SUPPLEMENTARY MATERIAL

S1. Research questions

Making a diagnosis of rheumatoid arthritis

Q1- What is the evidence for the differential diagnostic value of individual imaging modalities for RA?

Q2- What is the evidence for the diagnostic value above clinical criteria of individual imaging modalities for RA

Detecting inflammation and damage

Q3- What is the evidence for the added value (sensitivity, specificity etc) of individual imaging modalities in detecting inflammation (synovitis, tenosynovitis, osteitis, bursitis, enthesitis) above clinical evaluation?

Q4- What is the evidence of the added value above clinical examination for the comparative value (sensitivity, specificity etc) of individual imaging modalities in detecting tissue damage (bone, cartilage, tendons, ligaments)?

Predicting prognosis in RA: Outcome

Q5- What is the evidence for the prognostic (prediction of outcome) value of individual imaging modalities for RA?

Q6- What is the evidence for the prognostic (prediction of outcome) value above other known prognostic markers of individual imaging modalities for RA?

(Outcome: activity, damage, Qol, HAQ, mortality, surgery, HE, cumulative/AUC/temporal change)

Predicting prognosis in RA: Response to treatment

Q7- What is the evidence for the prognostic (prediction of therapeutic response) value of individual imaging modalities for RA?

Q8- What is the evidence for the prognostic (prediction of therapeutic response) value above other known prognostic markers of individual imaging modalities for RA?
(Outcome: activity, damage, Qol, HAQ, mortality, surgery, HE, cumulative/AUC/temporal change)

Monitoring disease progression

Q9- When (time and under what clinical circumstances), where (which joints), how (modality specifics) and how often, and with what imaging modality should we monitor RA disease inflammation?

Q10- When (time and under what clinical circumstances), where (which joints), how (modality specifics) and how often, and with what imaging modality should we monitor RA disease damage?

Q11- When (time and under what clinical circumstances), where (which joints), how (modality specifics) how often, and with what imaging modality do we need to image the spine in RA?

Imaging in clinical remission

Q12- What is the relationship between individual imaging modalities and clinical remission in RA?

Q13- What is the impact with respect to outcome of imaging-detected inflammation /damage in the patient in clinical remission?

S2. Details of search strategy performed using EMBASE (1980 to June 2011); MEDLINE (1948 to June 2011); and the Cochrane Central Register of Controlled Trials (CENTRAL, The Cochrane Library, second quarter 2011) without language restrictions. The Cochrane Database of Systematic Reviews (CDSR) and the Database of Abstracts of Reviews of Effects (DARE) were also searched to ensure all potential studies were identified.

Search strategy, MEDLINE

1. exp arthritis, rheumatoid/
2. ((rheumat$ or reumat$) adj3 (arthrit$ or artrit$ or diseas$ or condition$ or nodule$)).tw.
3. 1 or 2
4. Diagnostic Imaging/
5. Radiography/
6. exp Magnetic Resonance Imaging/
7. magnetic resonance.tw.
8. mri$.tw.
9. exp Ultrasonography/
10. (ultrasonic adj (diagnos$ or tomography or imaging$)).tw.
11. echotomograph$.tw.
12. echograph$.tw.
13. ultrasonography$.tw.
14. ultrasound.tw.
15. sonograph$.tw.
16. exp Tomography, X-Ray Computed/
17. exp Contrast Media/
18. computed adj2 tomography.tw.
19. cat scan$.tw.
20. ct.tw.
21. X-Rays/
22. xray$.tw.

23. (roentgen adj ray$).tw.

24. Absorptiometry, Photon/

25. Absorptiometr$.tw.

26. ((dxa or dexa) adj scan$).tw.

27. radiogram$.tw.

28. dxr.tw.

29. Radionuclide Imaging/

30. (Scintigraph$ or scintiphotograph$).tw.

31. ((gamma camera or radionuclide) adj imag$).tw.

32. radioisotope scan$.tw.

33. Positron-Emission Tomography/

34. Positron emission tomograp$.tw.

35. pet scan$.tw.

36. or/4-35

37. 3 and 36

38. randomized controlled trial.pt.

39. controlled clinical trial.pt.

40. randomized.ab.

41. placebo.ab.

42. drug therapy.fs.

43. randomly.ab.

44. trial.ab.

45. groups.ab.

46. or/38-45

47. (animals not (humans and animals)).sh.

48. 46 not 47

49. 37 and 48

50. exp cohort studies/

51. cohort$.tw.

52. controlled clinical trial.pt.

53. epidemiologic methods/

54. limit 53 to yr=1966-1989

55. exp case-control studies/

56. (case$ and control$).tw.

57. or/50-52,54-56

58. 37 and 57

59. ("review" or "review academic" or "review tutorial").pt.

60. (medline or medlars or embase or pubmed).tw,sh.

61. (scisearch or psychinfo or psycinfo).tw,sh.

62. (psychlit or psyclit).tw,sh.

63. cinahl.tw,sh.

64. ((hand adj2 search$) or (manual$ adj2 search$)).tw,sh.

65. (electronic database$ or bibliographic database$ or computeri?ed database$ or online database$).tw,sh.

66. (pooling or pooled or mantel haenszel).tw,sh.

67. (retraction of publication or retracted publication).pt.

68. (peto or dersimonian or der simonian or fixed effect).tw,sh.

69. or/60-68

70. 59 and 69

71. meta-analysis.pt.

72. meta-analysis.sh.

73. (meta-analys$ or meta analys$ or metaanalys$).tw,sh.

74. (systematic$ adj5 review$).tw,sh.

75. (systematic$ adj5 overview$).tw,sh.

76. (quantitativ$ adj5 review$).tw,sh.

77. (quantitativ$ adj5 overview$).tw,sh.

78. (quantitativ$ adj5 synthesis$).tw,sh.

79. (methodologic$ adj5 review$).tw,sh.

80. (methodologic$ adj5 overview$).tw,sh.

81. (integrative research review$ or research integration).tw.

82. or/71-81

83. 37 and 82

84. limit 37 to "diagnosis (best balance of sensitivity and specificity)"

85. or/49,58,83-84

Search strategy, EMBASE

1. exp rheumatoid arthritis/

2. ((rheumat$ or reumat$) adj3 (arthrit$ or artrit$ or diseas$ or condition$ or nodule$)).tw.

3. 1 or 2

4. diagnostic imaging/

5. radiography/

6. exp nuclear magnetic resonance imaging/

7. magnetic resonance.tw.

8. mri$.tw.

9. exp echography/

10. (ultrasonic adj (diagnos$ or tomography or imaging$)).tw.

11. echotomograph$.tw.

12. echograph$.tw.

13. ultrasonography$.tw.

14. ultrasound.tw.

15. sonograph$.tw.

16. exp computer assisted tomography/

17. exp contrast medium/

18. (computed adj2 tomography).tw.

19. cat scan$.tw.

20. ct.tw.

21. X ray/

22. xray$.tw.

23. (roentgen adj ray$).tw.

24. photon absorptiometry/

25. Absorptiometr$.tw.

26. ((dxa or dexa) adj scan$).tw.

27. radiogram$.tw.

28. dxr.tw.

29. scintiscanning/

30. (Scintigraph$ or scintiphotograph$).tw.

31. ((gamma camera or radionuclide) adj imag$).tw.

32. radioisotope scan$.tw.

33. positron emission tomography/

34. Positron emission tomograp$.tw.

35. pet scan$.tw.

36. or/4-35

37. 3 and 36

38. (random$ or placebo$).ti,ab.

39. ((single$ or double$ or triple$ or treble$) and (blind$ or mask$)).ti,ab.

40. controlled clinical trial$.ti,ab.

41. RETRACTED ARTICLE/

42. or/38-41

43. (animal$ not human$).sh,hw.

44. 42 not 43

45. 37 and 44

46. exp cohort analysis/

47. exp longitudinal study/

48. exp prospective study/

49. exp follow up/

50. cohort$.tw.

51. exp case control study/

52. (case$ and control$).tw.

53. or/46-52

54. 37 and 53

55. exp review/

56. (literature adj3 review$).ti,ab.

57. exp meta analysis/

58. exp "Systematic Review"/

59. or/55-58

60. (medline or medlars or embase or pubmed or cinahl or amed or psychlit or psyclit or psychinfo or psycinfo or scisearch or cochrane).ti,ab.

61. RETRACTED ARTICLE/

62. 60 or 61

63. 59 and 62

64. (systematic$ adj2 (review$ or overview)).ti,ab.

65. (meta?anal$ or meta anal$ or meta-anal$ or metaanal$ or metanal$).ti,ab.

66. or/63-65

67. 37 and 66

68. limit 37 to "diagnosis (best balance of sensitivity and specificity)"

69. or/45,54,67-68

Search strategy, The Cochrane Library

#1 MeSH descriptor Arthritis, Rheumatoid explode all trees

#2 ((rheumat* or reumat*) near/3 (arthrit* or artrit* or diseas* or condition* or nodule*)):ti,ab

#3 (#1 OR #2)

#4 MeSH descriptor Diagnostic Imaging, this term only

#5 MeSH descriptor Radiography, this term only

#6 MeSH descriptor Magnetic Resonance Imaging explode all trees

#7 "magnetic resonance":ti,ab

#8 mri*:ti,ab

#9 MeSH descriptor Ultrasonography explode all trees

#10 (ultrasonic next (diagnos* or tomography or imaging*)):ti,ab

#11 echotomograph*:ti,ab

#12 echograph*:ti,ab

#13 ultrasonography:ti,ab

#14 ultrasound:ti,ab

#15 sonograph*:ti,ab

#16 MeSH descriptor Tomography, X-Ray Computed explode all trees

#17 MeSH descriptor Contrast Media explode all trees

#18 "computed tomography":ti,ab

#19 "Cat scan*":ti,ab

#20 ct:ti,ab

#21 MeSH descriptor X-Rays, this term only

#22 xray*:ti,ab

#23 (roentgen next ray*):ti,ab

#24 MeSH descriptor Absorptiometry, Photon, this term only

#25 Absorptiometr*:ti,ab

#26 ((dxa or dexa) next scan*):ti,ab

#27 radiogram*:ti,ab

#28 dxr:ti,ab

#29 MeSH descriptor Radionuclide Imaging, this term only

#30 (Scintigraph* or scintiphotograph*):ti,ab

#31 ((gamma camera or radionuclide) next imag*):ti,ab

#32 "radioisotope scan*":ti,ab

#33 MeSH descriptor Positron-Emission Tomography, this term only

#34 "Positron emission tomograp*":ti,ab

#35 "pet scan*":ti,ab

#36 (#4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 OR #21 OR #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35)

#37 (#3 AND #36)

Figure S3. Flowchart showing the literature search of 6888 articles, from which 346 articles were selected for detailed review; 199 articles met the inclusion criteria.

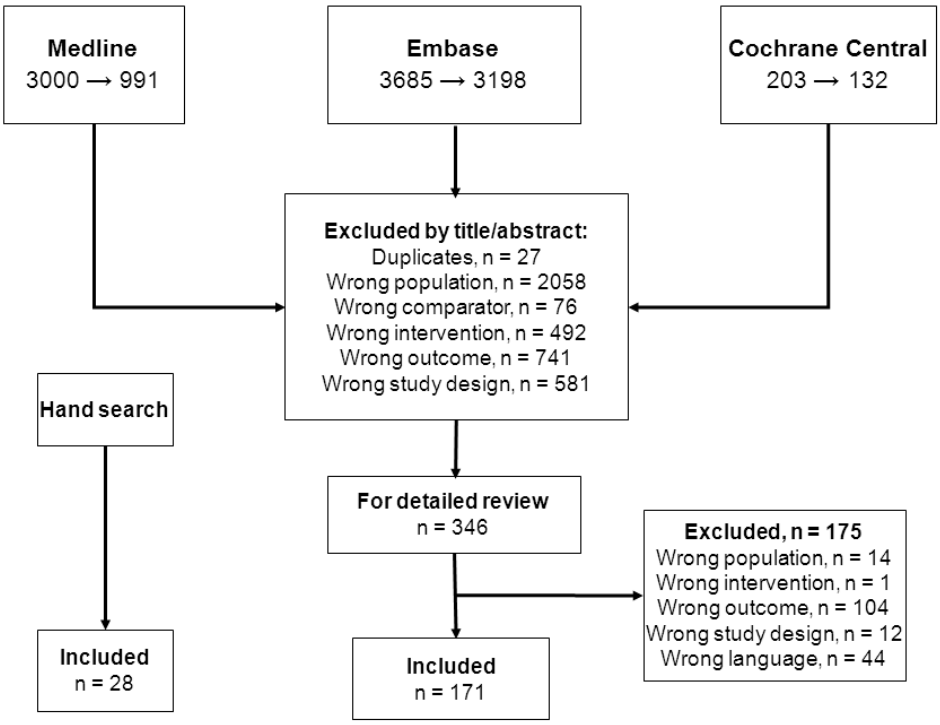

Table S4. Number of included articles per question

	Number of included articles
Q1- What is the evidence for the differential diagnostic value of individual imaging modalities for RA?	3
Q2- What is the evidence for the diagnostic value above clinical criteria of individual imaging modalities for RA?	15
Q3- What is the evidence for the added value (sensitivity , specificity etc) of individual imaging modalities in detecting inflammation (synovitis, tenosynovitis, osteitis, bursitis, enthesitis) above clinical evaluation?	51
Q4- What is the evidence of the added value above clinical examination for the comparative value (sensitivity, specificity etc) of individual imaging modalities in detecting tissue damage (bone, cartilage, tendons, ligaments)?	3
Q5- What is the evidence for the prognostic (prediction of outcome) value of individual imaging modalities for RA?	12
Q6- What is the evidence for the prognostic (prediction of outcome) value above other known prognostic markers of individual imaging modalities for RA?	38
Q7- What is the evidence for the prognostic (prediction of therapeutic response) value of individual imaging modalities for RA?	0
Q8- What is the evidence for the prognostic (prediction of therapeutic response) value above other known prognostic markers of individual imaging modalities for RA?	2
Q9- When (time and under what clinical circumstances), where (which joints), how (modality specifics) and how often, and with	23

what imaging modality should we monitor RA disease inflammation?	
Q10- When (time and under what clinical circumstances), where (which joints), how (modality specifics) and how often, and with what imaging modality should we monitor RA disease damage?	55
Q11- When (time and under what clinical circumstances), where (which joints), how (modality specifics) how often, and with what imaging modality do we need to image the spine in RA?	13
Q12- What is the relationship between individual imaging modalities and clinical remission in RA?	7
Q13- What is the impact with respect to outcome of imaging-detected inflammation /damage in the patient in clinical remission?	7

S5. Reference list of included articles per recommendation

Recommendation 1. (in patients with at least one joint with definite clinical synovitis)

When there is diagnostic doubt, conventional radiography, US or MRI can be used to improve the certainty of a diagnosis of RA above clinical criteria alone.

1. Agrawal S, Bhagat SS, Dasgupta B. Improvement in diagnosis and management of musculoskeletal conditions with one-stop clinic-based ultrasonography. *Mod Rheumatol* 2009;**19**:53-56.

2. Matsos MP, Khalidi N, Zia P, et al. Ultrasound of the hands and feet for rheumatological disorders: influence on clinical diagnostic confidence and patient management. *Skeletal Radiol* 2009;**38**:1049–1054.

3. Narváez J, Sirvent E, Narváez JA, et al. Usefulness of magnetic resonance imaging of the hand versus anticyclic citrullinated peptide antibody testing to confirm the diagnosis of clinically suspected early rheumatoid arthritis in the absence of rheumatoid factor and radiographic erosions. *Semin Arthritis Rheum* 2008;**38**:101-109.

4. Sugimoto H, Takeda A, Masuyama J, et al. Early-stage rheumatoid arthritis: diagnostic accuracy of MR imaging. *Radiology* 1996;**198**:185-192.

5. Sugimoto H, Takeda A, Hyodoh K. Early-stage rheumatoid arthritis: Prospective study of the effectiveness of MR imaging for diagnosis. *Radiology* 2000;**216**:569-575.

Recommendation 2. The presence of inflammation seen with US or MRI can be used to predict the progression to clinical RA from undifferentiated inflammatory arthritis

1. de Bois MHW, Arndt JW, Speyer I, et al. Technetium-99m labelled human immunoglobulin scintigraphy predicts rheumatoid arthritis in patients with arthralgia. *Scand **J** Rheumatol* 1996;**25**:155-158.

2. Duer A, Østergaard M, Hørslev-Petersen K, et al. Magnetic resonance imaging and bone scintigraphy in the differential diagnosis of unclassified arthritis. *Ann Rheum Dis* 2008;**67**;48-51.

3. Duer-Jensen A, Horslev-Petersen K, Hetland ML, et al. MRI bone edema is an independent predictor of development of rheumatoid arthritis in patients with early undifferentiated arthritis. *Arthritis Rheum* 2011;**63**:2192–2202.

4. Eshed I, Feist E, Althoff CE, et al. Tenosynovitis of the flexor tendons of the hand detected by MRI: an early indicator of rheumatoid arthritis *Rheumatology (Oxford)* 2009;**48**:887-891.

5. Filer A, De Pablo P, Allen G, et al. Utility of ultrasound joint counts in the prediction of rheumatoid arthritis in patients with very early synovitis. *Ann Rheum Dis* 2011;**70**:500-507.

6. Mori G, Tokunaga D, Takahashi KA, et al. Maximum intensity projection as a tool to diagnose early rheumatoid arthritis. *Mod Rheumatol* 2008;**18**:247–251.

7. Ozgul A, Yasar E, Arslan N, et al. The comparison of ultrasonographic and scintigraphic findings of early arthritis in revealing rheumatoid arthritis according to criteria of American College of Rheumatology. *Rheumatol Int* 2009;**29**:765–768.

8. Petre MA, Cheng CK, Boire G, et al. Prognostic value of patient history, radiography and serology on poor outcomes in undifferentiated inflammatory arthritis patients (abstract). *Arthritis Rheum* 2009;**60 Suppl 10**:1191.

9. Salaffi F, Ciapetti A, Gasparini S, et al. A clinical prediction rule combining routine assessment and power Doppler ultrasonography for predicting progression to rheumatoid arthritis from early-onset undifferentiated arthritis. *Clin Exp Rheumatol* 2010;**28**: 686-694.

10. Solou-Gervais E, Legrand J-L, Cortet B, et al. Magnetic resonance imaging of the hand for the diagnosis of rheumatoid arthritis in the absence of anti-cyclic citrullinated peptide antibodies: a prospective study. *J Rheumatol* 2006;**33**:1760–1765.

11. Tamai M, Kawakami A, Uetani M, et al. A prediction rule for disease outcome in patients with undifferentiated arthritis using magnetic resonance imaging of the wrists and finger joints and serologic autoantibodies. *Arthritis Rheum* 2009:**61**, No. 6;772–778.

12. Zhang L, Li J, He W, et al. The prediction and evaluation of the progression to rheumatoid arthritis in 157 patients with undifferentiated arthritis (abstract). *Int J Rheum Dis* 2010;**13 Suppl 1**:0908.

Recommendation 3. US and MRI are superior to clinical examination in the detection of joint inflammation; these techniques should be considered for more accurate assessment of inflammation

1. Andonopoulos AP, Yarmenitis S, Sfountouris H, et al. Baker's cyst in rheumatoid arthritis: an ultrasonographic study with a high resolution technique. *Clin Exp Rheumatol* 1995;**13**:633-636.

2. Bajaj S, Lopez-Ben R, Oster R, Alarcón GS. Ultrasound detects rapid progression of erosive disease in early rheumatoid arthritis: a prospective longitudinal study. *Skeletal Radiol* 2007;**36**:123–128.

3. Batalov A, Kuzmanova S, Atanasov. Ultrasound follow-up study of arthroscoped patients with gonitis. *Folia Medica* 1999;**41**:63-70.

4. Beckers C, Ribbens C, André B, et al. Assessment of disease activity in rheumatoid arthritis with ^{18}F-FDG PET. *J Nucl Med* 2004;**45**:956-964.

5. Calisir C, Murat Aynaci AI, Korkmaz C. The accuracy of magnetic resonance imaging of the hands and feet in the diagnosis of early rheumatoid arthritis. *Joint Bone Spine* 2007;**74**:362-7.

6. Carotti M, Salaffi F, Manganelli P, et al. Power Doppler sonography in the assessment of synovial tissue of the knee joint in rheumatoid arthritis: a preliminary experience. *Ann Rheum Dis* 2002;**61**:877-882.

7. Chávez-López MA, Naredo E, Acebes-Cachafeiro JC, et al. Diagnostic accuracy of physical examination of the knee in rheumatoid arthritis: Clinical and ultrasonographic study of joint effusion and Baker's cyst. *Reumatol Clin* 2007;**3**:98-100.

8. Cheung PP, Ruyssen-Witrand A, Gossec L, et al. Reliability of patient self-evaluation of swollen and tender joints in rheumatoid arthritis: a comparison study with ultrasonography, physician, and nurse assessments. *Arthritis Care Res* 2010;**62**:1112-1119.

9. Cindaş A, Gökçe-Kutsal Y, Özgen Kirth P, et al. Scintigraphic evaluation of synovial inflammation in rheumatoid arthritis with ^{99m}technetium-labelled human polyclonal immunoglobulin G. *Rheumatol Int* 2001;**20**:71-77.

10. Damjanov N, Radunović G, Prodanović S, et al. Construct validity and reliability of ultrasound disease activity score in assessing joint inflammation in RA: comparison with DAS-28. *Rheumatology (Oxford)* 2012;**51**:120-128.

11. de Bois MH, Tak PP, Arndt JW, et al. Joint scintigraphy for quantification of synovitis with ^{99m}Tc-labelled human immunoglobulin G compared to histological examination. *Clin Exp Rheumatol* 1995;**13**:155-159.

12. Emery P, van der Heijde D, Østergaard M, et al. Exploratory analyses of the association of MRI with clinical, laboratory and radiographic findings in patients with rheumatoid arthritis. *Ann Rheum Dis* 2011;**70**:2126–2130.

13. Filippucci E, Iagnocco A, Salaffi F, et al. Power Doppler sonography monitoring of synovial perfusion at the wrist joints in patients with rheumatoid arthritis treated with adalimumab. *Ann Rheum Dis* 2006;**65**:1433-1437.

14. Forslind K, Johanson A, Larsson EM et al. Magnetic resonance imaging of the fifth metatarsophalangeal joint compared with conventional radiography in patients with early rheumatoid arthritis. *Scand J Rheumatol* 2003;**32**:131-137.

15. Forslind K, Larsson EM, Eberhardt K, et al. Magnetic resonance imaging of the knee: a tool for prediction of joint damage in early rheumatoid arthritis? *Scand J Rheumatol* 2004;**33**:154–161.

16. Goerres GW, Forster A, Uebelhart D, et al. F-18 FDG whole-body PET for the assessment of disease activity in patients with rheumatoid arthritis. *Clin Nucl Med* 2006;**31**: 386–390.

17. Goupille P, Roulot B, Akoka S, et al. Magnetic resonance imaging: a valuable method for the detection of synovial inflammation in rheumatoid arthritis. *J Rheumatol* 2001;**28**:35-40.

18. Haavardsholm EA, Ostergaard M, Hammer HB, et al. Monitoring anti-TNF alpha treatment in rheumatoid arthritis: responsiveness of magnetic resonance imaging and ultrasonography of the dominant wrist joint compared with conventional measures of disease activity and structural damage. *Ann Rheum Dis* 2009;**68**:1572-1579.

19. Hammer HB, Sveinsson M, Kongtorp AK, et al. A 78-joints ultrasonographic assessment is associated with clinical assessments and is highly responsive to improvement in a longitudinal study of patients with rheumatoid arthritis starting adalimumab treatment. *Ann Rheum Dis* 2010;**69**:1349–1351.

20. Hmamouchi I, Bahiri R, Srifi N, et al. A comparison of ultrasound and clinical examination in the detection of flexor tenosynovitis in early arthritis. *BMC Musculoskelet Disord* 2011;**12**:91.

21. Horikoshi M, Suzuki T, Sugihara M, et al. Comparison of low-field dedicated extremity magnetic resonance imaging with articular ultrasonography in patients with rheumatoid arthritis. *Mod Rheumatol* 2010;**20**:556-560.

22. Jamar F, Manicourt D-H, Leners N, et al. Evaluation of disease activity in rheumatoid arthritis and other arthritides using ^{99m}technetium labelled nonspecific human immunoglobulin. *J Rheumatol* 1995;**22**:850-854.

23. Kane D, Balint PV, Sturrock RD, et al. Ultrasonography is superior to clinical examination in the detection and localization of knee joint effusion in rheumatoid arthritis. *J Rheumatol* 2003;**30**:966-971.

24. Kaya M, Tuna H, Fatih Firat M, et al. ^{99m}Tc-dextran scintigraphy to detect disease activity in patients with rheumatoid arthritis. *Nucl Med Commun* 2004;**25**:597–601.

25. Krejza J, Kuryliszyn-Moskal A, Sierakowski S, et al. Ultrasonography of the periarticular changes in patients with early active rheumatoid arthritis. *Med Sci Monit* 1998;**4**:366-369.

26. Luukkainen RK, Saltyshev M, Koski JM, et al. Relationship between clinically detected joint swelling and effusion diagnosed by ultrasonography in metatarsophalangeal and talocrural joints in patients with rheumatoid arthritis. *Clin Exp Rheumatol* 2003;**21**:632-634.

27. Luukainen R, Sanila MT, Saltyshev M, et al. Relationship between clinically detected joint swelling and effusion diagnosed by ultrasonography in elbow joints in patients with rheumatoid arthritis. *Clin Rheumatol* 2005;**24**:228–231.

28. Luukainen R, Sanila MT, Luukainen P. Poor relationship between joint swelling detected on physical examination and effusion diagnosed by ultrasonography in glenohumeral joints in patients with rheumatoid arthritis. *Clin Rheumatol* 2007;**26**:865–867.

29. Martins FPP, Gutfilen B, de Souza SAL, et al. Monitoring rheumatoid arthritis synovitis with ^{99m}Tc-anti-CD3. *B J Radiol* 2008;**81**:25–29.

30. Möttönen TT, Hannonen P, Toivanen J, et al. Scintigraphy of rheumatoid peripheral joints. Reliability of visual assessment vs. computerized methods. *Scand J Rheumatol* 1987;**16**:421-427.

31. Naredo E, Bonilla G, Gamero F, et al. Assessment of inflammatory activity in rheumatoid with grey scale and power Doppler ultrasonography arthritis: a comparative study of clinical evaluation. *Ann Rheum Dis* 2005;**64**;375-381.

32. Pons F, Moyá F, Herranz R, et al. Detection and quantitative analysis of joint activity inflammation with ^{99Tc}m-polyclonal human immunoglobulin G. *Nucl Med Commun* 1993;**14**:225-231.

33. Pons F, Sanmarti R, Herranz R, et al. Scintigraphic evaluation of the severity of inflammation of the joints with ^{99}Tc^{m}-HIG in rheumatoid arthritis. *Nucl Med Commun* 1996;**17**:523-528.

34. Remans J, Berghs H, Drieskens L, et al. Proximal interphalangeal arthroscintigraphy in rheumatoid arthritis. *Ann Rheum Dis* 1978;**37**:440-443.

35. Ribbens C, André B, Marcelis S, et al. Rheumatoid hand joint synovitis: gray-scale and power Doppler US quantifications following anti–tumor necrosis factor–α treatment: pilot study. *Radiology* 2003;**229**:562–569.

36. Riente L, Delle Sedie A, Filippucci E, et al. Ultrasound Imaging for the rheumatologist XXVII. Sonographic assessment of the knee in patients with rheumatoid arthritis. *Clin Exp Rheumatol* 2010;**28**:300-303.

37. Riente L, Delle Sedie A, Scirè CA et al. Ultrasound imaging for the rheumatologist. XXXI. Sonographic assessment of the foot in patients with rheumatoid arthritis. *Clin Exp Rheumatol* 2011;**29**:1-5.

38. Roimicher L, Lopes FPPL, de Souza SAL, et al. ^{99m}Tc-anti-TNF-α scintigraphy in RA: a comparison pilot study with MRI and clinical examination. *Rheumatology (Oxford)* 2011;**50**:2044-2050.

39. Salaffi F, Filippucci E, Carotti M, et al. Inter-observer agreement of standard joint counts in early rheumatoid arthritis: a comparison with grey scale ultrasonography - a preliminary study. *Rheumatology (Oxford)* 2008;**47**:54–58.

40. Sewell KL, Ruthazer R, Parker JA. The correlation of indium-111 joint scans with clinical synovitis in rheumatoid arthritis. *J Rheumatol* 1993;**20**:2015-2019.

41. Shmerling RH, Parker JA, Johns WD, et al. Measurement of joint inflammation in rheumatoid arthritis with indium-111 chloride. *Ann Rheum Dis* 1990;**49**: 88-92.

42. Spiegel TM, King W, Weiner SR, et al. Measuring disease activity: comparison of joint tenderness, swelling, and ultrasonography in rheumatoid arthritis. *Arthritis Rheum* 1987;**30**:1283-1288**.**

43. Szkudlarek M, Court-Payen M, Strandberg C, et al. Power Doppler ultrasonography for assessment of synovitis in the metacarpophalangeal joints of patients with rheumatoid arthritis: a comparison with dynamic magnetic resonance imaging. *Arthritis Rheum* 2001;**44**:2018-2023.

44. Szkudlarek M, Jensen K, Thomsen H, et al. Ultrasonography of the metacarpophalangeal and proximal interphalangeal joints in rheumatoid arthritis: a comparison with magnetic resonance imaging, conventional radiography and clinical examination. *Arthritis Res Ther* 2006;**8**:R52.

45. Tamai M, Kawakami A, Iwamoto N, et al. Comparative study of the detection of joint injury in early-stage rheumatoid arthritis by magnetic resonance imaging of the wrist and finger joints and physical examination. *Arthritis Care Res* 2011;**63**:436–439.

46. Tannenbaum H, Rosenthall L. A prospective study comparing the clinical examination

of peripheral joints with radionuclide scintigraphy in patients with rheumatoid arthritis. *Clin Exp Rheumatol* 1987;**5**:11-16.

47. Terslev L, von der Recke P, Savnik A, et al. Diagnostic sensitivity and specificity of Doppler ultrasound in rheumatoid arthritis. *J Rheumatol* 2008;**35**:49-53.

48. Tonolli-Serabian I, Poet JL, Dufour M, et al. Magnetic resonance imaging of the wrist in rheumatoid arthritis: comparison with other inflammatory joint diseases and control subjects. *Clin Rheumatol* 1996;**15**:137-142.

49. Wakefield RJ, Freeston JE, O'Connor P, et al. The optimal assessment of the rheumatoid arthritis hindfoot: a comparative study of clinical examination, ultrasound and high field MRI. *Ann Rheum Dis* 2008;**67**:1678-1682.

50. Weissberg DL, Resnick D, Taylor A, et al. Rheumatoid arthritis and its variants: analysis of scintiphotographic, radiographic, and clinical examinations. *Am J Roentgenol* 1978;**131**:665-673.

Recommendation 4. Conventional radiography of the hands and feet should be used as the initial imaging technique to detect damage. However, US and/or MRI should be considered if conventional radiographs do not show damage and may be used to detect damage at an earlier time point (especially in early RA)

1. Bayar N, Altan Kara S, Keles I, et al. Temporomandibular joint involvement in rheumatoid arthritis: a radiological and clinical study. *Cranio* 2002;**20**:105-110.

2. Forslind K, Johanson A, Larsson EM et al. Magnetic resonance imaging of the fifth metatarsophalangeal joint compared with conventional radiography in patients with early rheumatoid arthritis. *Scand J Rheumatol* 2003;**32**:131-137.

3. Forslind K, Larsson EM, Eberhardt K, et al. Magnetic resonance imaging of the knee: a tool for prediction of joint damage in early rheumatoid arthritis? *Scand J Rheumatol* 2004;**33**:154–161.

Recommendation 5. MRI bone oedema is a strong independent predictor of subsequent radiographic progression in early RA and should be considered for use as a prognostic indicator. Joint inflammation (synovitis) detected by MRI or US as well as joint damage detected by conventional radiographs, MRI or US can also be considered for the prediction of further joint damage

1. Bansbank N, Young A, Brennan A, et al. A prognostic model for functional outcome in early rheumatoid arthritis. *J Rheumatol* 2006;**33**:1503–10.

2. Benton N, Stewart N, Crabbe J, et al. MRI of the wrist in early rheumatoid arthritis can be used to predict functional outcome at 6 years. *Ann Rheum Dis* 2004;**63**;555-561.

3. Bøyesen P, Haavardsholm EA, Østergaard M, et al. MRI in early rheumatoid arthritis: Synovitis and bone marrow oedema are independent predictors of subsequent radiographic progression. *Ann Rheum Dis* 2011;**70**:428-433.

4. Bøyesen 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**:176-179.

5. Cavet G, Shen Y, Abraham S, et al. Predicting radiographic progression in rheumatoid arthritis with ultrasound and biomarkers (abstract). *Arthritis Rheum* 2009;**60 Suppl 10**:1464.

6. Conaghan PG, O'Connor P, McGonagle D, et al. Elucidation of the relationship between synovitis and bone damage: a randomized magnetic resonance imaging study of individual joints in patients with early rheumatoid arthritis. *Arthritis Rheum* 2003;**48**:64-71.

7. Coombe B, Dougados M, Goupille P, et al. Prognostic factors for radiographic damage in early rheumatoid arthritis: a multiparameter prospective study. *Arthritis Rheum* 2001;**44**:1736–1743.

8. Courvoisier N, Dougados M, Cantagrel A, et al. Prognostic factors of 10-year radiographic outcome in early rheumatoid arthritis: a prospective study. *Arthritis Res Ther* 2008;**10**:R106.

9. de Bois MH, Westedt ML, Arndt JW, et al. Value of ^{99m}Tc-IgG scintigraphy in the prediction of joint destruction in patients with rheumatoid arthritis of recent onset. *Rheumatol Int* 1995;**15**:155-158.

10. Dixey J, Solymossy C, Young A. Is it possible to predict radiological damage in early rheumatoid arthritis (RA)? A report on the occurrence, progression, and prognostic factors of radiological erosions over the first 3 years in 866 patients from the early RA study (ERAS). *J Rheumatol* 2004;**31**:48-54.

11. Dohn UM, Ejbjerg B, Boonen A, et al. No overall progression and occasional repair of erosions despite persistent inflammation in adalimumab-treated rheumatoid arthritis patients: Results from a longitudinal comparative MRI, ultrasonography, CT and radiography study. *Ann Rheum Dis* 2011;**70**:252-258.

12. Forslind K, Larsson EM, Eberhardt K, et al. Magnetic resonance imaging of the knee: a tool for prediction of joint damage in early rheumatoid arthritis? *Scand J Rheumatol* 2004;**33**:154–161.

13. Forslind K, Boonen A, Albertsson K, et al. Hand bone loss measured by digital X-ray radiogrammetry is a predictor of joint damage in early rheumatoid arthritis. *Scand J Rheumatol* 2009;**38**:431-438.

14. Gandjbakhch F, Foltz V, Mallet A, et al. Bone marrow oedema predicts structural progression in a 1-year follow-up of 85 patients with RA in remission or with low disease activity with low-field MRI. Ann Rheum Dis 2011;70:2159-2162.

15. Gossec L, Dougados M, Goupille P, et al. Prognostic factors for remission in early rheumatoid arthritis: a multiparameter prospective study. *Ann Rheum Dis* 2004;**63**:675–680.

16. Güler-Yüksel M, Klarenbeek NB, Yvonne PM Goekoop-Ruiterman YPM, et al. Accelerated hand bone mineral density loss is associated with progressive joint damage in hands and feet in recent-onset rheumatoid arthritis. *Arthritis Res Ther* 2010;**12**:R96.

17. Haavardsholm EA, Bøyesen P, Østergaard M, et al. Magnetic resonance imaging findings in 84 patients with early rheumatoid arthritis: Bone marrow oedema predicts erosive progression. *Ann Rheum Dis* 2008;**67**:794-800.

18. Hetland ML, Ejbjerg B, Hørslev-Petersen K, et al. MRI bone oedema is the strongest predictor of rheumatoid arthritis. Results from a 2-year randomised controlled trial (CIMESTRA). *Ann Rheum Dis* 2009;**68**;384-390.

19. Hetland ML, Stengaard-Pedersen K, Junker P, et al. Radiographic progression and remission rates in early rheumatoid arthritis – MRI bone oedema and anti-CCP predicted radiographic progression in the 5-year extension of the double-blind randomised CIMESTRA trial. *Ann Rheum Dis* 2010;**69**:1789–1795.

20. Hoff M, Haugeberg G, Ødegård S, et al. Cortical hand bone loss after 1 year in early rheumatoid arthritis predicts radiographic hand joint damage at 5-year and 10-year follow-up. *Ann Rheum Dis* 2009;**68**:324-329.

21. 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**:663-675.

22. Huang J, Stewart N, Crabbe J, et al. A 1-year follow-up study of dynamic magnetic resonance imaging in early rheumatoid arthritis reveals synovitis to be increased in shared epitope-positive patients and predictive of erosions at 1 year. *Rheumatology (Oxford)* 2000;**39**:407-416.

23. Kamishima T, Tanimura K, Shimizu M, et al. Monitoring anti-interleukin 6 receptor antibody treatment for rheumatoid arthritis by quantitative magnetic resonance

imaging of the hand and power Doppler ultrasonography of the finger. *Skeletal Radiol* 2011;**40**:745-755.

24. Kapetanovic MC, Lindqvist E, Algulin J, et al. Early changes in bone mineral density measured by digital X-ray radiogrammetry predict up to 20 years radiological outcome in rheumatoid arthritis. *Arthritis Res Ther* 2011;**13**:R31.

25. Lillegraven S, Bøyesen P, Berner Hammer H, et al. Tenosynovitis of the extensor carpi ulnaris tendon predicts erosive progression in early rheumatoid arthritis. *Ann Rheum Dis* 2011;**70**:2049-50.

26. Lindegaard HM, Vallø J, Hørslev-Petersen K, et al. Low-cost, low-field dedicated extremity magnetic resonance imaging in early rheumatoid arthritis: a 1-year follow-up study. *Ann Rheum Dis* 2006;**65**:1208-1212.

27. Markatseli TE, Voulgari PV, Alamanos Y, et al. Prognostic factors of radiological damage in rheumatoid arthritis: a 10-year retrospective study. *J Rheumatol* 2011;**38**:44–52.

28. McQueen F, Beckley V, Crabbe J, et al. Magnetic resonance imaging evidence of tendinopathy in early rheumatoid arthritis predicts tendon rupture at six years. *Arthritis Rheum* 2005;**52**:744-751.

29. McQueen FM, Benton N, Crabbe J, et al. Bone edema scored on magnetic resonance imaging scans of the dominant carpus at presentation predicts radiographic joint damage of the hands and feet six years later in patients with rheumatoid arthritis. *Arthritis Rheum* 2003;**48**:1814–1827.

30. McQueen FM, Benton N, Crabbe J, et al. What is the fate of erosions in early rheumatoid arthritis? Tracking individual lesions using χ rays and magnetic resonance imaging over the first two years of disease. *Ann Rheum Dis* 2001;**60**:859-868.

31. McQueen FM, Stewart N, Crabbe J, et al. Magnetic resonance imaging of the wrist in

early rheumatoid arthritis reveals progression of erosions despite clinical improvement. *Ann Rheum Dis* 1999;**8**:156-163.

32. Möttönen TT, Hannonen P, Toivanen J, et al. Value of joint scintigraphy in the prediction of erosiveness in early rheumatoid arthritis. *Ann Rheum Dis* 1988;**47**:183-189.

33. Mundwiler ML, Maranian P, Brown DH, et al. The utility of MRI in predicting radiographic erosions in the metatarsophalangeal joints of the rheumatoid foot: a prospective longitudinal cohort study. *Arthritis Res Ther* 2009;**11**:R94.

34. Naredo E, Möller I, Cruz A, et al. Power Doppler ultrasonographic monitoring of response to anti-tumor necrosis factor therapy in patients with rheumatoid arthritis. *Arthritis Rheum* 2008;**58**:2248-2256.

35. Naredo E, Collado P, Cruz A, et al. Longitudinal power doppler ultrasonographic assessment of joint inflammatory activity in early rheumatoid arthritis: predictive value in disease activity and radiologic progression. *Arthritis Rheum* 2007;**57**:116–124.

36. Ornbjerg LM, Østergaard M, Boyesen, P, et al. Predictors of radiographic joint destruction in rheumatoid arthritis patients during TNF-inhibitor treatment in clinical practice (abstract). *Arthritis Rheum* 2009;**60 Suppl 10**:1000.

37. Østergaard M, Duer A, Nielsen H, et al. Magnetic resonance imaging for accelerated assessment of drug effect and prediction of subsequent radiographic progression in rheumatoid arthritis: a study of patients receiving combined anakinra and methotrexate treatment. *Ann Rheum Dis* 2005;**64**:1503–1506.

38. Østergaard M, Hansen M, Stoltenberg M, et al. New radiographic bone erosions in the wrists of patients with rheumatoid arthritis are detectable with magnetic resonance imaging a median of two years earlier. *Arthritis Rheum* 2003;**48**:2128-2131.

39. Østergaard M, Hansen M, Stoltenberg M, et al. Magnetic resonance imaging–

determined synovial membrane volume as a marker of disease activity and a predictor of progressive joint destruction in the wrists of patients with rheumatoid arthritis. *Arthritis Rheum* 1999;**42**:918–929.

40. Palosaari K, Vuotila J, Takalo R, et al. Bone oedema predicts erosive progression on wrist MRI in early RA - a 2-yr observational MRI and NC scintigraphy study. *Rheumatology (Oxford)* 2006;**45**:1542-1548.

41. Pascual-Ramos V, Contreras-Yanñez I, Cabiedes-Contreras J, et al. Hypervascular synovitis and American College of Rheumatology classification criteria as predictors of radiographic damage in early rheumatoid arthritis. *Ultrasound Q* 2009;**25**:31-38.

42. Plant MJ, Saklatvala J, Borg, AA, et al. Measurement and prediction of radiological progression in early rheumatoid arthritis. *J Rheumatol* 1994;**21**:1808-1813.

43. Renesses S, González-Escribano MF, Fernández-Suárez A, et al. The value of HLA-DRB1 shared epitope, –308 tumor necrosis factor-α gene promoter polymorphism, rheumatoid factor, anti-citrullinated peptide antibodies, and early erosions for predicting radiological outcome in recent-onset rheumatoid arthritis. *J Rheumatol* 2009;**36**:1143–9.

44. Reynolds PPM, Heron C, Pilcher J, et al. Prediction of erosion progression using ultrasound in established rheumatoid arthritis: a 2-year follow-up study. *Skeletal Radiol* 2009;**38**:473–478.

45. Stewart A, Mackenzie LM, Black AJ, et al. Predicting erosive disease in rheumatoid arthritis. A longitudinal study of changes in bone density using digital X-ray radiogrammetry:a pilot study. *Rheumatology (Oxford)* 2004;**43**:1561–1564.

46. Tanaka N, Sakahashi H, Ishii S, et al. Synovial membrane enhancement and bone erosion by magnetic resonance imaging for prediction of radiologic progression in patients with early rheumatoid arthritis. *Rheumatol Int* 2005;**25**:103–107.

47. Taylor PC, Steuer A, Gruber J, et al. Comparison of ultrasonographic assessment of synovitis and joint vascularity with radiographic evaluation in a randomized, placebo-controlled study of infliximab therapy in early rheumatoid arthritis. *Arthritis Rheum* 2004;**50**:1107–1116.

48. Zhang J, Redden DT, McGwin G, et al. Generalized bone loss as a predictor of three-year radiographic damage in African American patients with recent-onset rheumatoid arthritis. *Arthritis Rheum* 2010;**62**:2219-2226.

Recommendation 6. Inflammation seen on imaging may be more predictive of a therapeutic response than clinical features of disease activity; imaging may be used to predict response to treatment

1. Ellegaard K, Christensen R, Torp-Pedersen S, et al. Ultrasound Doppler measurements predict success of treatment with anti-TNF-α drug in patients with rheumatoid arthritis: a prospective cohort study. *Rheumatology (Oxford)* 2011;**50**:506-512.

2. Elzinga EH, van der Laken CJ, Comans EFI, et al. ^{18}F-FDG PET as a tool to predict the clinical outcome of infliximab treatment of rheumatoid arthritis: an explorative study. *J Nucl Med* 2011;**52**:77–80.

Recommendation 7. Given the improved detection of inflammation by MRI and US than by clinical examination, they may be useful in monitoring disease activity

1. Bruyn GAW, Naredo E, Möller I, et al. Reliability of ultrasonography in detecting shoulder disease in patients with rheumatoid arthritis. Ann Rheum Dis 2009;68:357–361.

2. Calisir C, Murat Aynaci AI, Korkmaz C. The accuracy of magnetic resonance imaging of the hands and feet in the diagnosis of early rheumatoid arthritis. *Joint Bone Spine*

2007;**74**:362-7.

3. Ejbjerg BJ, Narvestad E, Jacobsen S, et al. Optimised, low cost, low field dedicated extremity MRI is highly specific and sensitive for synovitis and bone erosions in rheumatoid arthritis wrist and finger joints: Comparison with conventional high field MRI and radiography. *Ann Rheum Dis* 2005;**64**:1280-1287.

4. Freeston JE, Brown AK, Hensor EMA, et al. Extremity magnetic resonance imaging assessment of synovitis (without contrast) in rheumatoid arthritis may be less accurate than power Doppler ultrasound. *Ann Rheum Dis* 2008;**67**:1351.

5. Haavardsholm EA, Østergaard M, Ejbjerg BJ, et al. Reliability and sensitivity to change of the OMERACT rheumatoid arthritis magnetic resonance imaging score in a multireader, longitudinal setting. *Arthritis Rheum* 2005;**52**:3860-3867.

6. Haavardsholm EA, Ostergaard M, Hammer HB, et al. Monitoring anti-TNF alpha treatment in rheumatoid arthritis: responsiveness of magnetic resonance imaging and ultrasonography of the dominant wrist joint compared with conventional measures of disease activity and structural damage. *Ann Rheum Dis* 2009;**68**:1572-1579.

7. Hermann K-GA, Backhaus M, Schneider U, et al. Rheumatoid arthritis of the shoulder joint comparison of conventional radiography, ultrasound, and dynamic contrast-enhanced magnetic resonance imaging. *Arthritis Rheum* 2003;**48**:3338–3349.

8. Horikoshi M, Suzuki T, Sugihara M, et al. Comparison of low-field dedicated extremity magnetic resonance imaging with articular ultrasonography in patients with rheumatoid arthritis. *Mod Rheumatol* 2010;**20**:556-560.

9. 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**:663-675.

10. Klauser A, Demharter J, De Marchi A, et al. Contrast enhanced gray-scale

sonography in assessment of joint vascularity in rheumatoid arthritis: Results from the IACUS study group. *Eur Radiol* 2005;**15**:2404-2410.

11. Naredo E, Möller I, Cruz A, et al. Power Doppler ultrasonographic monitoring of response to anti-tumor necrosis factor therapy in patients with rheumatoid arthritis. *Arthritis Rheum* 2008;**58**:2248-2256.

12. Palosaari K, Vuotila J, Takalo R, et al. Contrast-enhanced dynamic and static MRI correlates with quantitative $^{99}Tc^{m}$-labelled nanocolloid scintigraphy. Study of early rheumatoid arthritis patients. *Rheumatology (Oxford)* 2004;**43**:1364-1373.

13. Scheel AK, Hermann K-GA, Kahler E, et al. A novel ultrasonographic synovitis scoring system suitable for analyzing finger joint inflammation in rheumatoid arthritis. *Arthritis Rheum* 2005;**52**:733–743.

14. Schirmer C, Scheel AK, Althoff CE, et al. Diagnostic quality and scoring of synovitis, tenosynovitis and erosions in low-field MRI of patients with rheumatoid arthritis: A comparison with conventional MRI. *Ann Rheum Dis* 2007;**66**:522-529.

15. Szkudlarek M, Court-Payen M, Strandberg C, et al. Power Doppler ultrasonography for assessment of synovitis in the metacarpophalangeal joints of patients with rheumatoid arthritis: a comparison with dynamic magnetic resonance imaging. *Arthritis Rheum* 2001;**44**:2018-2023.

16. Szkudlarek M, Narvestad E, Klarlund, M et al. Ultrasonography of the metatarsophalangeal joints in rheumatoid arthritis: Comparison with magnetic resonance imaging, conventional radiography, and clinical examination. *Arthritis Rheum* 2004;**50**:2103-2112.

17. Szkudlarek M, Jensen K, Thomsen H, et al. Ultrasonography of the metacarpophalangeal and proximal interphalangeal joints in rheumatoid arthritis: a comparison with magnetic resonance imaging, conventional radiography and clinical examination. *Arthritis Res Ther* 2006;**8**:R52.

18. 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**:937–943.

19. Terslev L, von der Recke P, Savnik A, et al. Diagnostic sensitivity and specificity of Doppler ultrasound in rheumatoid arthritis. *J Rheumatol* 2008;**35**:49-53.

20. Wakefield RJ, O'Connor PJ, Conaghan PG, et al. Finger tendon disease in untreated early rheumatoid arthritis: a comparison of ultrasound and magnetic resonance imaging. *Arthritis Care Res* 2007;**57**:1158-1164.

21. Wakefield RJ, Freeston JE, O'Connor P, et al. The optimal assessment of the rheumatoid arthritis hindfoot: a comparative study of clinical examination, ultrasound and high field MRI. *Ann Rheum Dis* 2008;**67**:1678-1682.

22. Wamser G, Bohndorf K, Vollert K, et al. Power Doppler sonography with and without echo-enhancing contrast agent and contrast-enhanced MRI for the evaluation of rheumatoid arthritis of the shoulder joint: differentiation between synovitis and joint effusion. *Skeletal Radiol* 2003;**32**:351–359.

23. Ziswiler HR, Aeberli D, Villier PM, et al. High-resolution ultrasound confirms reduced synovial hyperplasia following rituximab treatment in rheumatoid arthritis. *Rheumatology (Oxford)* 2009;**48**:939-943.

Recommendation 8. The periodic evaluation of joint damage, usually by radiographs of the hands and feet, should be considered. MRI (and possibly US) is more responsive to change in joint damage and can be used to monitor disease progression

1. Alasaarela E, Suramo I, Tervonen O, et al. Evaluation of humeral head erosions in rheumatoid arthritis: a comparison of ultrasonography, magnetic resonance imaging, computed tomography and plain radiography. *Br J Rheumatol* 1998;**37**:1152-6.

2. Bajaj S, Lopez-Ben R, Oster R, Alarcón GS. Ultrasound detects rapid progression of erosive disease in early rheumatoid arthritis: a prospective longitudinal study. *Skeletal Radiol* 2007;**36**:123–128.

3. Beltran J, Caudill JL, Herman LA, et al. Rheumatoid Arthritis: MR imaging manifestations. *Radiology* 1987;**165**:153-157.

4. Bird P, Kirkham B, Portek I, et al. Documenting damage progression in a two-year longitudinal study of rheumatoid arthritis patients with established disease (the DAMAGE study cohort): is there an advantage in the use of magnetic resonance imaging as compared with plain radiography? *Arthritis Rheum* 2004;**50**:1383–1389.

5. Böttcher J, Pfeil A, Heinrich B, et al. Digital radiogrammetry as a new diagnostic tool for estimation of disease-related osteoporosis in rheumatoid arthritis compared with pQCT. *Rheumatol Int* 2005;**25**:457–464.

6. Böttcher J, Pfeil A, Mentzel H, et al. Peripheral bone status in rheumatoid arthritis evaluated by digital X-ray radiogrammetry and compared with multisite quantitative ultrasound. *Calcif Tissue Int* 2006;78:25-34.

7. Bruyn GAW, Naredo E, Möller I, et al. Reliability of ultrasonography in detecting shoulder disease in patients with rheumatoid arthritis. Ann Rheum Dis 2009;68:357–361.

8. Calisir C, Murat Aynaci AI, Korkmaz C. The accuracy of magnetic resonance imaging of the hands and feet in the diagnosis of early rheumatoid arthritis. *Joint Bone Spine* 2007;**74**:362-7.

9. Canella C, Philippe P, Pansini V, et al. Use of tomosynthesis for erosion evaluation in rheumatoid arthritic hands and wrists. *Radiology* 2010;**258**:199-205.

10. Ciechomska A, Andrysiak R, Serafin-Król M, et al. Ultrasonography, magnetic resonance imaging and conventional radiography of bone erosions in rheumatoid

arthritis - a comparative study. *Reumatologia* 2005;**43**:301-309.

11. Corvetta A, Giovagnoni A, Baldelli S, et al. MR imaging of rheumatoid hand lesions: comparison with conventional radiology in 31 patients. *Clin Exp Rheumatol* 1992;**10**:217-222.

12. Døhn UM, Ejbjerg BJ, Court-Payen M, et al. Are bone erosions detected by magnetic resonance imaging and ultrasonography true erosions? A comparison with computed tomography in rheumatoid arthritis metacarpophalangeal joints. *Arthritis Res Ther* 2006;**8**:R110.

13. Døhn UM, Ejbjerg BJ, Hasselquist M, et al. Rheumatoid arthritis bone erosion volumes on CT and MRI: reliability and correlations with erosion scores on CT, MRI and radiography. *Ann Rheum Dis* 2007;**66**:1388–1392.

14. Døhn 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**:R25.

15. Duer-Jensen A, Vestergaard A, Døhn UM, et al. Detection of rheumatoid arthritis bone erosions by two different dedicated extremity MRI units and conventional radiography. *Ann Rheum Dis* 2008;**67**:998-1003.

16. Dohn UM, Ejbjerg B, Boonen A, et al. No overall progression and occasional repair of erosions despite persistent inflammation in adalimumab-treated rheumatoid arthritis patients: Results from a longitudinal comparative MRI, ultrasonography, CT and radiography study. *Ann Rheum Dis* 2011;**70**:252-258.

17. Ejbjerg BJ, Narvestad E, Jacobsen S, et al. Optimised, low cost, low field dedicated extremity MRI is highly specific and sensitive for synovitis and bone erosions in rheumatoid arthritis wrist and finger joints: Comparison with conventional high field MRI and radiography. *Ann Rheum Dis* 2005;**64**:1280-1287.

18. Ejbjerg BJ, Vestergaard A, Jacobsen S, et al. The smallest detectable difference and sensitivity to change of magnetic resonance imaging and radiographic scoring of structural joint damage in rheumatoid arthritis finger, wrist, and toe joints a comparison of the OMERACT rheumatoid arthritis magnetic resonance imaging score applied to different joint combinations and the Sharp/van der Heijde radiographic score. *Arthritis Rheum* 2005;**52**:2300–2306.

19. Forslind K, Johanson A, Larsson EM et al. Magnetic resonance imaging of the fifth metatarsophalangeal joint compared with conventional radiography in patients with early rheumatoid arthritis. *Scand J Rheumatol* 2003;**32**:131-137.

20. Forslind K, Larsson EM, Eberhardt K, et al. Magnetic resonance imaging of the knee: a tool for prediction of joint damage in early rheumatoid arthritis? *Scand J Rheumatol* 2004;**33**:154–161.

21. Freeston JE, Conaghan PG, Dass S, et al. Does extremity-MRI improve erosion detection in severely damaged joints? A study of long-standing rheumatoid arthritis using three imaging modalities. *Ann Rheum Dis* 2007;**66**:1538-1540.

22. Gaylis NB, Needell SD, Rudensky D, et al. Comparison of in-office magnetic resonance imaging versus conventional radiography in detecting changes in erosions after one year of infliximab therapy in patients with rheumatoid arthritis. *Mod Rheumatol* 2007;**17**:273-278.

23. Gill G, Chary-Valckenaere I, Sommier J-P, et al. Is ultrasonography a useful, reproducible and relevant tool to assess erosion progression in rheumatoid arthritis? (abstract). *Arthritis Rheum* 2009;**60 Suppl 10**:1455.

24. Haavardsholm EA, Østergaard M, Ejbjerg BJ, et al. Reliability and sensitivity to change of the OMERACT rheumatoid arthritis magnetic resonance imaging score in a multireader, longitudinal setting. *Arthritis Rheum* 2005;**52**:3860-3867.

25. Haugeberg G, Green MJ, Conaghan PG, et al. Hand bone densitometry: a more sensitive standard for the assessment of early bone damage in rheumatoid arthritis. *Ann Rheum Dis* 2007;**66**:1513–1517.

26. Hermann K-GA, Backhaus M, Schneider U, et al. Rheumatoid arthritis of the shoulder joint comparison of conventional radiography, ultrasound, and dynamic contrast-enhanced magnetic resonance imaging. *Arthritis Rheum* 2003;**48**:3338–3349.

27. Hoff M, Haugeberg G, Kvien TK. Hand bone loss as an outcome measure in established rheumatoid arthritis: 2-year observational study comparing cortical and total bone loss. Arthritis Res Ther 2007,**9**:R81.

28. 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**:663-675.

29. Jensen T, Klarlund M, Hansen M, et al. Bone loss in unclassified polyarthritis and early rheumatoid arthritis is better detected by digital x ray radiogrammetry than dual x ray absorptiometry: relationship with disease activity and radiographic outcome. *Ann Rheum Dis* 2004;**63**:15-22.

30. Jensen T, Hansen M, Jensen KE, et al. Comparison of dual X-ray absorptiometry (DXA), digital X-ray radiogrammetry (DXR), and conventional radiographs in the evaluation of osteoporosis and bone erosions in patients with rheumatoid arthritis. *Scand J Rheumatol* 2005;**34**:27–33.

31. Klocke R, Glew D, Cox N, et al. Sonographic erosions of the rheumatoid little toe. *Ann Rheum Dis* 2001;**60**:896.

32. Klarlund M, Østergaard M, Gideon P, et al. Wrist and finger joint MR imaging in rheumatoid arthritis. *Acta Radiol* 1999;**40**:400-409.

33. Lerch K, Borisch N, Paetzel C, et al. Sonographic evaluation of the elbow in

rheumatoid arthritis: a classification of joint destruction. *Ultrasound Med Biol* 2003;**29**:1131–1135.

34. Lillegraven S, Boyesen P, Østergaard M, et al. MRI and X-Ray measured changes in joint space narrowing are closely associated in early RA patients: a pilot study (abstract). *Arthritis Rheum* 2010;**62 Suppl 10**:132.

35. Lindqvist E, Jonsson K, Saxne T et al. Course of radiographic damage over 10 years in a cohort with early rheumatoid arthritis. *Ann Rheum Dis* 2003;**62**:611–616.

36. Lopez-Ben R, Bernreuter WK, Moreland LW, et al. Ultrasound detection of bone erosions in rheumatoid arthritis: a comparison to routine radiographs of the hands and feet. *Skeletal Radiol* 2004;**33**:80–84.

37. Magnani M, Salizzoni E, Mulè R, et al. Ultrasonography detection of early bone erosions in the metacarpophalangeal joints of patients with rheumatoid arthritis. *Clin Exp Rheumatol* 2004;**22**:743-748.

38. McQueen FM, Stewart N, Crabbe J, et al. Magnetic resonance imaging of the wrist in early rheumatoid arthritis reveals a high prevalence of erosions at four months after symptom onset. *Ann Rheum Dis* 1998;**57**:350-356.

39. Østergaard M, Hansen M, Stoltenberg M, et al. New radiographic bone erosions in the wrists of patients with rheumatoid arthritis are detectable with magnetic resonance imaging a median of two years earlier. *Arthritis Rheum* 2003;**48**:2128-2131.

40. Østergaard M, Døhn UM, Duer-Jensen A, et al. Patterns of magnetic resonance imaging bone erosion in rheumatoid arthritis — which bones are most frequently involved and show the most change? *J Rheumatol* 2011;**38**:2014–17.

41. Paimela L, Laasonen L, Helve T, et al. Comparison of the original and the modified Larsen methods and the sharp method in scoring radiographic progression in early rheumatoid arthritis. *J Rheumatol* 1998;**25**:1063-1066.

42. Perry D, Stewart N, Benton N, et al. detection of erosions in the rheumatoid hand; a comparative study of multidetector computerized tomography versus magnetic resonance scanning. *J Rheumatol* 2005;**32**:256–67.

43. Poleksic L, Zdravkovic D, Jablanovic D, et al. Magnetic resonance imaging of bone destruction in rheumatoid arthritis: comparison with radiography. *Skeletal Radiol* 1993;**22**:577-580.

44. Rahmani M, Chegini H, Najafizadeh SR, et al. Detection of bone erosion in early rheumatoid arthritis: Ultrasonography and conventional radiography versus non-contrast magnetic resonance imaging. *Clinical Rheumatol* 2010;**29**:883-891.

45. Scheel AK, Hermann K-GA, Ohrndorf S, et al. Prospective 7 year follow up imaging study comparing radiography, ultrasonography, and magnetic resonance imaging in rheumatoid arthritis finger joints. *Ann Rheum Dis* 2006;**65**:595-600.

46. Schirmer C, Scheel AK, Althoff CE, et al. Diagnostic quality and scoring of synovitis, tenosynovitis and erosions in low-field MRI of patients with rheumatoid arthritis: A comparison with conventional MRI. *Ann Rheum Dis* 2007;**66**:522-529.

47. Sheane BJ, Beddy P, O'Connor M, et al. Targeted ultrasound of the fifth metatarsophalangeal joint in an early inflammatory arthritis cohort. *Arthritis Care Res* 2009;**61**:1004-1008.

48. Szkudlarek M, Narvestad E, Klarlund, M et al. Ultrasonography of the metatarsophalangeal joints in rheumatoid arthritis: Comparison with magnetic resonance imaging, conventional radiography, and clinical examination. *Arthritis Rheum* 2004;**50**:2103-2112.

49. Szkudlarek M, Jensen K, Thomsen H, et al. Ultrasonography of the metacarpophalangeal and proximal interphalangeal joints in rheumatoid arthritis: a comparison with magnetic resonance imaging, conventional radiography and clinical examination. *Arthritis Res Ther* 2006;**8**:R52.

50. Swen WAA, Jacobs JWG, Hubach, PCG, et al. Comparison of sonography and magnetic resonance imaging for the diagnosis of partial tears of finger extensor tendons in rheumatoid arthritis. *Rheumatology (Oxford)* 2000;**39**:55-62.

51. 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**:937–943.

52. Tonolli-Serabian I, Poet JL, Dufour M, et al. Magnetic resonance imaging of the wrist in rheumatoid arthritis: comparison with other inflammatory joint diseases and control subjects. *Clin Rheumatol* 1996;**15**:137-142.

53. Wakefield RJ, Gibbon WW, Conaghan PG, et al. The value of sonography in the detection of bone erosions in patients with rheumatoid arthritis: A comparison with conventional radiography. *Arthritis Rheum* 2000;**43**:2762-2770.

54. Weidekamm C, Køller M, Weber M, et al. Diagnostic value of high-resolution B-mode and Doppler sonography for imaging of hand and finger joints in rheumatoid arthritis. *Arthritis Rheum* 2003;**48**:325-333.

Recommendation 9. Monitoring of functional instability of the cervical spine by lateral radiograph obtained in flexion and neutral should be performed in patients with clinical suspicion of cervical involvement. When the radiograph is positive or specific neurological symptoms and signs are present, MRI should be performed

1. Fezoulidis I, Neuhold A, Wicke L, et al. Diagnostic imaging of the occipito-cervical junction in a patients with rheumatoid arthritis. *Eur J Radiol* 1989;**9**:5-11.

2. Jacobsen EA, Riise T. MRI of cervical spine with flexion and extension used in patients with rheumatoid arthritis. *Scand J Rheumatol* 2000;**29**:249-54.

3. Karhu JO, Parkkola RK, Koskinen SK. Evaluation of flexion/extension of the upper cervical spine in patients with rheumatoid arthritis: an MRI study with a dedicated

positioning device compared to conventional radiographs. *Acta Radiol* 2005;**46**:55-66.

4. Kauppi M, Neva MH. Sensitivity of lateral view cervical spine radiographs taken in the neutral position in atlantoaxial subluxation in rheumatic diseases. *Clin Rheumatol* 1998;**17**:511-514.

5. Oostveen JCM, Roozeboom AR, van de Laar MAFJ, et al. Functional turbo spin echo magnetic resonance imaging versus tomography for evaluating cervical spine involvement in rheumatoid arthritis. *Spine* 1998;**23**:1237-1244.

6. Reijnierse M, Breedveld FC, Kroon HM, et al. Are magnetic resonance flexion views useful in evaluating the cervical spine of patients with rheumatoid arthritis? *Skeletal Radiol* 2000;**29**:85–89.

7. Richards JS, Kerr GS, Nashel DJ. Odontoid erosions in rheumatoid arthritis: utility of the open mouth view. *J Clin Rheumatol* 2000;**6**:309-312.

8. Shimada H, Abematsu M, Ishiso Y, et al. Classification of odontoid destruction in patients with rheumatoid arthritis using reconstructed computed tomography: reference to vertical migration. *J Rheumatol* 2011;**38**:863–867.

9. Stiskal MA, Neuhold A, Szolar OH, et al. Rheumatoid arthritis of the craniocervical region by MR imaging: detection and characterization. *AJR Am J Roentgenol* 1995;**165**:585-592.

10. Younes M, Belghali S, Kriâa S, et al. Compared imaging of the rheumatoid cervical spine: prevalence study and associated factors. *Joint Bone Spine* 2009;**76**:361-368.

11. Yurube T, Sumi M, Nishida K, et al. Progression of cervical spine instabilities in rheumatoid arthritis: a prospective cohort study of outpatients over 5 years. *Spine* 2011;**36**:647–653.

12. Aisen AM, Martel W, Ellis JH, et al. Cervical spine involvement in rheumatoid arthritis: MR imaging. *Radiology* 1987;**165**:159-163.

13. Reijnierse M, Dijkmans BA, Hansen B, et al. Neurologic dysfunction in patients with rheumatoid arthritis of the cervical spine. Predictive value of clinical, radiographic and MR imaging parameters. *Eur Radiol* 2001;**11**:467-73.

Recommendation 10. MRI and US can detect inflammation that predicts subsequent joint damage, even when clinical remission is present and can be used to assess persistent inflammation

1. Brown AK, Quinn MA, Karim Z, et al. Presence of significant synovitis in rheumatoid arthritis patients with disease-modifying antirheumatic drug–induced clinical remission: evidence from an imaging study may explain structural progression. *Arthritis Rheum* 2006;**54**;3761–3773.

2. Brown AK, Conagham PG, Karim Z, et al. An explanation for the apparent dissociation between clinical remission and continued structural deterioration in rheumatoid arthritis. *Arthritis Rheum* 2008;**58**:2958–2967.

3. Cimmino MA, Innocenti S, Livrone F, et al. Dynamic gadolinium-enhanced magnetic resonance imaging of the wrist in patients with rheumatoid arthritis can discriminate active from inactive disease. *Arthritis Rheum* 2003;**48**:1207–1213.

4. Gandjbakhch F, Conaghan PG, Ejbjerg B, et al. Synovitis and osteitis are very frequent in rheumatoid arthritis clinical remission: results from an MRI study of 294 patients in clinical remission or low disease activity state. *J Rheumatol* 2011;**38**:2039–44.

5. Lillegraven S, Prince FHM, Shadick NA, et al. Remission and radiographic outcome in rheumatoid arthritis: application of the 2011 ACR/EULAR remission criteria in an observational cohort. *Ann Rheum Dis* 2012;**71**:681-6.

6. Mäkinen H, Kautiainen H, Hannonen P, et al. Sustained remission and reduced radiographic progression with combination disease modifying antirheumatic drugs in early rheumatoid arthritis. *J Rheumatol* 2007;**34**:316–21.

7. Molenaar ETH, Voskuyl AE, Dinant HJ, et al. Progression of radiologic damage in patients with rheumatoid arthritis in clinical remission. *Arthritis Rheum* 2004;**50**:36–42.

8. Ozgocmen S, Ozdemir H, Kiris A, et al. Clinical evaluation and power Doppler sonography in rheumatoid arthritis: evidence for ongoing synovial inflammation in clinical remission. *South Med J* 2008;**101**:240-245.

9. Peluso G, Michelutti A, Bosello S, et al. Clinical and ultrasonographic remission determines different chances of relapse in early and long standing rheumatoid arthritis. *Ann Rheum Dis* 2011;**70**:172–175.

10. Saleem B, Brown AK, Keen H, et al. Should imaging be a component of rheumatoid arthritis remission criteria? A comparison between traditional and modified composite remission scores and imaging assessments. *Ann Rheum Dis* 2011;**70**:792–798.

11. Scirè CA, Montecucco C, Codullo V, et al. Ultrasonographic evaluation of joint involvement in early rheumatoid arthritis in clinical remission: power Doppler signal predicts short-term relapse. *Rheumatology (Oxford)* 2009;**48**:1092–1097.

12. Tishler M, Lysyy O, Levy O, et al. ^{99m}Tc-albumin nanocolloid joint scintigraphy in rheumatoid arthritis patients who are in clinical remission – is remission real? *Clin Exp Rheumatol* 2010;**28**:360-364.

13. Varsamidis K, Varsamidou E, Tjetjis V, et al. Doppler sonography in assessing disease activity in rheumatoid arthritis. *Ultrasound Med Biol* 2005;**31**:739–743.

14. Wakefield RJ, Freeston JE, Hensor EMA, et al. Delay in imaging versus clinical response: a rationale for prolonged treatment with anti–tumor necrosis factor medication in early rheumatoid arthritis**.** *Arthritis Rheum* 2007;**57**:1564–1567.