Novel Composite Radiographic Score for Longitudinal Observational Studies of Psoriatic Arthritis: A Proof-of-concept Study

William Tillett, Gavin Shaddick, Deepak Jadon, Graham Robinson, Eleanor Korendowych, and Neil McHugh

ABSTRACT. ***Objective.*** To devise a feasible composite radiographic score for use in observational studies of psoriatic arthritis (PsA).

Methods. Radiographs from 50 patients with PsA were evaluated with the PsA-modified Sharp, Sharp/van der Heijde (SvdH), and Ratingen scores. Data reductions were made to devise a concise score.

Results. The Reductive X-ray Score for Psoriatic Arthritis (ReXSPA) required the assessment of only 22 joints (117 points), including erosion, joint space narrowing, and osteoproliferation in the hands and feet. The ReXSPA accounted for 80% of change detected with the SvdH score.

Conclusion. We report a proof-of-concept radiographic score for observational studies derived though data reduction. (J Rheumatol First Release January 15 2016; doi:10.3899/jrheum.150114)

Key Indexing Terms:
PSORIATIC ARTHRITIS RADIOGRAPHY OUTCOME ASSESSMENT

The measurement of radiographic joint damage is highly valuable in characterizing disease severity, progression, and prognosis in longitudinal observational studies of psoriatic arthritis (PsA). An essential attribute of a scoring method for use in large longitudinal observational studies is that it can be applied feasibly, within the constraints of cost and time. Existing radiographic measures are time-consuming to perform, leading to limited data collection from existing longitudinal observational studies. Radiographic damage is frequently reported as the presence or absence of damage. The only radiographic measure currently used on a routine basis is the modified Steinbrocker global score[1]. In the modified Steinbrocker score, the radiographic features of soft tissue swelling, osteopenia, erosion, joint space narrowing (JSN), lysis, and ankylosis are combined into a single numeric value for each joint. Combining the radiographic features reduces the time taken to perform the score and has the added advantage of following the presumed but unproven order of radiographic progression. Composite scores have been developed for use in PsA, which require radiographic features to be assessed and scored separately for erosion and JSN [PsA-modified Sharp Score[2] and the Sharp/van der Heijde (SvdH) score[3]] or erosion and osteoproliferation (PsA Ratingen score[4]). We have previously reported a comparison of the feasibility, reliability, and sensitivity to change of these existing radiographic scores used in PsA[5]. The modified Sharp and SvdH methods were found to be the most reliable and sensitive to change, but took longer to perform. The modified Steinbrocker was the most feasible, taking about half the time to score, but lacking the sensitivity of the composite methods.

Our objective was to devise a more feasible composite radiographic score through a reductive analysis of existing composite scores for use in large longitudinal observational studies.

MATERIALS AND METHODS

We have previously reported the details of the patient selection, radiographic techniques, and scoring methods used in our study[5]. In brief, standard antero-posterior radiographs of the hands and forefeet from 50 patients with PsA were scored at 2 timepoints with each of the PsA-modified Sharp, SvdH, and Ratingen scores[1]. All selected patients fulfilled the Classification Criteria for Psoriatic Arthritis (CASPAR) criteria[6,7]. Radiographs were scored by the authors WT and DJ in known chronological order to optimize sensitivity to change, and because observational studies usually score radiographs in known order.

Statistical analysis was undertaken in the statistical package R (2014; www.R-project.org). Analysis was performed on cases that demonstrated

From the Royal National Hospital for Rheumatic Diseases; Department of Mathematics, University of Bath; Department of Pharmacy and Pharmacology, University of Bath; Department of Radiology, Royal United Hospital, Bath, UK.

Funded through an unrestricted grant from Abbvie Laboratories Ltd.

W. Tillett, BSc, MBChB, PhD, MRCP, Royal National Hospital for Rheumatic Diseases; G. Shaddick, MSc, PhD, Department of Mathematics, University of Bath; D. Jadon, MBBCh, MRCP, Royal National Hospital for Rheumatic Diseases; G. Robinson, MBBS, FRCR, Department of Radiology, Royal United Hospital; E. Korendowych, PhD, MRCP, Royal National Hospital for Rheumatic Diseases; N. McHugh, MB, ChB, MD, FRCP, Department of Pharmacy and Pharmacology, University of Bath.

Address correspondence to Dr. W. Tillett, Royal National Hospital for Rheumatic Diseases, Upper Borough Walls, Bath, BA11RL, UK. E-mail: w.tillett@nhs.net

Accepted for publication October 29, 2015.

Personal non-commercial use only. The Journal of Rheumatology Copyright © 2016. All rights reserved.

Downloaded on April 23, 2024 from www.jrheum.org

progressive disease of any radiographic feature during the followup period. The aim was to apply data reduction techniques to a dataset consisting of changes (progression) in each of the components of the radiographic scores. Subsets selection using simulated annealing based on principal components analysis[8] was used to find optimal subsets based on the r_m (multiple correlations) coefficient, a measure of the similarity between a reduced dataset and the original. The coefficient ranges from 0 to 1, with larger values indicating strong similarity and higher proportions of explained variation. The fewest number of variables that would give r_m > 0.9 was found. Initially, this was performed on the full dataset using all variables, from all scores, constrained only to make a symmetrical score. A second analysis had the additional constraint that scoring of erosion or joint narrowing had to be consistent within each of the scoring methods. Finally, the analysis was restricted to exclude small wrist joints because these were felt to be time-consuming to score and debatably, less clinically relevant. A number of candidate scoring systems fulfilling the specified criteria performed very similarly (r_m coefficients within 0.001). Choosing the final scoring system based on the best-performing one would have been arbitrary and instead we selected the most "clinically reasonable" scoring system. The performance of the finally derived novel score was assessed according to its ability to predict progression as measured by the PsA-modified Sharp, SvdH, and Ratingen scores.

RESULTS

The patients' mean age was 50.1 years, mean disease duration was 10.1 years, and mean followup was 2.1 years. Interrater and intrarater reliability were excellent for all methods (ICC > 0.89)[5]. Details on the radiographic damage of the cohort are included in Appendix 1. The first reduction (the full dataset, restricted only to be symmetrical) identified a score consisting of 24 variables. The second analysis (further restricted to only 1 method of JSN and erosion, excluding small wrist joints), as detailed above, identified 6 possible scores, of which the best are reported here (Table 1). The resulting Reductive X-ray Score for Psoriatic Arthritis (ReXSPA) requires the assessment of only 22 joints and a score out of 117 possible points. This is compared with 42 variables (168 points) for the modified Steinbrocker or 104 (528 points) for SvdH score. Within this dataset, the ReXSPA accounts for over 90% of the variance of the full dataset and has a sensitivity to change of 80% when detecting progression, as defined by the most sensitive method, the SvdH (Table 1).

Table 1. Correlation, sensitivity, and area under curve analyses of the novel ReXSPA score compared with existing methods. Sensitivity is defined as the ability to predict progression in a patient, defined as any recorded change in the given scoring system.

Score	Spearman Correlation Coefficient	Sensitivity
Any change, full dataset		0.77
SvdH	0.88	0.80
MSS	0.84	0.82
Ratingen	0.67	0.86
SvdH erosion	0.75	0.96
mSS erosion	0.73	0.96
Ratingen destruction	0.62	0.95
SvdH JSN	0.69	0.79
mSS JSN	0.69	0.84
Ratingen proliferation	0.54	0.86

ReXSPA: Reductive X-ray Score for Psoriatic Arthritis; SvdH: Sharp/van der Heijde method; mSS: modified Sharp score; JSN: joint space narrowing.

The joints included in the final selected model are illustrated in Figure 1, and scales for the measurements are shown in Table 2. Assessment of JSN and erosion was made using the scale from the SvdH score and osteoproliferation using the PsA Ratingen scale at the hands, wrist, and feet. Ankylosis was only scored in the SvdH JSN score.

DISCUSSION

We propose a novel composite radiographic score for longitudinal observational studies that is sensitive to change and includes 3 hallmark features of PsA: erosion, JSN, and osteoproliferation. This novel score requires fewer joints to be assessed than the other most commonly used score in observational studies, the PsA-modified Steinbrocker, while maintaining a similar sensitivity to change as the SvdH score.

Global scores are briefer and quicker to perform, but have the significant disadvantage of combining data into a single numeric value. Raw data on individual radiographic features (domains) are therefore not available for future subanalysis. In comparison, composite scores have the advantage of being more sensitive to change and able to preserve the data relating to specific radiographic features. For example, data may be required from existing cohorts for a genetic association study where specificity of joint damage is the most important attribute. A composite score allows for separate analysis of erosion, or in the case of the Ratingen score, osteoproliferation, the only radiographic feature sufficiently specific to PsA to be included in the ClASsification for Psoriatic ARthritis (CASPAR) criteria[6].

The ReXSPA is a tool proposed for observational cohorts to allow large-scale data collection. We believe that none of the existing scores are optimal for use in the observational setting. The modified Steinbrocker may be considered feasible (readily learned and applied in our dataset in a mean of 6.2 min), but it is not sufficiently sensitive to change, does not allow subanalysis of individual radiographic features, and does not include osteoproliferation and scores for osteopenia, which is both rare in PsA and prone to interrater variability[5]. The SvdH score is sensitive to change and readily learned, but takes more than twice as long to perform (mean of 14.4 min in our dataset), the difference between scoring nearly 10 films in an hour versus 4[5].

A strength of the approach we have taken in our present study is to allow the data (sensitivity to change) to determine the final score. However, we recognize that other approaches could have been taken. It could be possible to reduce an existing score; such an approach has been adopted with the Psoriatic Arthritis Impact of Disease score with 2 versions available, 9 and 12 domains[9]. The SvdH score may seem the most suitable method for this approach, but would not include

Personal non-commercial use only. The Journal of Rheumatology Copyright © 2016. All rights reserved.

Downloaded on April 23, 2024 from www.jrheum.org

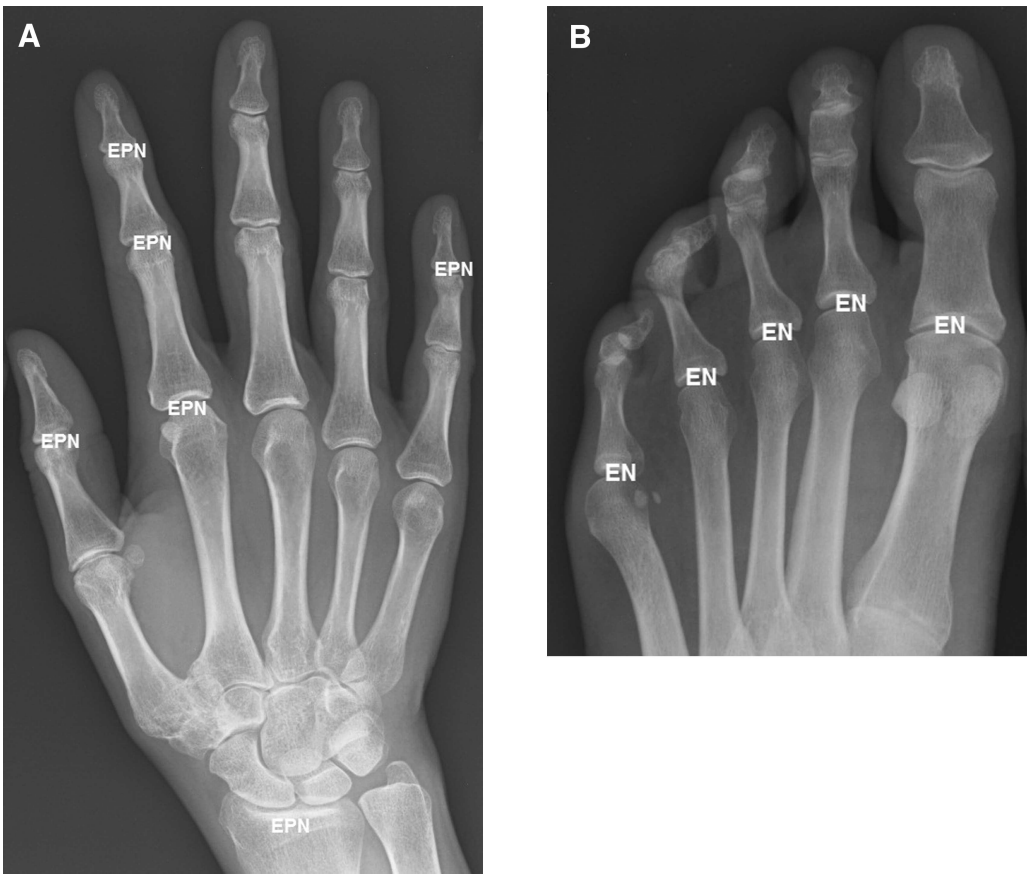

Figure 1. Joints assessed in the ReXSPA score. ReXSPA: The Reductive X-ray Score for Psoriatic Arthritis; E: erosion; P: osteoproliferation; N: joint space narrowing.

Table 2. ReXSPA scales.

Proliferation, from PsA Ratingen Score	Erosion, from Sharp/van der Heijde	Joint Space Narrowing, from Sharp/van der Heijde
0 = normal	0 = no erosions	0 = normal
1 = bony proliferation measured from the original bone surface of 1–2 mm, or clearly identifiable bone growth not exceeding 25% of the original diameter of the bone	1= discrete erosion	1 = asymmetrical minimal narrowing with loss of up to a maximum of 25%
2 = bony proliferation of 2–3 mm or bone growth between 25% to 50%	2 = large erosion not passing the midline	2 = definite narrowing with loss of up to 50% of the normal space
3 = bony proliferation > 3 mm or bone growth 50%	3 = large erosion passing the midline	3 = definite narrowing with loss of 50–99% of > the normal space or subluxation
	4 = combination of above	4 = absence of a joint space, presumptive evidence of ankylosis, or complete subluxation
	5 = combination of above	
Proliferation score/18 points Total score /117	Erosion score/55 points	JSN score/44 points

ReXSPA: Reductive X-ray Score for Psoriatic Arthritis; PsA: psoriatic arthritis; JSN: joint space narrowing.

osteoproliferation, which is specific to PsA and has been shown to be sensitive to change[5]. Alternatively, the Ratingen score does not include JSN, which is clinically relevant and sensitive to change. On this basis, we believe that using the full dataset of all variables (JSN, erosion, and osteoproliferation from all joints) with data-driven selection has justified our approach. Though our present study is large for a comparison of radiographic measures, the score has been

Personal non-commercial use only. The Journal of Rheumatology Copyright © 2016. All rights reserved.

Downloaded on April 23, 2024 from www.jrheum.org

derived from a small group of patients and needs to be applied in the clinical setting in a larger dataset. Further, the ReXSPA score remains a proposal derived from the existing dataset, and feasibility and reliability are yet to be formally determined. Finally, the radiographs were scored in known chronological order. While this is consistent with the intended clinical use in the observational setting (and optimizes sensitivity to change), the approach has the potential to introduce expectation bias.

We report a proof-of-concept radiographic score for observational studies in PsA derived though data reduction. The composite ReXSPA score has a similar sensitivity as the SvdH, the most sensitive method developed, but is briefer than the modified Steinbrocker, the most feasible method. This ReXSPA score can now be further assessed in larger studies.

ACKNOWLEDGMENT

We acknowledge contributions from Jana James (psoriatic arthritis research partner), Nicola Waldron (psoriatic arthritis nurse specialist), Charlotte Cavill (database manager), and Mandy Knight (database administrator).

REFERENCES

1. Rahman P, Gladman DD, Cook RJ, Zhou Y, Young G, Salonen D. Radiological assessment in psoriatic arthritis. Br J Rheumatol 1998;37:760-5.
2. Sharp JT, Bluhm GB, Brook A, Brower AC, Corbett M, Decker JL, et al. Reproducibility of multiple-observer scoring of radiologic abnormalities in the hands and wrists of patients with rheumatoid arthritis. Arthritis Rheum 1985;28:16-24.
3. van der Heijde D. How to read radiographs according to the Sharp/van der Heijde method. J Rheumatol 2000;27:261-3.
4. Wassenberg S, Fischer-Kahle V, Herborn G, Rau R. A method to score radiographic change in psoriatic arthritis. Z Rheumatol 2001;60:156-66.
5. Tillett W, Jadon D, Shaddick G, Robinson G, Sengupta R, Korendowych E, et al. Feasibility, reliability, and sensitivity to change of four radiographic scoring methods in patients with psoriatic arthritis. Arthritis Care Res 2014;66:311-7.
6. Taylor W, Gladman D, Helliwell P, Marchesoni A, Mease P, Mielants H; CASPAR Study Group. Classification criteria for psoriatic arthritis: development of new criteria from a large international study. Arthritis Rheum 2006;54:2665-73.
7. Tillett W, Costa L, Jadon D, Wallis D, Cavill C, McHugh J, et al. The ClASsification for Psoriatic ARthritis (CASPAR) criteria—a retrospective feasibility, sensitivity, and specificity study. J Rheumatol 2012;39:154-6.
8. Cadima J, Cerdeira JO, Minhoto M. Computational aspects of algorithms for variable selection in the context of principal components. Comput Stat Data Anal 2004;47:225-36.
9. Gossec L, de Wit M, Kiltz U, Braun J, Kalyoncu U, Scrivo R, et al. A patient-derived and patient-reported outcome measure for assessing psoriatic arthritis: elaboration and preliminary validation of the Psoriatic Arthritis Impact of Disease (PsAID) questionnaire, a 13-country EULAR initiative. Ann Rheum Dis 2014;73:1012-9.

APPENDIX 1. Patient characteristics. Values are mean (SD).

Variables	Baseline, 2 Yrs Prior to Anti-TNF
Age, yrs, n = 50	50.1 (12.06)
Disease duration, yrs, n = 34	10.1 (8.39)
Steinbrocker	15.4 (21.63)
Ratingen	13.2 (25.23)
Modified Sharp	26.3 (39.05)
Sharp/van der Heijde	26.8 (38.25)

Anti-TNF: antitumor necrosis factor.

Personal non-commercial use only. The Journal of Rheumatology Copyright © 2016. All rights reserved.

Downloaded on April 23, 2024 from www.jrheum.org

Correction

Novel Composite Radiographic Score for Longitudinal Observational Studies of Psoriatic Arthritis: A Proof-of-concept Study

Tillett W, Shaddick G, Jadon D, Robinson G, Korendowych E, McHugh N. Novel composite radiographic score for longitudinal observational studies of psoriatic arthritis: a proof-of-concept study. J Rheumatol 2016; doi:10.3899/jrheum.150114. In the print version of the article, and the PDF version (available online), the total possible number of points for the Reductive X-ray Score for Psoriatic Arthritis is incorrect. It should be 234. The change applies to the Abstract (under Results), in the first paragraph under Results in the text, and to the last row of Table 2.

These corrections have been made to the online version of the article.

doi:10.3899/jrheum.150114.C1