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Title

Utility of Magnetic Resonance Imaging (MRI) in Diagnosing and Monitoring Enthesitis in Patients with Spondyloarthritis: an OMERACT Systematic Literature Review

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None

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Running head

MRI enthesitis in SpA

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Abstract

Objectives: A systematic literature review was performed to document published MRI lesion definitions and scoring systems for enthesitis in SpA. **Methods:** PubMed, EMBase and Cochrane library databases were searched for original publications involving adult SpA patients undergoing MRI of axial/peripheral joints. Selected articles were assessed for quality using a standardised assessment tool and metric indices. **Results:** Considering the heterogeneous nature, quality and outcome measures of studies, statistical data pooling was considered inappropriate. A qualitative narrative of results was undertaken based on study designs. **Conclusions:** Lack of a comprehensive, validated score warrants additional research to develop an MRI enthesitis scoring system.

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Introduction

Enthesitis, inflammation at the insertion site of tendon, ligament or joint capsule into bone, is considered to be a key pathological feature in spondyloarthritis (SpA) and psoriatic arthritis (PsA). [1] Compared to conventional assessment of enthesitis using clinical scores, MRI detects both soft tissue and intra-osseous abnormalities in active enthesitis, potentially aiding early diagnosis and outcome measurement in SpA and PsA. [2] With the advent of treat-to-target concept and novel therapies, objective and sensitive monitoring of response of enthesitis to therapy is desirable, and a validated

MRI scoring system would be a useful adjunct to clinical practice as well as providing additional information as an outcome measure in clinical trials.

The Outcome Measures in Rheumatology (OMERACT) MRI in Inflammatory Arthritis Working Group undertook a systematic literature review (SLR) to describe the MRI variables, definitions and scoring systems used to diagnose and monitor enthesitis in SpA. We assessed the quality and reported psychometric qualities, including validity, reliability and responsiveness, of original publications, in order to understand if there were a need for a novel MRI scoring system for enthesitis in SpA. [3,4]

Methods

Selection criteria and search strategies: We searched Medline, EMBase and Cochrane Library databases from their inception till February 2018 for original publications involving adult patients (>18 years) with SpA in whom MRI of axial or peripheral joints had been performed using a high-field magnet (≥1.5T), to assess enthesitis. Exclusion criteria included studies on enthesitis related to other conditions including degenerative, trauma-related, and inflammatory diseases other than SpA. The search strategy was designed to select cross-sectional, case-control, randomised controlled and non-randomised studies in English language containing at least one term from each of the following search blocks: 1) Spondyloarthritis, spondylarthritis, psoriatic arthritis or ankylosing spondylitis. 2) Enthesopathy, enthesitis or enthesis. 3) Magnetic resonance imaging or MRI. The selected studies were evaluated for definitions of MRI enthesitis lesions, quality of studies using a standardised assessment tool and for their metric qualities.

Selection of studies and data extraction: Two reviewers (AJM and SK) independently selected the studies, systematically screened the titles and abstracts, applying inclusion and exclusion criteria. Selected articles were retrieved in full, and the same reviewers assessed each article for its eligibility. Disagreements between the reviewers on article selection were resolved by discussion. Data were extracted to a standardised form. Any discordance in opinion was resolved by consensus and involvement of a third reviewer (MØ). The data extraction sheet contained the following information: author, year of publication, study design, study population, number of participants, intervention, comparator, MRI field strength, sequences used, MRI sites used for evaluating enthesitis, definitions of MRI inflammatory and structural enthesitis, and scoring system used. (Table 1)

Quality assessment of selected studies: A standardised tool (Appendix) for assessment of quality of the analysed studies based on a set of 12 predefined criteria addressing the following components: study population, enthesitis imaging feature, outcome of interest, study design and analysis and data presentation, was developed and assessed in a binary mode (yes/no). Concepts from review of quality assessment tools in systematic reviews of observational studies were adapted for developing these criteria.[5] Quality was reported on a scale of 0-12, with higher scores indicating better quality. Included studies that scored <3 on the scale were excluded from the final analysis.

Psychometric properties of included studies: Each selected article was analysed and assessed in order to determine whether it satisfied certain aspects of validity. The following metric qualities were evaluated: face and content validity, construct validity, criterion validity and discriminant validity (reliability and responsiveness) (Table 2).

Statistical Analysis: Details of the studies were reported with descriptive statistics such as frequencies and percentages for categorical data and mean and SD for continuous data. Due to variability in studies, meta-analysis could not be performed.

Results

Literature search:

The study selection process is depicted in a PRISMA flow diagram (Figure 1).

Study characteristics: Attributes of the included studies are summarised in Table 1. The majority of included studies were of cross-sectional design (20; 51%).[2, 6-24] Eight case-control, [25-32] six cohort, [33-38] three randomized controlled trials, [39-41] and two other longitudinal studies. [42,43] were included. Study populations involved SpA in 22, AS in 7, PsA in 9 studies and chronic low back pain in 1 study. Totally, 1534 (range: 8 - 127) individuals in different groups were evaluated for MRI enthesitis in all the studies together. Peripheral enthesitis were evaluated in 24 (62%),[7,10,11,15-29,34,38] axial enthesitis in 8 studies,[6,8,12-14,,36,42,43] and enthesitis at both sites using whole body MRI in 7 studies.[2,9,30,33,37,40,41,] Both T1-weighted (T1w) and T2w fat suppressed or its comparable sequences were included in all the studies. Comparison with other methods of evaluating enthesitis (ultrasonography and clinical assessment) was described in 10 studies,[7,9-11,18,30-32,35,36,] while 5 studies compared different MRI sequences to assess enthesitis.[6,13,14,25,42] Only 4 studies compared efficacy of MRI against a gold standard.[11,13,35,42,]

Qualitative assessment of enthesitis at different regions was used in 82% of studies. Only eight studies mentioned a semi-quantitative or quantitative MRI scoring system.[2,14,16,17,19,25,39,40,] No studies described a validated, comprehensive MRI

scoring system measuring all the aspects of enthesitis in any region. The majority of studies defined inflammatory enthesitis as enhancement of ligaments, increased signal intensity, perientheseal increased signal intensity, adjacent bone marrow edema, soft tissue signal around ligaments or tendons, thickening of ligaments, capsulitis in sacroiliac joints, extracapsular soft tissue enhancement, Achilles tendon diameter of bone marrow edema, perientheseal fluid and/or tendinitis in T1w post-gadolinium or short tau inversion recovery (STIR) sequences. Entheseal structural damage defined by few studies include bone erosions, enthesophytes, focal signal intensity changes and calcaneal spur in T1w-sequences. [2,7,16,25,27-29,32]

Quality assessment of included studies: Quality scores assessed using a standardised tool are provided in Table 2. With one exception, all 38 studies met the minimal quality requirement score of 4. High quality scores (10-12) were present in only 2 studies,[2,40] while the remaining 36 studies had moderate quality scores (5-9).

Assessment of psychometric properties: Table 2 describes psychometric properties of the selected studies. Face validity was assessed in 33 (87%) studies; content validity in 19 (50%) studies, and construct validity of MRI as related to ultrasonography and clinical examination in 5 (13%) and 6 (16%) studies, respectively. Five studies reported construct validity of different MRI sequences in relation to each other. [6,13,14,25,42] Criterion validity of MRI in relation to histology was described only by Tan et al.[22] Reliability of MRI in detecting enthesitis using various scoring methods was reported by 26 (68%) studies in which images were evaluated by two independent readers who were blinded to clinical outcomes. Responsiveness of various MRI enthesitis scores was reported in 6 (18%) studies, of which three showed statistically significant changes ($p<0.05$). [37,40,41]

Discussion

Axial and peripheral enthesitis constitute a core feature of SpA and PsA. The OMERACT PsA core domain set includes enthesitis, which makes it mandatory to be assessed in all clinical trials and observational studies.[44] MRI allows sensitive assessment of enthesitis in clinical trials. We have critically evaluated the published literature for available methods of evaluating enthesitis using MRI in SpA and PsA patients, and we identified notable limitations regarding standardisation of MRI enthesitis definitions across studies and validity of available semi-quantitative scores as outcome measures. The findings suggest there is no currently available reliable and validated MRI scoring system for enthesitis. Many studies have included definitions of MRI lesions suggestive of enthesitis, [2,7,9,10,18,23,24,28,29,33,34,37,39,40]but definitions differ, hindering direct comparison of the available methods. A fifth of the selected studies described a semi-quantitative scoring system, albeit without standardisation and lack of internal validity, as all were developed based on expert opinion.

Poor content validity of reported scoring methods was another limitation of the literature. Most studies have focused on assessing inflammatory aspects of enthesitis, and not the structural variables which denote chronic, irreversible changes. MRI inflammatory lesions are amenable to change and responsive to therapy. Wide variation in the entheseal sites to be assessed adds to the challenge in standardisation. Lack of a standardised definition to define the borders of enthesitis makes it difficult to differentiate it from other inflammatory variables, like synovitis and tenosynovitis, thus increasing the variability of scores in each study.

Construct validity was evaluated in relation to ultrasonography and clinical examination. Most of the studies showed a poor correlation between MRI and ultrasonography. This again emphasises the lack of standardised definitions of MRI enthesitis lesions. Limited information exists regarding criterion validity as only one study which compared MRI with histology. Lack of significant responsiveness of available qualitative and semi-quantitative MRI enthesitis scores suggest limited utility as outcome measures in clinical trials.

The above-mentioned limitations and the lack of validated, generally accepted MRI enthesitis assessment systems warrant the development of a reliable and feasible MRI enthesitis scoring system, to increase the utility of MRI as an outcome measure in SpA and PsA clinical trials.

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References

1. Eshed I, Bollow M, McGonagle DG, Tan AL, Althoff CE, Asbach P, Hermann KG. MRI of enthesitis of the appendicular skeleton in sponydloarthritis. Ann Rheum Dis 2007;66:1553-59
2. Poggenborg RP, Eshed I, Østergaard M, Sørensen IJ, Møller JM, Madsen OR, Pedersen SJ. Enthesitis in patients with psoriatic arthritis, axial spondyloarthritis and healthy subjects assessed by 'head-to-toe' whole-body MRI and clinical examination. Ann Rheum Dis 2015;74:823-29
3. Boers M, Kirwan JR, Tugwell P, Beaton D, Bingham CO III, Conaghan PG, et al. The OMERACT Handbook. [Internet. Accessed May 17, 2017.] Available from: https://omeract.org/resources
4. Boers M, Kirwan JR, Wells G, Beaton D, Gossec L, d'Agostino MA, et al. Developing core outcome measurement sets for clinical trials: OMERACT filter 2.0. J Clin Epidemiol 2014;67:745-53
5. Downs SH, Black N. The feasibility of creating a checklist for the assessment of the methodological quality both of randomized and non-randomized studies for health care interventions. J Epidemiol Community Health 1998;52:377-84
6. Agten CA, Zubler V, Rosskopf AB, Weiss B, Pfirrmann CWA. Enthestis of lumbar spinal ligaments in clinically suspected spondyloarthritis: value of gadolium-enhanced MR images in comparison to STIR. Skeletal Radiol 2016;45:187-95
7. Maldonado RA, Ruta S, Valuntas ML, Garcia M. Ultrasonography assessment of heel entheses in patients with spondyloarthritis: a comparative study with magnetic resonance imaging and conventional radiography. Clin Rheumatol 2017;36:1811-17

8. Aivazoglou LU, Zotti OR, Pinheiro MM, Junior MRC, Puchnick A, Fernandes ADRC, et al. Topographic MRI evaluation of the sacroiliac joints in patients with axial spondyloarthritis. Rev Bras Rheumatol Engl Ed 2017;57:378-84
9. Althoff CE, Seiper J, Song I-H, Haibel H, Weiss A, Diekhoff T, et al. Active inflammation and structural change in early active axial spondyloarthritis as detected by whole-body MRI. Ann Rheum Dis 2013;72:967-73
10. Aydin SZ, Tan AL, Hodsgon R, Grainger A, Emery P, Wakefield RJ, McGonagle D. Comparison of ultrasonography and magnetic resonance imaging for the assessment of clinically defined knee enthesitis in spondyloarthritis. Clin Exp Rheumatol 2013;31:933-36
11. Braum LS, McGonagle D, Bruns A, Philipp S, Hermann S, Aupperle K, et al. Characterisation of hand small joints arthropathy using high-resolution MRI - Limited discrimination between osteoarthritis and psoriatic arthritis. Eur Radiol 2013;23:1686-93
12. Fournie B, Boutes A, Dromer C, Sixou L, Le Guennec P, Granel J, Railhac JJ. Prospective study of anterior chest wall involvement in ankylosing spondylitis and psoriatic arthritis. Rev Rheum (Engl Ed) 1997;64:22-25
13. Giraudo C, Magnaldi S, Weber M, Puchner A, Platzgummer H, Kainberger F, Schuller-Weidekamm C. Optimizing the MRI protocol of the sacroiliac joints in spondyloarthritis: which para-axial sequences should be used? Eur Radiol 2016;26:122-9
14. Maksymowicz H, Kowalewski K, Lubkowska K, Zolud W, Sasieadek M. Diagnostic value of gadolinium-enhanced MR imaging of active sacroiliitis in seronegative spondyloarthropathy. Pol J Radiol 2010;75:58-65

15. Marzo-Ortega H, Tanner SF, Rohdes LA, Tan AL, Conaghan PG, Hensor EMA, et al. Magnetic resonance imaging in the assessment of metacarpophalangeal joint disease in early psoriatic and rheumatoid arthritis. Scand J Rheumatol 2009;38:79-83
16. McGonagle D, Marzo-Ortega H, O'Connor P, Gibbon W, Pease C, Reece Richard, Emery P. The role of biomechanical factors and HLA-B27 in magnetic resonance imaging-determined bone changes in plantar fascia enthesopathy. Arthritis Rheum 2002;46:489-93
17. McQueen F, Lassere M, Bird P, Haavardshom EA, Peterfy C, Conaghan PG, et al. Developing a magnetic resonance imaging scoring system for peripheral psoriatic arthritis. J Rheum 2007;34:859-861
18. Olivieri I, Barozzi L, Padul A, de Matteis M, Pierro A, Cantini F, et al. Retrocalcaneal bursitis in spondyloarthropathy: Assessment by ultrasonography and magnetic resonance imaging. J Rheumatol 1998;25:1352-7
19. Olivieri I. Salvarani C, Cantini F, Scarano E, Padula A, Niccoli L, et al. Fast spin echo-T2-weighted sequences with fat saturation in dactylitis of spondyloarthritis. No evidence of entheseal involvement of the flexor digitorum tendons. Arthritis Rheumatol 2002;46:2964-67
20. Paramarta JE, van der Leij C, Gofita I, Yeremenko N, van de Sande MG, de Hair MJ, et al. Peripheral joint inflammation in early onset spondyloarthritis is not specifically related to enthesitis. Ann Rheum Dis 2014;73:735-40
21. Ramirez J, Pomes I, Sobrino-Guijarro B, Pomes J, Sanmarti R, Canete JD. Ultrasound evaluation of greater trochanter pain syndrome in patients with

spondyloarthritis: Are there any specific features? Rheumatol Int. 2014;34:947-52

22. Tan AL, Benjamin M, Toumi H, Grainger AJ, Tanner SF, Emery P, McGonagle D. The relationship between the extensor tendon enthesis and the nail in distal interphalangeal joint disease in psoriatic arthritis--aa high-resolution MRI and histological study. Rheumatology 2007;46:253-56
23. Tan AL, Fukuba E, Halliday NA, Tanner SF, Emery P, McGonagle D. High-resolution MRI assessment of dactylitis in psoriatic arthritis shows flexor tendon pulley and sheath-related enthesitis. Ann Rheum Dis 2015;74:185-89
24. Tan AL, Grainger AJ, Tanner SF, Emery P, McGonagle D. A high-resolution magnetic resonance imaging study of distal interphalangeal joint arthropathy in psoriatic arthritis and osteoarthritis: are they the same? Arthritis Rheum 2006;54:1328-33
25. Chen B, Zhao Y, Cheng X, Ma Y, Chang EY, Kavanaugh A, et al. Three-dimensional ultrashort echo time cones (3D UTE-Cones) magnetic resonance imaging of entheses and tendons. Magn Reson Imaging 2018;49:4-9
26. Emad Y, Ragab Y, Bassyouni I, Moawayh O, Fawzy M, Saad A, et al. Enthesitis and related changes in the knees in seronegative spondyloarthropathies and skin psoriasis: magnetic resonance imaging case-control study. J Rheumatol 2010;37:1709-17
27. Erdem CZ, Sarikaya S, Erdem LO, Ozdolap S, Gundogdu S. MR imaging features of foot involvement in ankylosing spondylitis. Eur J Radiol 2005;53:110-19
28. Feydy A, Lavie-Brion MC, Gossec L, Lavie F, Guerini H, Nguyen C, et al. Comparative study of MRI and power Doppler ultrasonography of the heel in

patients with spondyloarthritis with and without heel pain and in controls. Ann Rheum Dis 2012;71:498-503

29. Lambert RGW, Dhillon SS, Jhangri GS, Sacks J, Sacks H, Wong B, et al. High prevalence of symptomatic enthesopathy of the shoulder in ankylosing spondylitis: deltoid origin involvement constitutes a hallmark of disease. Arthritis Rheum (Arthritis Care Res) 2004;51:681-90
30. Weckbach S, Schewe S, Michaely HF, Steffinger D, Reiser MF, Glaser C. Whole-body MR imaging in psoriatic arthritis: additional value for therapeutic decision making. Eur J Radiol 2011;77:149-55
31. Wiell C, Szkudlarek M, Hasselquist M, Møller JM, Nørregaard J, Terslev L, Østergaard M. Power Doppler ultrasonography of painful Achilles tendons and entheses in patients with and without spondyloarthropathy - A comparison with clinical examination and contrast-enhanced MRI. Clin Rheumatol 2013;32:301-08
32. Wiell C, Szkudlarek M, Hasselquist M, Møller JM, Vestergaard A, Nørregaard J, Terslev L, Østergaard M. Ultrasonography, magnetic resonance imaging, radiography, and clinical assessment of inflammatory and destructive changes in fingers and toes of patients with psoriatic arthritis. Arthritis Res Ther 2007;9:R119
33. Althoff CE, Sieper J, Song I-H, Weiss A, Deikhoff T, Haibel H, Hamm B, Hermann KG. Comparison of clinical examination versus whole-body magnetic resonance imaging of enthesitis in patients with early axial spondyloarthritis during 3 years of continuous etanercept. J Rheumatol 2016;43:618-24

34. Eshed I, Althoff CE, Feist E, Minden K, Schink T, Hamm B, Hermann K-G. Magnetic resonance imaging of hindfoot involvement in patients with spondyloarthritides: comparison of low-field and high-field strength units. Eur J Radiol 2008;65:140-47
35. Godfrin B, Zabraniecki L, Lamboley V, Bertrand-Latour F, Sans N, Fournie B. Spondyloarthropathy with entheseal pain. A prospective study in 33 patients. Joint Bone Spine 2004;71:557-62
36. Zhen-Guo H, Xue-Zhe Z, Wen H, Guo-Chun W, Hui-Qiong Z, Xin L, et al. The application of MR imaging in the detection of hip involvement in patients with ankylosing spondylitis. Eur J Radiol 2013;82:1487-93
37. Karpitschka M, Godau-Kellner P, Kellner H, Horng A, Theisen D, Glaser C, et al. Assessment of therapeutic response in ankylosing spondylitis patients undergoing anti-tumour necrosis factor therapy by whole-body magnetic resonance imaging. Eur Radiol 2013;23:1773-84
38. Marzo-Ortega H, McGonagle D, O'Connor P, Emery P. Efficacy of etanercept in the treatment of the entheseal pathology in resistant spondyloarthropathy: a clinical and magnetic resonance imaging study. Arthritis Rheum 2001;44:2112-17
39. Dougados M, Combe B, Braun J, Landwew R, Sibilia J, Cantagrel A, et al. A randomised, multicentre, double-blind, placebo-controlled trial of etanercept in adults with refractory heel enthesitis in spondyloarthritis: the HEEL trial. Ann Rheum Dis 2010;69:1430-35
40. Krabbe S, Østergaard M, Eshsed I, Sørensen IJ, Jensen B, Møller JM, et al. Whole-body MRI in axial spondyloarthritis: Reduction of sacroiliac, spinal, and

entheseal inflammation in a placebo-controlled trial of adalimumab. J Rheumatol 2018;45:621-29

41. Song I-H, Hermann KG, Haibel H, Althoff CE, Listing J, Burmester GR, et al. Effects of etanercept versus sulfasalazine in early axial spondyloarthritis on active inflammatory lesions as detected by whole-body MRI (ESTHER): a 48-week randomised controlled trial. Ann Rheum Dis 2011;70:590-96
42. de Hooge M, van den Berg R, Navarro-Compan V, van Gaalen F, van der Heijde D, Huizinga T, et al. Magnetic resonance imaging of the sacroiliac joints in the early detection of spondyloarthritis: no added value of gadolinium compared with short tau inversion recovery sequence. Rheumatology 2013;52:1220-24
43. Tan AL, Marzo-Ortega H, O'Connor P, Fraser A, Emery P, McGonagle D. Efficacy of anakinra in active ankylosing spondylitis: a clinical and magnetic resonance imaging study. Ann Rheum Dis 2004;63:1041-45
44. Orbai A-M, de Wit M, Mease P, Duffin KC, Elmamoun M, Tilett W, et al. Updating the psoriatic arthritic core domain set: A report from the PsA workshop at OMERACT 2016. J Rheumatol 2017;44:1522-28