Improvement in deployment of MRI of the sacroiliac joints in patients suspected for spondyloarthritis using a targeted intervention: a case study

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Abstract

Objective. To assess characteristics of deployment of MRI of the SI joints (MR-SI) in patients with suspected axial spondyloarthritis (SpA) before and after a targeted intervention.

Methods. In a retrospective chart review study, all MR-SI performed in the period 1 April 2004 to 31 December 2010 were collected. Inclusion criteria were complete patient data and MR-SI ordered by a rheumatologist for suspicion of axial SpA. MR-SI reports were graded as normal, suspected sacroiliitis or sacroiliitis. In April 2007 an intervention was made to improve deployment. Rheumatologists were provided with data on ordering behaviour, patient characteristics and MRI outcomes. An introduction on the effect of pretest chance on positive and negative predictive value was given; the burden for patients and costs was illustrated. An alternative behavioural strategy was offered in the form of a simple diagnostic algorithm. Percentages of MRIs and positive MRI for sacroiliitis were compared before and after intervention.

Results. From April 2004 to April 2007, 198 MR-SIs were performed, of which 166 (83.9%) were normal, 5 (2.5%) were suspicious and 27 (13.6%) were positive. After the intervention, patients displayed significantly more SpA features. More optimal patient selection resulted in 79 MR-SI requests, a decrease of 60.1%. Fifty-seven (72.2%) reports were normal, 0 were suspicious and 22 (27.8%) were positive.

Conclusion. A simple, one-time, five-step feedback intervention resulted in a 60% reduction in MR-SI requests with a doubling of the percentage of MR-SI positive for sacroiliitis. This approach may benefit future research in areas with diagnostic uncertainty and suboptimal testing.

Key words: spondyloarthritis, sacroiliac joint, sacroiliitis, MRI, feedback, diagnosis, implementation research, cognitive bias.

Introduction

Sacroiliitis— inflammation of one or both SI joints — is characteristic of axial spondyloarthritis (SpA). Clinically, patients may present with inflammatory back pain and other SpA-related features. Nevertheless, there is no gold standard for early diagnosis of axial SpA. To overcome this problem, several classification criteria sets have been developed that combine clinical features of history and physical examination with blood tests, HLA-B27 typing and imaging [1, 2, 3]. To aid clinicians in making an early diagnosis, a diagnostic algorithm has been proposed [4]. The imaging part of the diagnostic workup for SpA consists of radiographs or MRI of the SI joints (MR-SI). Conventional radiography will only display structural changes of long-standing disease. Consequently it may be normal in the early stages and therefore less suitable for diagnosing early axial SpA. In contrast, MRI is able to visualize early, inflammatory and structural changes [5]. Indeed, it has been shown that the sensitivity and specificity of MR-SI are better than radiographs. Thus requesting an MR-SI might be a better option for the clinician in diagnosing early axial SpA.
However, in 2007, it was noticed in the Sint Maartenskliniek—a large specialized hospital in rheumatology and orthopaedics in the Netherlands—that large numbers of MR-SIs were ordered, while only a few of them were found to be positive for sacroiliitis. This seemed to indicate suboptimal deployment of this diagnostic tool. Requesting a test in patients with a too low pretest probability is associated with a low number of positive MR-SIs, an absolute and relative increase in false-positive MR-SIs, increased patient burden and higher costs. Therefore an intervention was made to educate the rheumatologist and to provide an alternative strategy. The goal of this study is to describe the characteristics of deployment of MR-SI in patients with clinical suspicion of axial SpA before and after this targeted intervention.

Materials and methods

Patients

All MR-SI performed in the period 1 April 2004 to 31 December 2010 were collected in this retrospective before-and-after controlled study. Patients were recruited from an outpatient clinic of the rheumatology department at the Sint Maartenskliniek, Nijmegen, The Netherlands. The regional ethics committee (Arnhem/Nijmegen, The Netherlands) was approached about the study and confirmed that ethical approval was not required.

Methods

Patients and clinical data

Patients were included only if clinical patient data were available and the MR-SI was ordered by a rheumatologist for suspicion of axial SpA (Fig. 1). Patients were eligible for MRI if the conventional radiograph of the pelvis was reported normal or borderline by the radiologist. These were not separately evaluated.

Demographic characteristics (age, gender, name of treating rheumatologist), laboratory measurements (CRP, ESR, HLA-B27 status) and presence of SpA-related features in patient history or physical examination (alternating buttocok pain, acute anterior uveitis, dactylitis, arthritis, psoriasis, IBD, positive family history for SpA) were gathered of all patients (Tables 1 and 2).

MR-SI

MR-SI was performed with patients in a supine position using a Synergy spine coil in a 1.5 Tesla magnet (Intera Scan, Philips, Best, The Netherlands). Twenty-four coronal oblique images parallel to the SI joints with a field of view (FOV) of 420 mm, 3 mm slice thickness, 0.3 mm slice gap and a 512 × 512 matrix were obtained. A coronal T1-weighted spin-echo sequence was acquired with a repetition time (TR) of 350 ms, echo time (TE) of 16 ms and number of signals average (NSA) of 3. Furthermore, a coronal dual turbo spin-echo sequence with frequency-selective fat suppression (TR/TE 2500/shortest 120, NSA 2) was obtained. Original written MR-SI reports were graded as normal, suspected sacroiliitis or sacroiliitis by a physician well trained in evaluating MR-SI (M.H.E.V.). Sacroiliitis was defined as the definite presence of a subchondral region of high signal intensity on the STIR sequence, low on T1, on more than one image on either the sacral or iliac side of an SI joint, or both. Suspected sacroiliitis was defined as a one-sided subchondral high signal intensity region on the STIR sequence present on only one image.

Intervention

In April 2007, a five-step intervention of 1.5 h was made to improve deployment of MR-SI by a rheumatologist-epidemiologist (A.A.d.B.). First, all rheumatologists (n = 11) were provided with data on patient characteristics, requesting behaviour from themselves and colleagues, and MR-SI outcomes from the period April 2004 to April 2007. Thereafter a short introduction on the effect of pretest chance on predictive value was given and consequences including increased number of false positives, burden for patients and costs were illustrated. Finally, an
alternative behavioural strategy was offered in the form of a simple diagnostic algorithm (Fig. 2) [4]. Rheumatologists were encouraged to use the new algorithm, and it was made available in all outpatient clinic rooms, but no further feedback was given, and no booster sessions were provided.

Statistics

Statistical analysis was performed using SPSS for Windows (version 17.0; SPSS, Chicago, IL, USA). Imputation with absent was used in rare or clearly not present, but not recorded exposition data in variables of SpA-related features. Descriptive statistics were expressed as mean ± S.D. unless stated otherwise. Test characteristics were described using cross-tabulation per diagnostic investigation. Differences between groups were calculated using an unpaired t-test for parametric distributed numerical data or a \( \chi^2 \) test in case of categorical data. P-values and 95% CIs were reported; a P-value < 0.05 was considered statistically significant.

Results

In the period 2004–07, a total of 224 MR-SI were retrieved. After inclusion of complete patient data and MR-SI requested by a rheumatologist for reasons of axial SpA, 198 MR-SI remained (Fig. 1A). Of these patients, 50 (25%) were male with a mean age of 36 ± 9.8 years. Thirty-five of the 66 tested patients were HLA-B27 positive (Table 1). A total of 111 MR-SI were retrieved in the period 2007–10. After inclusion, 79 MR-SI remained, corresponding with a reduction in total MR-SI requests of 60% (Fig. 1B). There were 25 (32%) males with a mean age of 35 ± 9.4 years. Patients were significantly more frequently tested for HLA-B27 compared with the period before the intervention (82% vs 33%). A statistically significant decrease in missing CRP and ESR values in 2007–10 compared with 2004–07 (Table 1) was appreciated.

Table 2 displays the distribution of SpA features for both periods, combined for presence in patient history and/or physical examination data. Patients presented statistically significant more SpA features in the period after the intervention, e.g. alternating buttock pain, arthritis, heel pain, good response to NSAIDs and positive family history for SpA.

MRI outcomes

From 2004 to 2007, 166 (84%) MR-SI were graded as normal, 5 (2%) as suspicious for sacroiliitis and 27 (14%) as sacroiliitis. In the period 2007–10, 57 (72%) MR-SI were normal, 0 were suspicious for sacroiliitis.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>2004–07 (n = 198)</th>
<th>2007–10 (n = 79)</th>
<th>Pearson’s ( \chi^2 ) test P-value (( &lt;0.05 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternating buttock pain</td>
<td>2 (1.0)</td>
<td>39 (49.4)</td>
<td>0.000*</td>
</tr>
<tr>
<td>Arthritis</td>
<td>27 (13.6)</td>
<td>21 (26.6)</td>
<td>0.010*</td>
</tr>
<tr>
<td>Dactylitis</td>
<td>4 (2.0)</td>
<td>3 (3.8)</td>
<td>0.395</td>
</tr>
<tr>
<td>Heel pain</td>
<td>15 (7.6)</td>
<td>20 (25.3)</td>
<td>0.000*</td>
</tr>
<tr>
<td>IBD</td>
<td>4 (2.0)</td>
<td>5 (6.3)</td>
<td>0.054</td>
</tr>
<tr>
<td>Psoriasis</td>
<td>22 (11.1)</td>
<td>9 (11.4)</td>
<td>0.974</td>
</tr>
<tr>
<td>Uveitis anterior</td>
<td>5 (2.5)</td>
<td>6 (7.6)</td>
<td>0.051</td>
</tr>
<tr>
<td>Good response to NSAID</td>
<td>44 (22.2)</td>
<td>29 (36.7)</td>
<td>0.013*</td>
</tr>
<tr>
<td>Positive family history of SpA</td>
<td>35 (17.7)</td>
<td>30 (38.0)</td>
<td>0.000*</td>
</tr>
</tbody>
</table>

*Statistically significant, P < 0.05.
and 22 (28%) sacroiliitis. Optimizing patient selection resulted in a 60% reduction in the total number of MR-SI requests with a concomitant doubling in MR-SI positive for sacroiliitis. Furthermore, there was a tendency towards less variation in MR-SI requests and outcomes between rheumatologists, with the greatest decrease in rheumatologist no. 10 (Fig. 3). Notably, between 2007 and 2010 a total of 710 new patients were diagnosed with axial SpA compared with 637 new patients between 2004 and 2007.

**Discussion**

The work presented here demonstrates that performing MR-SI in suboptimally selected patients with a too low pretest chance of axial SpA will result in high number of MR-SI requests. This is associated with a low yield in finding sacroiliitis (resulting in a higher false-positive rate), increased patient burden and costs. A simple, five-step intervention leads to considerable improvement in different process measures and a reduction in the total number of MR-SI requests with a concomitant increase in MR-SI positive for sacroiliitis (Supplementary data, available at Rheumatology Online).

In this era of reducing health care costs while maintaining and/or enhancing health care quality, a more rational requesting behaviour of doctors is important. However, behavioural change in medical professionals is difficult to obtain. Some research has been done on factors influencing the success rate of guideline adherence. Different, but largely overlapping, models have been developed, classifying barriers for behavioural change into three groups: knowledge, attitude and external barriers [6, 7]. The intervention used in this study was designed to include two of the three groups: knowledge and external barriers.

Knowledge about pre- and post-test chances of the presence or absence of disease was provided, as well as data on test characteristics of MRI. Also, feedback was provided regarding previous behaviour. Of note, the term feedback has been defined by J. Ende in 1983 as ‘the control of a system by reinserting into the system the results of its own performance’. By increasing awareness on the impact of behaviour, a subject is able to make choices regarding future actions [8]. Thereafter, some
barriers for successful modification of behaviour towards employment of MR-SI were identified and targeted. Rheumatologists were unaware of the correct indication for requesting MRI-SI (barrier knowledge) and furthermore did not know where to find the right algorithm (external barrier). As an intervention, the Berlin diagnostic algorithm was offered as an alternative strategy, and it was provided in all outpatient rooms [4].

The third area that can be targeted with an intervention, attitude, has been of interest among the rheumatologists in our hospital since 2006. Rheumatologists participated in different communication training sessions to induce a transparent and safe learning environment.

To our knowledge, research on the effect of interventions to improve diagnostic test requesting behaviour is scarce and has been performed in primary health care more than secondary care. For example, in general practitioners, it has been demonstrated that providing feedback reduces the use of diagnostic tests with consequently lower patient burden and costs [9]. Furthermore, conformity between medical performance and previously formulated criteria or standards increased not only for the mentioned test, but also for requests in general [7, 10, 11].

The predominance of females in the cohort seen in the outpatient clinic both before and after the intervention is surprising. In accordance with established cohorts of patients with AS, our population with patients with definite SpA was predominantly male. However, the current study population concerns patients with atypical SpA. These patients are characterized by lack of typical signs and symptoms and laboratory (HLA B27) and imaging (plain SI radiograph) outcomes. This might explain the lack of the classical high male-to-female ratio of AS patients. In addition, the high proportion of female patients could be a reflection of improved, but still not optimal, case selection, even after intervention. Furthermore, in patients with the entire spectrum of axial SpA, including patients with non-radiographic sacroiliitis, there is a predominance of female patients [12]. As the current cohort consists of patients with a suspicion of SpA, it is in line with these data that there is a predominance of female patients in this study.

Our study has some limitations. First, the study does not include a control group, so change in MR-SI requests could have occurred in the absence of feedback [11]. However, the magnitude and persistence of the effects seen in both process and outcome measures suggest a real and clear benefit. Interestingly, previous studies suggest that interventions only have a temporary effect, and that they need to be repeated routinely by a person who is appreciated by the group [6, 10]. In our study, however, the effect was sustained over a period of 3 years. A second limitation relates to the fact that explanations for differences in test ordering behaviour and response to interventions differ among studies, precluding simple generalization of our intervention to other contexts [6, 10]. Finally, we did not evaluate the economic consequences and cost-effectiveness of our intervention. Controlled studies assessing the value of a diagnostic modality or strategy with regard to clinical outcome and cost-effectiveness are, however, notoriously difficult and expensive to perform. Although feedback itself accounts for extra costs as well [9], we believe that our study clearly suggests that the benefits outweigh the efforts and costs associated with the intervention.

**Conclusions**

A relatively simple, one-time, five-step feedback intervention can result in an overall improvement in the use of MRI, with more favourable patient selection, a large reduction in the total number of MR-SI requests with concomitant deployment of MRI for patients suspected for SpA.
doubling of the number of MR-SIs positive for sacroiliitis and improvement in other performance/outcome measures. This approach might be suitable as a blueprint for optimization of other diagnostic scenarios with possible suboptimal testing.

**Rheumatology key messages**

- A feedback intervention improves diagnostic performance in patients with a suspicion of SpA/sacroiliitis.
- Future research may use feedback interventions for improving diagnostic behaviour in scenarios with suboptimal testing for patients with spondyloarthritis.

**Disclosure statement:** The authors have declared no conflicts of interest.

**Supplementary data**

Supplementary data are available at *Rheumatology* Online.

**References**