

# CLINICAL IMAGING

## Imaging of the Extremities

Independent Study Course 27.3.2

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CONTINUING PHYSICAL THERAPY EDUCATION



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## REFERENCES

1. American College of Radiology. Diagnostic Radiology: Musculoskeletal Imaging Practice Parameters. <http://www.acr.org/Quality-Safety/Standards-Guidelines/Practice-Guidelines-by-Modality/Musculoskeletal>. Accessed June 9, 2017.
2. American College of Radiology. ACR-AIUM-SPR-SRU Practice Parameter For The Performance Of The Musculoskeletal Ultrasound Examination. [http://www.acr.org/-/media/ACR/Documents/PGTS/guidelines/US\\_Musculoskeletal.pdf](http://www.acr.org/-/media/ACR/Documents/PGTS/guidelines/US_Musculoskeletal.pdf). Accessed June 9, 2017.
3. American College of Radiology. ACR Appropriateness Criteria®. <https://acsearch.acr.org/list>. Accessed June 9, 2017.
4. American College of Radiology. ACR-SPR-SSR Practice Parameter for the Performance of Radiography of the Extremities. Available at: [http://www.acr.org/-/media/ACR/Documents/PGTS/guidelines/Extremity\\_Radiography.pdf](http://www.acr.org/-/media/ACR/Documents/PGTS/guidelines/Extremity_Radiography.pdf). Accessed June 9, 2017.
5. Clohisy JC, Carlisle JC, Beaulé PE, et al. A systematic approach to the plain radiographic evaluation of the young adult hip. *J Bone Joint Surg Am*. 2008;90 Suppl 4:47-66. doi: 10.2106/JBJS.H.00756.
6. McKinnis LN. Radiologic Evaluation of the Pelvis and Hip. In: Wolf SL, eds. *Fundamentals of Musculoskeletal Imaging*. Philadelphia, PA: F.A. Davis Company; 2014.
7. American College of Radiology. ACR-SPR-SSR Practice Parameter For The Performance And Interpretation Of Magnetic Resonance Imaging (MRI) Of The Hip And Pelvis For Musculoskeletal Disorders. Available at: [http://www.acr.org/-/media/ACR/Documents/PGTS/guidelines/MRI\\_Hip\\_Pelvis.pdf](http://www.acr.org/-/media/ACR/Documents/PGTS/guidelines/MRI_Hip_Pelvis.pdf). Accessed June 9, 2017.
8. Starr V, Ha BY. Imaging update on developmental dysplasia of the hip with the role of MRI. *AJR Am J Roentgenol*. 2014;203(6):1324-1335. doi: 10.2214/AJR.13.12449.
9. Schwend RM, Shaw BA, Segal LS. Evaluation and treatment of developmental hip dysplasia in the newborn and infant. *Pediatr Clin North Am*. 2014;61(6):1095-1107. doi: 10.1016/j.pcl.2014.08.008. Epub 2014 Sep 18.
10. Clinical practice guideline: early detection of developmental dysplasia of the hip - committee on quality improvement, subcommittee on

- developmental dysplasia of the hip. *Pediatrics*. 2000;105(4 pt 1):896-905.
11. Chaudhry S, Phillips D, Feldman D. Legg-Calve-Perthes disease: an overview with recent literature. *Bull Hosp Jt Dis* (2013). 2014;72(1):18-27.
  12. Barker DJ, Hall AJ. The epidemiology of Perthes' disease. *Clin Orthop Relat Res*. 1986;(209):89-94.
  13. Dimeglio A, Canavese F. Imaging in Legg-Calve-Perthes disease. *Orthop Clin North Am*. 2011;42(3):297-302, v. doi: 10.1016/j.ocl.2011.04.003. Epub 2011 Jun 8.
  14. Dillman JR, Hernandez RJ. MRI of Legg-Calve-Perthes disease. *AJR Am J Roentgenol*. 2009;193(5):1394-1407. doi: 10.2214/AJR.09.2444.
  15. Joseph B, Price CT. Consensus statements on the management of Perthes disease. *Orthop Clin North Am*. 2011;42(3):437-440. doi: 10.1016/j.ocl.2011.05.001.
  16. Lehmann CL, Arons RR, Loder RT, Vitale MG. The epidemiology of slipped capital femoral epiphysis: an update. *J Pediatr Orthop*. 2006;26(3):286-290.
  17. Georgiadis AG, Zaltz I. Slipped capital femoral epiphysis: how to evaluate with a review and update of treatment. *Pediatr Clin North Am*. 2014;61(6):1119-1135. doi: 10.1016/j.pcl.2014.08.001. Epub 2014 Sep 26.
  18. Jarrett DY, Matheney T, Kleinman PK. Imaging SCFE: diagnosis, treatment and complications. *Pediatr Radiol*. 2013;43 Suppl 1:S71-82. doi: 10.1007/s00247-012-2577-x. Epub 2013 Mar 12.
  19. Pun S, Kumar D, Lane NE. Femoroacetabular impingement. *Arthritis Rheumatol*. 2015;67(1):17-27. doi: 10.1002/art.38887.
  20. Anderson SE, Siebenrock KA, Tannast M. Femoroacetabular impingement: evidence of an established hip abnormality. *Radiology*. 2010;257(1):8-13. doi: 10.1148/radiol.10091480.
  21. Domayer SE, Ziebarth K, Chan J, Bixby S, Mamisch TC, Kim YJ. Femoroacetabular cam-type impingement: diagnostic sensitivity and specificity of radiographic views compared to radial MRI. *Eur J Radiol*. 2011;80(3):805-810. doi: 10.1016/j.ejrad.2010.10.016. Epub 2010 Nov 11.
  22. Ganz R, Parvizi J, Beck M, Leunig M, Nötzli H, Siebenrock KA. Femoroacetabular impingement: a cause for osteoarthritis of the hip. *Clin Orthop Relat Res*. 2003;(417):112-120.
  23. Giori NJ, Trousdale RT. Acetabular retroversion is associated with osteoarthritis of the hip. *Clin Orthop Relat Res*. 2003;(417):263-269.
  24. Hack K, Di Primio G, Rakhrus K, Beaulé PE. Prevalence of cam-type femoroacetabular impingement morphology in asymptomatic volunteers. *J Bone Joint Surg Am*. 2010;92(14):2436-2444. doi: 10.2106/JBJS.J.01280.
  25. Jaberi FM, Parvizi J. Hip pain in young adults: femoroacetabular impingement. *J Arthroplasty*. 2007;22(7 Suppl 3):37-42.
  26. Jäger M, Wild A, Westhoff B, Krauspe R. Femoroacetabular impingement caused by a femoral osseous head-neck bump deformity: clinical, radiological, and experimental results. *J Orthop Sci*. 2004;9(3):256-263.
  27. Kassarjian A, Brisson M, Palmer WE. Femoroacetabular impingement. *Eur J Radiol*. 2007;63(1):29-35. Epub 2007 May 7.
  28. Parvizi J, Leunig M, Ganz R. Femoroacetabular impingement. *J Am Acad Orthop Surg*. 2007;15(9):561-570.
  29. Pulido L, Parvizi J. Femoroacetabular impingement. *Semin Musculoskelet Radiol*. 2007;11(1):66-72.
  30. Sankar WN, Nevitt M, Parvizi J, Felson DT, Agricola R, Leunig M. Femoroacetabular impingement: defining the condition and its role in the pathophysiology of osteoarthritis. *J Am Acad Orthop Surg*. 2013;21 Suppl 1:S7-S15. doi: 10.5435/JAAOS-21-07-S7.
  31. Clohisy JC, Baca G, Beaulé PE, et al. Descriptive epidemiology of femoroacetabular impingement: a North American cohort of patients undergoing surgery. *Am J Sports Med*. 2013;41(6):1348-1356. doi: 10.1177/0363546513488861. Epub 2013 May 13.
  32. Frank JM, Harris JD, Erickson BJ, et al. Prevalence of femoroacetabular impingement imaging findings in asymptomatic volunteers: a systematic review. *Arthroscopy*. 2015;31(6):1199-1204. doi: 10.1016/j.arthro.2014.11.042. Epub 2015 Jan 28.
  33. Bedi A, Dolan M, Leunig M, Kelly BT. Static and dynamic mechanical causes of hip pain. *Arthroscopy*. 2011;27(2):235-251. doi: 10.1016/j.arthro.2010.07.022. Epub 2010 Oct 29.
  34. Sink EL, Gralla J, Ryba A, Dayton M. Clinical presentation of femoroacetabular impingement in adolescents. *J Pediatr Orthop*. 2008;28(8):806-811. doi: 10.1097/BPO.0b013e31818e194f.
  35. Clohisy JC, Knaus ER, Hunt DM, Lesher JM, Harris-Hayes M, Prather H. Clinical presentation of patients with symptomatic anterior hip impingement. *Clin Orthop Relat Res*. 2009;467(3):638-644. doi: 10.1007/s11999-008-0680-y. Epub 2009 Jan 7.
  36. Audenaert EA, Peeters I, Vigneron L, Baelde N, Pattyn C. Hip morphological characteristics and range of internal rotation in femoroacetabular impingement. *Am J Sports Med*. 2012;40(6):1329-1336. doi: 10.1177/0363546512441328. Epub 2012 Apr 2.
  37. Wyss TF, Clark JM, Weishaupt D, Nötzli HP. Correlation between internal rotation and bony anatomy in the hip. *Clin Orthop Relat Res*. 2007;460:152-158.
  38. Agricola R, Heijboer MP, Bierma-Zeinstra SM, Verhaar JA, Weinans H, Waarsing JH. Cam impingement causes osteoarthritis of the hip: a nationwide prospective cohort study (CHECK). *Ann Rheum Dis*. 2013;72(6):918-923. doi: 10.1136/annrheumdis-2012-201643. Epub 2012 Jun 23.
  39. Martin HD, Kelly BT, Leunig M, et al. The pattern and technique in the clinical evaluation of the adult hip: the common physical examination tests of hip specialists. *Arthroscopy*. 2010;26(2):161-172. doi: 10.1016/j.arthro.2009.07.015.
  40. Prather H, Harris-Hayes M, Hunt DM, Steger-May K, Mathew V, Clohisy JC. Reliability and agreement of hip range of motion and provocative physical examination tests in asymptomatic volunteers. *PM R*. 2010;2(10):888-895. doi: 10.1016/j.pmrj.2010.05.005.
  41. Meyer DC, Beck M, Ellis T, Ganz R, Leunig M. Comparison of six radiographic projections to assess femoral head/neck asphericity. *Clin Orthop Relat Res*. 2006;445:181-185.
  42. Nepple JJ, Martel JM, Kim YJ, Zaltz I, Clohisy JC, ANCHOR Study Group. Do plain radiographs correlate with CT for imaging of cam-type femoroacetabular impingement? *Clin Orthop Relat Res*. 2012;470(12):3313-3320. doi: 10.1007/s11999-012-2510-5.
  43. Nötzli HP, Wyss TF, Stoecklin CH, Schmid MR, Treiber K, Hodler J. The contour of the femoral head-neck junction as a predictor for the risk of anterior impingement. *J Bone Joint Surg Br*. 2002;84(4):556-560.
  44. Gosvig KK, Jacobsen S, Palm H, Sonne-Holm S, Magnusson E. A new radiological index for assessing asphericity of the femoral head in cam impingement. *J Bone Joint Surg Br*. 2007;89(10):1309-1316.
  45. Fraitzl CR, Kappe T, Pennekamp F, Reichel H, Billich C. Femoral head-neck offset measurements in 339 subjects: distribution and implications for femoroacetabular impingement. *Knee Surg Sports Traumatol Arthros*. 2013;21(5):1212-1217. doi: 10.1007/s00167-012-2042-2. Epub 2012 May 19.
  46. Gosvig KK, Jacobsen S, Sonne-Holm S, Palm H, Troelsen A. Prevalence of malformations of the hip joint and their relationship to sex, groin pain, and risk of osteoarthritis: a population-based survey. *J Bone Joint Surg Am*. 2010;92(5):1162-1169. doi: 10.2106/JBJS.H.01674.
  47. Jung KA, Restrepo C, Hellman M, AbdelSalam H, Morrison W, Parvizi J. The prevalence of cam-type femoroacetabular deformity in asymptomatic adults. *J Bone Joint Surg Br*. 2011;93(10):1303-1307. doi: 10.1302/0301-620X.93B10.26433.
  48. Pollard TC, Villar RN, Norton MR, et al. Femoroacetabular impingement and classification of the cam deformity: the reference interval in normal hips. *Acta Orthop*. 2010;81(1):134-141. doi: 10.3109/17453671003619011.
  49. Beaulé PE, Hynes K, Parker G, Kemp KA. Can the alpha angle assessment of cam impingement predict acetabular cartilage delamination? *Clin Orthop Relat Res*. 2012;470(12):3361-3367. doi: 10.1007/s11999-012-2601-3.
  50. Kelly BT, Bedi A, Robertson CM, Dela Torre K, Giveans MR, Larson CM. Alterations in internal rotation and alpha angles are associated with arthroscopic cam decompression in the hip. *Am J Sports Med*. 2012;40(5):1107-1112. doi: 10.1177/0363546512437731. Epub 2012 Mar 5.

51. Larson CM, Sikka RS, Sardelli MC, et al. Increasing alpha angle is predictive of athletic-related "hip" and "groin" pain in collegiate National Football League prospects. *Arthroscopy*. 2013;29(3):405-410. doi: 10.1016/j.arthro.2012.10.024. Epub 2013 Jan 26.
52. Agricola R, Heijboer MP, Roze RH, et al. Pincer deformity does not lead to osteoarthritis of the hip whereas acetabular dysplasia does: acetabular coverage and development of osteoarthritis in a nationwide prospective cohort study (CHECK). *Osteoarthritis Cartilage*. 2013;21(10):1514-1521. doi: 10.1016/j.joca.2013.07.004. Epub 2013 Jul 9.
53. Wiberg G. Studies on dysplastic acetabula and congenital subluxation of the hip joint with special reference to the complication of osteo-arthritis. *Acta Chir Scand*. 1939;83:5-135.
54. Tonnis D. *Congenital Dysplasia and Dislocation of the Hip in Children and Adults*. New York, NY: Springer; 1987.
55. Smith TO, Hilton G, Toms AP, Donell ST, Hing CB. The diagnostic accuracy of acetabular labral tears using magnetic resonance imaging and magnetic resonance arthrography: a meta-analysis. *Eur Radiol*. 2011;21(4):863-874. doi: 10.1007/s00330-010-1956-7. Epub 2010 Sep 22.
56. Agten CA, Sutter R, Buck FM, Pfirrmann CW. Hip imaging in athletes: sports imaging series. *Radiology*. 2016;280(2):351-369. doi: 10.1148/radiol.2016151348.
57. Palisch A, Zoga AC, Meyers WC. Imaging of athletic pubalgia and core muscle injuries: clinical and therapeutic correlations. *Clin Sports Med*. 2013;32(3):427-447. doi: 10.1016/j.csm.2013.03.002. Epub 2013 May 8.
58. Bennell KL, Hunter DJ, Hinman RS. Management of osteoarthritis of the knee. *BMJ*. 2012;345:e4934.
59. Abhishek A, Doherty M. Diagnosis and clinical presentation of osteoarthritis. *Rheum Dis Clin North Am*. 2013;39(1):45-66. doi: 10.1016/j.rdc.2012.10.007.
60. American College of Radiology. Appropriateness Criteria for Nontraumatic Knee Pain. <https://acsearch.acr.org/docs/69432/> Narrative/. Accessed June 12, 2017.
61. Bachmann LM, Haberzeth S, Steurer J, ter Riet G. The accuracy of the Ottawa knee rule to rule out knee fractures: a systematic review. *Ann Intern Med*. 2004;140(2):121-124.
62. Stiell IG, Greenberg GH, Wells GA, et al. Prospective validation of a decision rule for the use of radiography in acute knee injuries. *JAMA*. 1996;275(8):611-615.
63. Seaberg DC, Jackson R. Clinical decision rule for knee radiographs. *Am J Emerg Med*. 1994;12(5):541-543.
64. Seaberg DC, Yealy DM, Lukens T, Auble T, Mathias S. Multicenter comparison of two clinical decision rules for the use of radiography in acute, high-risk knee injuries. *Ann Emerg Med*. 1998;32(1):8-13.
65. Investigators M. Knee and Full Limb Radiography Operations Manual. [http://most.ucsf.edu/docs/Radiography\\_v1.0pMay2009.pdf](http://most.ucsf.edu/docs/Radiography_v1.0pMay2009.pdf). Accessed 2009.
66. Investigators O. Radiographic Procedure Manual for Examinations of the Knee, Hand, Pelvis and Lower Limbs - Osteoarthritis Initiative: A Knee Health Study. 2006.
67. McKinnis LN. Radiologic Evaluation of the Knee. In: Wolf SL, eds. *Fundamentals of Musculoskeletal Imaging*. Philadelphia, PA: F.A. Davis Company; 2014.
68. Gholve PA, Scher DM, Khakhar S, Widmann RF, Green DW. Osgood Schlatter syndrome. *Curr Opin Pediatr*. 2007;19(1):44-50.
69. Flowers MJ, Bhadreshwar DR. Tibial tuberosity excision for symptomatic Osgood-Schlatter disease. *J Pediatr Orthop*. 1995;15(3):292-297.
70. Davis KW. Imaging pediatric sports injuries: lower extremity. *Radiol Clin North Am*. 2010;48(6):1213-1235. doi: 10.1016/j.rcl.2010.07.004.
71. Yen YM. Assessment and treatment of knee pain in the child and adolescent athlete. *Pediatr Clin North Am*. 2014;61(6):1155-1173. doi: 10.1016/j.pcl.2014.08.003. Epub 2014 Oct 23.
72. Samim M, Smitaman E, Lawrence D, Moukaddam H. MRI of anterior knee pain. *Skeletal Radiol*. 2014;43(7):875-893. doi: 10.1007/s00256-014-1816-7. Epub 2014 Jan 29.
73. Gottsegen CJ, Eyer BA, White EA, Learch TJ, Forrester D. Avulsion fractures of the knee: imaging findings and clinical significance. *Radiographics*. 2008;28(6):1755-1770. doi: 10.1148/rug.286085503.
74. Kocher MS, Tucker R, Ganley TJ, Flynn JM. Management of osteochondritis dissecans of the knee: current concepts review. *Am J Sports Med*. 2006;34(7):1181-1191.
75. LLopis E, Padrón M. Anterior knee pain. *Eur J Radiol*. 2007;62(1):27-43. Epub 2007 Mar 12.
76. Grando H, Chang EY, Chen KC, Chung CB. MR imaging of extrasynovial inflammation and impingement about the knee. *Magn Reson Imaging Clin N Am*. 2014;22(4):725-741. doi: 10.1016/j.mric.2014.07.011. Epub 2014 Nov 1.
77. Stubnings N, Smith T. Diagnostic test accuracy of clinical and radiological assessments for medial patella plica syndrome: a systematic review and meta-analysis. *Knee*. 2014;21(2):486-490. doi: 10.1016/j.knee.2013.11.001. Epub 2013 Nov 13.
78. Paczesny L, Kruczynski J. Medial plica syndrome of the knee: diagnosis with dynamic sonography. *Radiology*. 2009;251(2):439-446. doi: 10.1148/radiol.2512081652. Epub 2009 Mar 10.
79. Kim SJ, Lee DH, Kim TE. The relationship between the MPP test and arthroscopically found medial patellar plica pathology. *Arthroscopy*. 2007;23(12):1303-1308.
80. Thomas S, Rupiper D, Stacy GS. Imaging of the patellofemoral joint. *Clin Sports Med*. 2014;33(3):413-436. doi: 10.1016/j.csm.2014.03.007. Epub 2014 May 24.
81. Diederichs G, Issever AS, Scheffler S. MR imaging of patellar instability: injury patterns and assessment of risk factors. *Radiographics*. 2010;30(4):961-981. doi: 10.1148/rug.304095755.
82. Dejour H, Walch G, Nove-Josserand L, Guier C. Factors of patellar instability: an anatomic radiographic study. *Knee Surg Sports Traumatol Arthrosc*. 1994;2(1):19-26.
83. Yablon CM, Pai D, Dong Q, Jacobson JA. Magnetic resonance imaging of the extensor mechanism. *Magn Reson Imaging Clin N Am*. 2014;22(4):601-620. doi: 10.1016/j.mric.2014.07.004. Epub 2014 Nov 1.
84. Rosas HG. Magnetic resonance imaging of the meniscus. *Magn Reson Imaging Clin N Am*. 2014;22(4):493-516. doi: 10.1016/j.mric.2014.07.002. Epub 2014 Nov 1.
85. Wise JN, Daffner RH, Weissman BN, et al. ACR Appropriateness Criteria® on acute shoulder pain. *J Am Coll Radiol*. 2011;8(9):602-609. doi: 10.1016/j.jacr.2011.05.008.
86. Beggs I. Shoulder ultrasound. *Semin Ultrasound CT MR*. 2011;32(2):101-113. doi: 10.1053/j.sult.2010.10.003.
87. Le Coroller T, Cohen M, Aswad R, Pauly V, Champsaur P. Sonography of the painful shoulder: role of the operator's experience. *Skeletal Radiol*. 2008;37(11):979-986. doi: 10.1007/s00256-008-0539-z. Epub 2008 Jul 24.
88. Sanders TG, Jersey SL. Conventional radiography of the shoulder. *Semin Roentgenol*. 2005;40(3):207-222.
89. Silfverskiöld JP, Straehley DJ, Jones WW. Roentgenographic evaluation of suspected shoulder dislocation: a prospective study comparing the axillary view and the scapular "Y" view. *Orthopedics*. 1990;13(1):63-69.
90. Rubin SA, Gray RL, Green WR. The scapular "Y": a diagnostic aid in shoulder trauma. *Radiology*. 1974;110:725-726.
91. Chandnani VP, Yeager TD, DeBerardinis T, et al. Glenoid labral tears: prospective evaluation with MRI imaging, MR arthrography, and CT arthrography. *AJR Am J Roentgenol*. 1993;161(6):1229-1235.
92. Probyn LJ, White LM, Salonen DC, Tomlinson G, Boynton EL. Recurrent symptoms after shoulder instability repair: direct MR arthrographic assessment--correlation with second-look surgical evaluation. *Radiology*. 2007;245(3):814-823. Epub 2007 Oct 19.
93. Neer CS, 2nd. Displaced proximal humeral fractures. I. Classification and evaluation. *J Bone Joint Surg Am*. 1970;52(1):1077-1089.
94. Neer CS, 2nd. Displaced proximal humeral fractures. II. Treatment of three-part and four-part displacement. *J Bone Joint Surg Am*. 1970;52(1):1090-1103.
95. Kristiansen B, Andersen UL, Olsen CA, Varmarken JE. The Neer classification of fractures of the proximal humerus. An assessment of interobserver variation. *Skeletal Radiol*. 1988;17(6):420-422.
96. Berkes MB, Dines JS, Little MT, et al. The impact of three-dimensional CT imaging on intraobserver and interobserver reliability of proximal humeral fracture classifications and treatment recommendations. *J Bone Joint Surg Am*. 2014;96(15):1281-1286.

97. Wohlwend JR, van Holsbeeck M, Craig J, et al. The association between irregular greater tuberosities and rotator cuff tears: a sonographic study. *AJR Am J Roentgenol.* 1998;171(1):229-233.
98. Goutallier D, Le Guilloux P, Postel JM, Radier C, Bernageau J, Zilber S. Acromio humeral distance less than six millimeter: its meaning in full-thickness rotator cuff tear. *Orthop Traumatol Surg Res.* 2011;97(3):246-251. doi: 10.1016/j.otsr.2011.01.010. Epub 2011 Apr 1.
99. Kreitner KF, Loew R, Runkel M, Zollner J, Thelen M. Low-field MR arthrography of the shoulder joint: technique, indications, and clinical results. *Eur Radiol.* 2003;13(2):320-329. Epub 2002 Aug 28.
100. Magee T, Williams D. 3.0-T MRI of the supraspinatus tendon. *AJR Am J Roentgenol.* 2006;187(4):881-886.
101. Magee TH, Williams D. Sensitivity and specificity in detection of labral tears with 3.0-T MRI of the shoulder. *AJR Am J Roentgenol.* 2006;187(6):1448-1452.
102. Merl T, Scholz M, Gerhardt P, et al. Results of a prospective multicenter study for evaluation of the diagnostic quality of an open whole-body low-field MRI unit. A comparison with high-field MRI measured by the applicable gold standard. *Eur J Radiol.* 1999;30(1):43-53.
103. Patten RM, Spear RP, Richardson ML. Diagnostic performance of magnetic resonance imaging for the diagnosis of rotator cuff tears using supplemental images in the oblique sagittal plane. *Invest Radiol.* 1994;29(1):87-93.
104. Epstein RE, Schweitzer ME, Frieman BG, Fenlin JM Jr, Mitchell DG. Hooked acromion: prevalence on MR images of painful shoulders. *Radiology.* 1993;187(2):479-481.
105. Morag Y, Jacobson JA, Shields G, et al. MR arthrography of rotator interval, long head of the biceps brachii, and biceps pulley of the shoulder. *Radiology.* 2005;235(1):21-30. Epub 2005 Feb 16.
106. Thomazeau H, Boukobza E, Morcet N, Chaperon J, Langlais F. Prediction of rotator cuff repair results by magnetic resonance imaging. *Clin Orthop Relat Res.* 1997;(344):275-283.
107. Gusmer PB, Potter HG, Schatz JA, et al. Labral injuries: accuracy of detection with unenhanced MR imaging of the shoulder. *Radiology.* 1996;200(2):519-524.
108. Legan JM, Burkhard TK, Goff WB 2nd, et al. Tears of the glenoid labrum: MR imaging of 88 arthroscopically confirmed cases. *Radiology.* 1991;179(1):241-246.
109. Spritzer CE, Collins AJ, Cooperman A, Speer KP. Assessment of instability of the long head of the biceps tendon by MRI. *Skeletal Radiol.* 2001;30(4):199-207.
110. Fuchs B, Weishaupt D, Zanetti M, Hodler J, Gerber C. Fatty degeneration of the muscles of the rotator cuff: assessment by computed tomography versus magnetic resonance imaging. *J Shoulder Elbow Surg.* 1999;8(6):599-605.
111. Thomazeau H, Rolland Y, Lucas C, Duval JM, Langlais F. Atrophy of the supraspinatus belly. Assessment by MRI in 55 patients with rotator cuff pathology. *Acta Orthop Scand.* 1996;67(3):264-268.
112. Zanetti M, Gerber C, Hodler J. Quantitative assessment of the muscles of the rotator cuff with magnetic resonance imaging. *Invest Radiol.* 1998;33(3):163-170.
113. Quinn SF, Sheley RC, Demlow TA, Szumowski J. Rotator cuff tendon tears: evaluation with fat-suppressed MR imaging with arthroscopic correlation in 100 patients. *Radiology.* 1995;195(2):497-500.
114. Singson RD, Hoang T, Dan S, Friedman M. MR evaluation of rotator cuff pathology using T2-weighted fast spin-echo technique with and without fat suppression. *AJR Am J Roentgenol.* 1996;166(5):1061-1065.
115. Ellman H. Diagnosis and treatment of incomplete rotator cuff tears. *Clin Orthop Relat Res.* 1990;(254):64-74.
116. Cofield RH. Rotator cuff disease of the shoulder. *J Bone Joint Surg Am.* 1985;67(6):974-979.
117. Gladstone JN, Bishop JY, Lo IK, Flatow EL. Fatty infiltration and atrophy of the rotator cuff do not improve after rotator cuff repair and correlate with poor functional outcome. *Am J Sports Med.* 2007;35(5):719-728. Epub 2007 Mar 2.
118. Goutallier D, Postel JM, Gleyze P, Leguilloux P, Van Driessche S. Influence of cuff muscle fatty degeneration on anatomic and functional outcomes after simple suture of full-thickness tears. *J Shoulder Elbow Surg.* 2003;12(6):550-554.
119. Goutallier D, Postel JM, Bernageau J, Lavau L, Voisin MC. Fatty muscle degeneration in cuff ruptures. Pre- and postoperative evaluation by CT scan. *Clin Orthop Relat Res.* 1994;(304):78-83.
120. Nazarian LN, Jacobson JA, Benson CB, et al. Imaging algorithms for evaluating suspected rotator cuff disease: Society of Radiologists in Ultrasound consensus conference statement. *Radiology.* 2013;267(2):589-595. doi: 10.1148/radiol.13121947. Epub 2013 Feb 11.
121. Erickson SJ. High-resolution imaging of the musculoskeletal system. *Radiology.* 1997;205(3):593-618.
122. Teeffey SA, Rubin DA, Middleton WD, Hildebolt CF, Leibold RA, Yamaguchi K. Detection and quantification of rotator cuff tears. Comparison of ultrasonographic, magnetic resonance imaging, and arthroscopic findings in seventy-one consecutive cases. *J Bone Joint Surg Am.* 2004;86-A(4):708-716.
123. Middleton WD, Payne WT, Teeffey SA, Hildebolt CF, Rubin DA, Yamaguchi K. Sonography and MRI of the shoulder: comparison of patient satisfaction. *AJR Am J Roentgenol.* 2004;183(5):1449-1452.
124. Smith TO, Back T, Toms AP, Hing CB. Diagnostic accuracy of ultrasound for rotator cuff tears in adults: a systematic review and meta-analysis. *Clin Radiol.* 2011;66(11):1036-1048. doi: 10.1016/j.crad.2011.05.007. Epub 2011 Jul 6.
125. Roy JS, Braën C, Leblond J, et al. Diagnostic accuracy of ultrasonography, MRI and MR arthrography in the characterisation of rotator cuff disorders: a systematic review and meta-analysis. *Br J Sports Med.* 2015;49(20):1316-1328. doi: 10.1136/bjsports-2014-094148. Epub 2015 Feb 11.
126. Crass JR, Craig EV, Feinberg SB. The hyperextended internal rotation view in rotator cuff ultrasonography. *J Clin Ultrasound.* 1987;15(6):416-420.
127. Stiell IG, Greenberg GH, McKnight RD, Nair RC, McDowell I, Worthington JR. A study to develop clinical decision rules for the use of radiography in acute ankle injuries. *Ann Emerg Med.* 1992;21(4):384-390.
128. Bachmann LM, Kolb E, Koller MT, Steurer J, ter Riet G. Accuracy of Ottawa ankle rules to exclude fractures of the ankle and mid-foot: systematic review. *BMJ.* 2003;326(7386):417.
129. Gribble PA, Bleakley CM, Caulfield BM, et al. Evidence review for the 2016 International Ankle Consortium consensus statement on the prevalence, impact and long-term consequences of lateral ankle sprains. *Br J Sports Med.* 2016;50(24):1496-1505. doi: 10.1136/bjsports-2016-096189. Epub 2016 Jun
130. Mosher TJ, Kransdorf MJ, Adler R, et al. ACR Appropriateness Criteria acute trauma to the ankle. *J Am Coll Radiol.* 2015;12(3):221-227. doi: 10.1016/j.jacr.2014.11.015
131. Campbell SE, Warner M. MR imaging of ankle inversion injuries. *Magn Reson Imaging Clin N Am.* 2008;16(1):1-18, v. doi: 10.1016/j.mric.2008.02.001.
132. Thomas JL, Christensen JC, Kravitz SR, et al. The diagnosis and treatment of heel pain: a clinical practice guideline-revision 2010. *J Foot Ankle Surg.* 2010;49(3 Suppl):S1-19. doi: 10.1053/j.jfas.2010.01.001.
133. Joong MA, El-Khoury GY. Radiologic evaluation of chronic foot pain. *Am Fam Physician.* 2007;76(7):975-983.
134. Lawrence DA, Rolen MF, Morshed KA, Moukaddam H. MRI of heel pain. *AJR Am J Roentgenol.* 2013;200(4):845-855. doi: 10.2214/AJR.12.8824.
135. Rosenberg ZS, Beltran J, Bencardino JT. From the RSNA Refresher Courses. Radiological Society of North America. MR imaging of the ankle and foot. *Radiographics.* 2000;20 Spec No:S153-179.
136. Dimmick S, Linklater J. Ankle impingement syndromes. *Radiol Clin North Am.* 2013;51(3):479-510. doi: 10.1016/j.rcl.2012.11.005. Epub 2013 Feb 27.
137. Hopper MA, Robinson P. Ankle impingement syndromes. *Radiol Clin North Am.* 2008;46(6):957-971, v. doi: 10.1016/j.rcl.2008.08.001.
138. American College of Radiology. ACR Appropriateness Criteria® stress (fatigue/insufficiency) fracture, including sacrum, excluding other vertebrae. <https://www.guideline.gov/summaries/summary/32618?Accessed June 13, 2017>.

139. Hecht PJ, Lin TJ. Hallux valgus. *Med Clin North Am.* 2014;98(2):227-232. doi: 10.1016/j.mcna.2013.10.007. Epub 2013 Dec 8.
140. Keith MW, Masear V, Chung K, et al. Diagnosis of carpal tunnel syndrome. *J Am Acad Orthop Surg.* 2009;17(6):389-396.
141. Sucher BM, Schreiber AL. Carpal tunnel syndrome diagnosis. *Phys Med Rehabil Clin N Am.* 2014;25(2):229-247. doi: 10.1016/j.pmr.2014.01.004.
142. Ahn AK, Chang D, Plate AM. Triangular fibrocartilage complex tears: a review. *Bull NYU Hosp Jt Dis.* 2006;64(3-4):114-118.
143. Smith TO, Drew B, Toms AP, Jerosch-Herold C, Chojnowski AJ. Diagnostic accuracy of magnetic resonance imaging and magnetic resonance arthrography for triangular fibrocartilaginous complex injury: a systematic review and meta-analysis. *J Bone Joint Surg Am.* 2012;94(9):824-832. doi: 10.2106/JBJS.J.01775.
144. Haugen IK, Bøyesen P. Imaging modalities in hand osteoarthritis--and perspectives of conventional radiography, magnetic resonance imaging, and ultrasonography. *Arthritis Res Ther.* 2011;13(6):248. doi: 10.1186/ar3509. Epub 2011 Dec 13.