine MRI is appropriate. Depends on availability and institutional preference.	O
MR arthrography wrist	8	Either MR arthrogram or routine MRI is appropriate. Depends on availability and institutional preference.	O
US wrist	3	Dependent on expertise.	O
X-ray arthrography wrist	2		☼
CT wrist without contrast	2		☼
Tc-99m bone scan wrist	2		☼ ☼ ☼
Biopsy/aspiration wrist	2		NS
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

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

Radiologic Procedure	Rating	Comments	<u>RRL*</u>
MRI wrist without contrast	9		O
CT wrist without contrast	5		☼
Tc-99m bone scan wrist	2		☼ ☼ ☼
US wrist	1		O
Biopsy/aspiration wrist	1		NS
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	<u>RRL*</u>
CT wrist without contrast	5	Only if needed to assess degree of collapse and associated fractures.	☼
MRI wrist without contrast	1		O
US wrist	1		O
Tc-99m bone scan wrist	1		☼ ☼ ☼
Biopsy/aspiration wrist	1		NS
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:****Pain for more than 3 weeks. Suspect occult 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.	☼
US wrist	1		O
Tc-99m bone scan wrist	1		☼ ☼ ☼
Biopsy/aspiration wrist	1		NS
Rating Scale: 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate			*Relative Radiation Level

Variant 10:**Suspect carpal tunnel syndrome.**

Radiologic Procedure	Rating	Comments	RRL*
X-ray wrist	9	As a baseline evaluation.	☼
MRI wrist without contrast	2	If mass is suspected or symptoms recur post surgery.	O
US wrist	2		O
CT wrist without contrast	1		☼
Tc-99m bone scan wrist	1		☼ ☼ ☼
Biopsy/aspiration wrist	1		NS
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

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Summary of Literature Review

The role of imaging in chronic wrist pain has received much attention but remains controversial. There is considerable disagreement about which imaging study, if any, should be performed in a given situation. If one compares the radiologic literature to the orthopedic literature, the controversy becomes apparent.

Radiography

Most physicians agree that imaging evaluation of the painful wrist should begin with radiographs [1]. This simple, relatively inexpensive study may establish a specific diagnosis in patients with arthritis, complications of injury, infection, some bone or soft-tissue tumors, and impaction syndromes, and occasionally in patients with wrist instability. Magnetic resonance imaging (MRI), on the other hand, detects bone marrow edema and chondromalacia at an earlier stage [2]. The standard radiographic examination consists of posterior-anterior (PA) and lateral views, and often an oblique view as well [2,3]. The lateral view is important for demonstrating malalignment indicative of instability, and soft-tissue changes such as abnormalities of the pronator quadratus fat stripe [4]. If the patient is suspected of having wrist instability, other views are often added to this routine [5]. A variety of dynamic views can be performed to elicit subtle instability not seen on static views [6], although

radiography only gives indirect information about ligamentous integrity [4]. Accurate measurements of ulnar variance are only possible by radiography [7]. The clenched-fist stress view of both wrists has been shown to aid in the diagnosis of scapholunate dissociation [8]. Specific suspected problems may require additional views (eg, PA in ulnar deviation) to look for a scaphoid fracture.

Fluoroscopy or video imaging has been used to establish the diagnosis of dynamic wrist instability, and it has been suggested that it is a cost-effective method of making this diagnosis [9]. However, at the present time, fluoroscopy is rapidly becoming a lost art and is primarily used for injection localization with arthrography.

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 sensitive, scintigraphy suffers from a lack of specificity.

Arthrography

Wrist arthrography with a radiocarpal injection was commonly used in diagnosing tears of the triangular fibrocartilage (TFCC) and interosseous ligaments [10]. Some authors have replaced the standard radiocarpal wrist arthrogram with a three-injection technique, with injections into the radiocarpal, midcarpal, and distal radioulnar joints [11]. Others have advocated bilateral tricompartmental arthrography because bilateral intercarpal communications are not uncommon [12].

Magnetic Resonance Imaging

MRI has been advocated for patients with chronic wrist pain because it provides a global examination of both the osseous and soft-tissue structures [13]. It may be diagnostic in patients with TFCC and interosseous ligament tears, occult fractures, avascular necrosis (AVN), and miscellaneous other abnormalities [7,14-16]. It is also recommended for evaluating tendon pathology, including tendinopathy, tenosynovitis, and rupture [2,17]. Currently, preoperative MRI is recommended by some authors to direct appropriate operative intervention or nonoperative treatment [18]. Contrast-enhanced and dynamic MRI have been suggested in specific situations such as detecting erosions and their progression in rheumatoid arthritis [19,20].

Some investigators have used MR arthrography, both direct and indirect, to detect ligamentous abnormalities of the wrist [21,22]. Haims and Schweitzer [23] found that indirect MR arthrography was more sensitive than conventional MRI in detecting scapholunate abnormalities but did not improve sensitivity in detecting TFCC or lunatotriquetral tears. While high accuracy has been reported for the MRI detection of central and radial-sided tears of the TFCC, conventional MRI is less accurate for peripheral tears [5,16]. Ruegger et al [24] found that MR arthrography of the distal radioulnar joint

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was accurate in depicting peripheral tears of the TFCC. MR arthrography has been specifically recommended in ulnar-sided wrist pain because of the complex anatomy at this site [22,25]. Note that differentiation should be made between the intrinsic and extrinsic ligaments of the wrist, as optimal imaging and treatment strategies may differ for visualization of these two subsets on MRI [4,22].

For scapholunate ligament tears, direct MR arthrography is superior to both MRI and conventional arthrography, especially for subtle injuries [22]. MR arthrography may permit exact localization of tears and inform about adjacent structures, including cartilage and ligaments [2,18]. MR arthrography, with its inherently high soft-tissue contrast, also enables detection of indirect signs of injury chronicity [21]. Direct MR arthrography is recommended for clinically relevant, suspected tears of the peripheral ulnar attachments of the TFCC because of its improved accuracy compared to conventional MRI [16].

The combination of MRI and MR arthrography may increase diagnostic accuracy as well [26]. Zanetti et al [27] felt that MR arthrography increased the diagnostic performance of the noncontrast examination.

One paper showed that immediate MRI for patients with possible occult wrist fractures with a modified screening protocol was nearly equivalent in cost to follow-up with delayed imaging [28]. This included the cost of orthopedic consultation and casting as well as additional follow-up with radiographs and orthopedic clinic visit(s). The loss of productivity resulting from casts and splints was excluded from the cost analysis. Differentiation between acute and chronic fracture, by the degree of enhancement and other MRI findings, is somewhat less reliable. MRI is highly recommended for occult scaphoid fractures [16].

Herneth et al [29] performed radiography, high-resolution ultrasound (US), and MRI on 15 consecutive patients with suspected scaphoid fractures. Of nine fractures, five were positive on radiograph, seven were positive on US and all nine were present on MRI.

MRI is helpful in diagnosing ulnar-sided pain caused by impaction syndromes [7,22]. It can differentiate between the impaction syndromes and also detect other causes of ulnar-sided pain, including occult fractures and TFCC tears. MRI and MR arthrography are considered superior to radiography for diagnosing early impaction syndromes, as radiography detects findings of impingement or impaction only after bony changes have occurred [7].

Other authors used computed tomography (CT) postarthrography for diagnosing ligament injuries of the wrist and claimed that it increased precision without affecting the sensitivity or specificity of the diagnosis [30]. Potential advantages of CT arthrography include the ability to image claustrophobic patients and obtain a more detailed evaluation of cortical bone [31]. One group routinely combines multidetector CT arthrography and MR arthrography in one synergistic and cost-effective procedure [31]. When comparing the two techniques,

Schmid et al [32] found that interobserver agreement was increased with CT arthrography and that CT arthrography was superior to MR arthrography for dorsal segment tears, with more equivalent performance for central and palmar tears.

Carpal tunnel syndrome is usually diagnosed by signs and symptoms and the results of electrodiagnostic studies [33]. MRI may be helpful in the evaluation of mass lesions in the carpal tunnel and for recurrent carpal tunnel symptoms postoperatively [34]. The findings obtained with MRI of the carpal tunnel have also been reported to predict surgical benefit independent of nerve conduction studies, and patients prefer MRI over electrodiagnostic studies [35]. Radiographs of the wrist may be obtained in the setting of suspected carpal tunnel syndrome as a baseline evaluation.

Newly developed, higher-field-strength magnets (3.0 Tesla) offer additional benefits, including increased signal-to-noise ratio (SNR), enhanced T2* contrast, increased chemical shift resolution, and better overall diagnostic performance, which is crucial for musculoskeletal applications, especially for the imaging of small joints, the median and ulnar nerves, and radiocarpal and intercarpal cartilage [26]. Another study demonstrated that 3.0 T imaging yields images with better SNR and contrast-to-noise ratio (CNR) than 1.5 T imaging in a reasonable acquisition time and with few artifacts [36]. Many speculate that 3.0 T imaging will overcome some of the shortcomings of MR arthrography at lower field strengths as well, especially for diagnosis of subtle TFCC lesions [24]; however, it has not been conclusively shown that MRI at higher field strength will improve diagnostic accuracy in detecting wrist abnormalities as compared to MRI at 1.5 T.

Ultrasound

US has been used to evaluate wrist ganglia [2,37,38], tenosynovitis, tendon rupture, and undiagnosed pain and swelling [39-41]. Occult or small wrist ganglia are equally well evaluated with US and MRI [16]. Recently, additional roles for US have been described, including measurements of TFCC thickness, detection of TFCC, detection of scapholunate and lunotriquetral tears, and the diagnosis of carpal tunnel syndrome [39,42-44]. When US is combined with radiography and stress views, instability may be diagnosed [39]. As it is readily available, noninvasive, and relatively inexpensive, it is likely to be increasingly used for high-resolution evaluation of superficial structures [39,45], and more work is needed to assess the applications of this technique and address issues of operator dependence [45]. US guidance has also been used for intra-articular injections and interventional procedures of the wrist [46-48]. Future directions may include sonographic arthrography for better delineation of the radial aspect of the wrist [39].

Computed Tomography

CT can be used, particularly in the follow-up of complex fractures or distal radioulnar subluxations. Serial CT imaging may be performed for assessing the degree of healing of wrist fractures [49]. Advantages of CT in wrist

imaging include its widespread availability, rapidity, and relatively lower cost [22]. CT is also useful for evaluating extent of subluxation at the distal radioulnar joint [2]. Multidetector CT arthrography has been reported to be useful in the diagnosis of tears of the interosseous ligaments and triangular fibrocartilage complex while also demonstrating cartilage and bone abnormalities [50].

Arthroscopy

Many articles, particularly in the orthopedic literature, dispute the value of imaging in the diagnosis of ligamentous tears, because the authors believe that arthroscopy is more accurate and that treatment can be performed along with the diagnostic portions of the procedure [51-53]. Traditionally, open surgery or arthroscopy has been considered the gold standard, but arthroscopy cannot be used to evaluate the extrinsic ligaments [4,21]. Arthroscopy is also a more expensive and invasive technique [18]. As always, clinical history, patient age, and exact site of pain are essential for narrowing the differential diagnoses, specifically with regard to traumatic versus degenerative lesions [22]. In one study, a new technique, virtual MR arthroscopy, revealed the TFCC in 12 of 19 patients, showing promise in TFCC evaluation from an intra-articular perspective [54]. To our knowledge, no outcome or cost analysis studies have been performed regarding the results of the various imaging options.

Aspiration/Biopsy

Ganglion cysts may be treated by surgical excision or aspiration followed by corticosteroid injection, which can be performed under US guidance. Percutaneous biopsy has been shown to be safe and accurate for diagnosing musculoskeletal lesions [55]. US or CT may be used for guiding percutaneous biopsy.

Summary

- Evaluation of the chronically painful wrist should begin with radiographs.
- Conventional wrist arthrography can be used to diagnose communicating ligament tears, but it does not provide a global examination of the wrist.
- MRI is recommended to evaluate the osseous and soft-tissue structures of the wrist. Direct MR arthrography is superior to MRI and conventional arthrography in diagnosing scapholunate ligament tears and peripheral tears of the triangular fibrocartilage.
- MRI is highly recommended for diagnosing occult fractures. CT is recommended for evaluating complex fractures and their follow-up as well as for distal radioulnar joint subluxation.
- US can be used to evaluate wrist ganglia, tenosynovitis, and tendon rupture, but its role in the evaluation of ligamentous tears remains to be determined.

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](#) [56].

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 NS (not specified).		

Supporting Document(s)

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

References

1. Forman TA, Forman SK, Rose NE. A clinical approach to diagnosing wrist pain. *Am Fam Physician* 2005; 72(9):1753-1758.
2. Coggins CA. Imaging of ulnar-sided wrist pain. *Clin Sports Med* 2006; 25(3):505-526, vii.
3. Ryley JP, Langstaff RJ, Barton NJ. The natural history of undiagnosed wrist pain in young women. A long-term follow-up. *J Hand Surg [Br]* 1992; 17(1):51-54.
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. 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* 2002; 178(2):419-422.
6. Ozelcik A, Gunal I, Kose N. Stress views in the radiography of scapholunate instability. *Eur J Radiol* 2005; 56(3):358-361.
7. 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.
8. 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.
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. Vanden Eynde S, De Smet L, Fabry G. Diagnostic value of arthrography and arthroscopy of the radiocarpal joint. *Arthroscopy* 1994; 10(1):50-53.
11. Weiss AP, Akelman E, Lambiase R. Comparison of the findings of triple-injection cinearthography of the wrist with those of arthroscopy. *J Bone Joint Surg Am* 1996; 78(3):348-356.
12. 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.
13. 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.
14. Peh WC, Gilula LA, Wilson AJ. Detection of occult wrist fractures by magnetic resonance imaging. *Clin Radiol* 1996; 51(4):285-292.
15. Bordalo-Rodrigues M, Schweitzer M, Bergin D, Culp R, Barakat MS. Lunate chondromalacia: evaluation of routine MRI sequences. *AJR* 2005; 184(5):1464-1469.
16. Zanetti M, Saupé N, Nagy L. Role of MR imaging in chronic wrist pain. *Eur Radiol* 2007; 17(4):927-938.
17. 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.
18. 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.
19. 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.
20. 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.
21. Berna-Serna JD, Martínez F, Reus M, Alonso J, Domenech G, Campos M. Evaluation of the triangular fibrocartilage in cadaveric wrists by means of arthrography, magnetic resonance (MR) imaging, and MR arthrography. *Acta Radiol* 2007; 48(1):96-103.
22. Zlatkin MB, Rosner J. MR imaging of ligaments and triangular fibrocartilage complex of the wrist. *Magn Reson Imaging Clin N Am* 2004; 12(2):301-331, vi-vii.
23. 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.
24. 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* 2007; 188(1):187-192.
25. Joshy S, Lee K, Deshmukh SC. Accuracy of direct magnetic resonance arthrography in the diagnosis of triangular fibrocartilage complex tears of the wrist. *Int Orthop* 2007.
26. Saupé 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.
27. 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.
28. Dorsay TA, Major NM, Helms CA. Cost-effectiveness of immediate MR imaging versus traditional follow-up for revealing radiographically occult scaphoid fractures. *AJR* 2001; 177(6):1257-1263.
29. Herneth AM, Siegmeth A, Bader TR, et al. Scaphoid fractures: evaluation with high-spatial-resolution US initial results. *Radiology* 2001; 220(1):231-235.
30. Theumann N, Favarger N, Schnyder P, Meuli R. Wrist ligament injuries: value of post-arthrography computed tomography. *Skeletal Radiol* 2001; 30(2):88-93.
31. Moser T, Dosch JC, Moussaoui A, Dietemann JL. Wrist ligament tears: evaluation of MRI and combined MDCT and MR arthrography. *AJR* 2007; 188(5):1278-1286.
32. 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.
33. 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.
34. 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.
35. 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.
36. Lenk S, Ludescher B, Martirosian 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.
37. Anderson SE, Steinbach LS, Stauffer E, Voegelin E. MRI for differentiating ganglion and synovitis in the chronic painful wrist. *AJR* 2006; 186(3):812-818.
38. Teehey SA, Dahiya N, Middleton WD, Gelberman RH, Boyer MI. Ganglia of the hand and wrist: a sonographic analysis. *AJR* 2008; 191(3):716-720.
39. 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* 2004; 182(2):333-336.
40. De Maeseneer M, Marcellis S, Osteaux M, Jager T, Machiels F, Van Roy P. Sonography of a rupture of the tendon of the extensor pollicis longus muscle: initial clinical experience and correlation with findings at cadaveric dissection. *AJR* 2005; 184(1):175-179.
41. Santiago FR, Plazas PG, Fernandez JM. Sonography findings in tears of the extensor pollicis longus tendon and correlation with CT, MRI and surgical findings. *Eur J Radiol* 2008; 66(1):112-116.
42. 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.
43. 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.
44. 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.
45. 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.
 46. Lohman M, Vasenius J, Nieminen O. Ultrasound guidance for puncture and injection in the radiocarpal joint. *Acta Radiol* 2007; 48(7):744-747.
 47. Luz KR, Furtado RN, Nunes CC, Rosenfeld A, Fernandes AR, Natour J. Ultrasound-guided intra-articular injections in the wrist in patients with rheumatoid arthritis: a double-blind, randomised controlled study. *Ann Rheum Dis* 2008; 67(8):1198-1200.
 48. Teh J, Vlychou M. Ultrasound-guided interventional procedures of the wrist and hand. *Eur Radiol* 2008.
 49. Quinn SF, Belsole RJ, Greene TL, Rayhack JM. CT of the wrist for the evaluation of traumatic injuries. *Crit Rev Diagn Imaging* 1989; 29(4):357-380.
 50. 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.
 51. 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.
 52. Metz VM, Mann FA, Gilula LA. Three-compartment wrist arthrography: correlation of pain site with location of uni- and bidirectional communications. *AJR* 1993; 160(4):819-822.
 53. Wilson AJ, Mann FA, Gilula LA. Imaging the hand and wrist. *J Hand Surg [Br]* 1990; 15(2):153-167.
 54. Sahin G, Dogan BE, Demirtas M. Virtual MR arthroscopy of the wrist joint: a new intraarticular perspective. *Skeletal Radiol* 2004; 33(1):9-14.
 55. Mitsuyoshi G, Naito N, Kawai A, et al. Accurate diagnosis of musculoskeletal lesions by core needle biopsy. *J Surg Oncol* 2006; 94(1):21-27.
 56. American College of Radiology. *Manual on Contrast Media*. Available at: http://www.acr.org/SecondaryMainMenuCategories/quality_safety/contrast_manual.aspx.

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.