Original paper

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The role of magnetic resonance imaging in monitoring patients with axial spondyloarthritis

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Abstract

Introduction: Axial spondyloarthritis (axSpA) comprises a group of chronic inflammatory joint diseases. Modern therapies enable the rapid achievement of low disease activity or even remission. Therefore, assessing disease activity is now crucial for making the best possible therapeutic decisions. In addition to standard clinical indices used to evaluate disease activity, magnetic resonance imaging (MRI) is increasingly employed to assess inflammation.

Material and methods: The study included patients with axSpA who had a Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) score ≥ 4 and a Spondyloarthritis Research Consortium of Canada (SPARCC) score ≥ 2. The MRI examinations of the sacroiliac joints were performed at the beginning and the end of the study to evaluate disease activity. The study lasted 3 months, during which patients were treated with certolizumab pegol.

Results: The study included 31 patients with axSpA (11 females, 20 males). The mean age of the patients was 36.7 years (SD 9.7), and the mean disease duration from the onset of the first symptoms was 7.4 years (SD 1.9). At the start of therapy, all patients had active disease, as determined by clinical assessment (BASDAI ≥ 4 and Ankylosing Spondylitis Disease Activity Score [ASDAS] > 2.1) and MRI evaluation (SPARCC ≥ 2). The percentage of patients with active disease after 3 months of therapy was 26% (BASDAI), 19% (ASDAS), and 97% (SPARCC). Significant clinical improvement as a result of the therapy was observed in 81% (ΔBASDAI ≥ 50%), 97% (ΔASDAS ≥ 1.1), and 87% (ΔSPARCC ≥ 2.5) of patients.

Conclusions: Magnetic resonance imaging provides a perspective on disease activity that complements traditionally used clinical indices. It does not replace these indices but rather offers additional insights during both the diagnostic process and the monitoring of therapy efficacy.

Key words: axial spondyloarthritis, magnetic resonance imaging, sacroiliac joints.

Introduction

Axial spondyloarthritis (axSpA) is a group of chronic joint inflammatory diseases affecting chiefly vertebral and sacroiliac joints (SIJ), producing characteristic pain [1, 2]. Axial spondyloarthritis includes, among others, axial psoriatic arthritis and ankylosing spondylitis.

The chronic inflammation in axSpA results in disability and reduction of the quality of life (QoL) of the patient [3, 4]. Concomitant diseases, such as osteoporosis and depression, are also an issue; their risk factor is higher than in the general population [5, 6]. The peak incidence of axSpA is in the second and third decades of life, thus affecting persons of working age, which impairs both their professional and social activities [4].

Modern medication allows low disease activity and possibly remission to be quickly achieved, significantly improving the patients' QoL and life expectancy [7], opening up possibilities unavailable a few decades ago. It is therefore imperative to adopt a new perspective on the disease itself. New therapeutic methods, however, require disease activity to be monitored more closely, a challenge from a clinical standpoint.

In order to fully benefit from the therapeutic effects of modern drugs, focus should be placed on early diagnosis of inflammatory arthropathy and proper monitoring of disease activity. Commencing the treatment early on allows the progression of irreversible radiological changes to be inhibited, whereas achieving low disease activity or remission makes it possible to reduce drug doses

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or even temporarily suspend aggressive treatment. Altogether this makes diagnostics based exclusively on laboratory tests and physical evaluation insufficient.

As a result, modern rheumatology places an ever greater emphasis on diagnostic imaging, ultrasound (US) and magnetic resonance imaging (MRI) in particular [8, 9]. These two tests allow one to evaluate the inflammation *in statu nascendi*, i.e., in the areas in which it develops – the synovial membrane, tendon sheaths, joint capsules, or bones making up a joint.

Diagnostic imaging allows for a remarkably precise assessment of the inflammation even in cases of pain and joint swelling undetectable in physical examination (subclinical inflammation) [10]. Irregularities visible in US and MRI tests, even at a subclinical level, are connected with a risk of disease exacerbation in the coming months [11].

The MRI testing is presently included in axSpA classification criteria in the Assessment of SpondyloArthritis International Society (ASAS) [12–14]. The use of MRI effectively expedites the diagnosis and allows the treatment to be started sooner.

Regrettably, in the case of monitoring disease activity and the efficacy of administered treatment, MRI testing is employed for the most part only in clinical and research studies. In routine clinical practice, the use of MRI depends by and large on the clinician's experience and the availability of the test itself. There is also a lack of clear guidelines governing the use of MRI in deciding on changes to the administered treatment. Considering the current state of knowledge, such guidelines would facilitate disease control, improving the patients' QoL, and inhibit long-term effects – radiological progression.

As it stands, one of the greatest challenges is how to relate active radiological changes to clinical parameters, which are in large part based on the patients' subjective judgment. This would make it easier to develop recommendations for using MRI in routine clinical practice.

The aim of the study was to assess the usefulness of MRI testing of SIJ in monitoring the efficacy of administered treatment compared to the clinical evaluation of disease activity.

Material and methods

Studied group

Patients with axSpA in whom the disease was diagnosed in concordance with the 2009 ASAS classification criteria were enrolled in the study [13, 14]. Participating patients were being treated at the Clinic of Rheumatology and Connective Tissue Diseases, Jan Biziel University Hospital No. 2 in Bydgoszcz (Poland).

Eligibility criteria included: a Bath Ankylosing Spondylitis Disease Activity Index (BASDAI) score of ≥ 4, and a Spondyloarthritis Research Consortium of Canada (SPARCC) score of ≥ 2.

Exclusion criteria were as follows: concomitant joint inflammation other than axSpA, contraindications to tumor necrosis factor α (TNF-α) inhibitor treatment, and inability to undergo an MRI sacroiliac joint (SIJ) examination.

The study lasted for 3 months. Patients were evaluated at the start (visit 1 – V1) and end of the study (visit 2 – V2). The TNF-α inhibitor treatment was initiated at the start of the study and continued throughout its duration. All patients were given the same drug – certolizumab pegol (CZP) – as part of the treatment.

The therapy plan involved a recommended initial dose of 400 mg (2 subdermal injections 200 mg each) in weeks 0, 2, and 4, followed by a maintenance dose, 200 mg subdermally, every 2 weeks.

Magnetic resonance imaging testing

The MRI tests were done on all patients using the Philips Ingenia 1.5 T device. All patients were evaluated by a single radiologist with multiple years of experience in describing changes in the course of axSpA.

The T1 weighted image, STIR/TIRM, and T2 fat-saturated/fat-suppressed (T2FS) sequences were used in the study – the examination protocol met all the ASAS/Outcome Measures in Rheumatology (OMERACT) guidelines [15]. Active SIJ inflammation in the form of bone marrow edema (BME) was evaluated on the SPARCC scale [16].

Spondyloarthritis Research Consortium of Canada scale

The SPARCC scale is used to evaluate active inflammation, that is BME, within each SIJ divided into 4 quadrants. The binary grade (0 – no BME; 1 – presence of BME) is based on the evaluation of 8 quadrants visible in 6 consecutive slices/layers in the coronal/diagonal view, in the STIR/TIRM sequence, with additional points factored in for each SIJ for signal intensity (provided the bone marrow edema signal is comparable to the blood vessel signal) and the extent of the edema inflammation (provided the area of inflammation extends at least 1 cm from the joint space). The total score ranges from 0 to 72.

Calculations in the study were made with the help of a template comprising 6 graphic schemes, one for each SIJ section, divided into individual quadrants, and additional grades for the intensity and severity of the marrow edema [17, 18].

Clinical and laboratory evaluation

Bath Ankylosing Spondylitis Disease Activity Index

The BASDAI questionnaire was used to evaluate disease activity. The questionnaire comprises 6 questions directly related to the evaluation of SpA symptoms. Each answer is graded on a scale of 0 to 10, with 0 meaning no issues and 10 meaning maximal issues. The final BASDAI result is the sum of all the points from the first four answers and the average of the last two, producing a result on a scale of 0–50 that is further divided by 5 (final result on a scale of 0–10). The study considers the active form of the disease, i.e., a BASDAI score of ≥ 4 [19].

Ankylosing Spondylitis Disease Activity Score

Disease activity was also evaluated using the Ankylosing Spondylitis Disease Activity Score (ASDAS) [20]. The ASDAS calculation considers back pain (question 2 of BASDAI), global patient assessment of peripheral joint pain and/or inflammation assessment (question 3 of BASDAI), duration of morning stiffness (question 6 of BASDAI), and C-reactive protein (CRP) level given in mg/l. Disease activity evaluation assumed: ASDAS < 1.3 – inactive disease; 1.3 ≤ ASDAS < 2.1 – moderate disease activity; 2.1 ≤ ASDAS ≤ 3.5 – high disease activity; ASDAS > 3.5 – very high disease activity. The study assumed that an ASDAS change of ≥ 1.1 means a clinically important improvement, and a change of ≥ 2.0 means a major improvement [20].

Laboratory tests

Additionally, the patients' CRP level, erythrocyte sedimentation rate (ESR), and the presence of the HLA-B27 antigen were evaluated.

Statistical analysis

The results were presented as a mean score (± standard deviation – SD) for continuous variables. Distribution equality was assessed with the Kolmogorov-Smirnov test. The paired Student *t*-test was used to compare differences between visits.

Table I. Demographic data of study group

	Value
Number of patients, *n*	31
Age [years]	36.7 ±9.7
Sex, female, *n* (%)	11 (35)
Disease duration – first symptoms [years]	7.4 ±1.9
Disease duration – diagnosis [years]	2.5 ±1.9
HLA-B27+, *n* (%)	30 (97)

In the case of categorical data, the results were given as a number (percent). Data comparison was performed using the χ^2 test.

The correlation was assessed with the Pearson correlation coefficient.

The level of statistical significance was set at $p \leq 0.05$.

Calculations were performed using MedCalc Statistical Software version 23.0.2 (MedCalc Software Ltd, Ostend, Belgium; https://www.medcalc.org; 2024) and MS Excel 2013 software.

Bioethical standards

The study was approved by the Bioethical Committee of the Collegium Medicum in Bydgoszcz, Poland (approval no. KB 640/2017). Prior to their enrollment, all patients received information on the study in both written and verbal form, and signed the informed consent document in order to participate.

Results

Thirty-one patients (11 females and 20 males) with axSpA were enrolled in the study; basic demographic data are presented in Table I. Mean patient age (SD) was 36.7 (9.7) years. In the study group there was a large difference between disease duration measured from diagnosis and duration measured from first symptoms; mean values were, respectively, 2.5 (1.9) and 7.4 (1.9) years. Presence of the HLA-B27 antigen was found in 30/31 (97%) patients.

Table II shows parameters related to the disease activity during each visit.

In all patients enrolled into the study, active disease was confirmed through the classical clinical indicators – BASDAI and ASDAS – and the MRI-SIJ examination.

Mean BASDAI, ASDAS, SPARCC, and Visual Analogue Scale (VAS) values, and laboratory parameters fell significantly as a result of the treatment.

In the BASDAI evaluation, clinically important improvement (BASDAI reduction of ≥ 50% compared to the initial value) was found in 25 (81%) patients. In the case of ASDAS evaluation, a major improvement (ΔASDAS ≥ 2.0) was found in 20 (67%) patients; a clinically important improvement (1.1 ≤ ΔASDAS < 2.0) was found in 10 (30%) patients; and 1 (3%) patient showed no signs of improvement. In the SPARCC evaluation, a clinically important improvement was defined as a reduction of at least 2.5. Such a drop in SPARCC value was found in 27 (87%) patients.

In the case of the patient with a lack of confirmed improvement in ASDAS evaluation, the same lack was also found in the BASDAI and SPARCC evaluations. On the BASDAI scale, no improvement was found in

Table II. Evaluation parameters of disease activity during visits

Parameter	Visit 1	Visit 2	*p*
CRP [mg/l]	21.4 ±37.9	3.5 ±4.8	0.009
ESR [mm/h]	20.7 ±27.1	8.6 ±10.8	0.02
VAS [cm]	7.7 ±1.2	2.9 ±2.1.	< 0.001
BASDAI	8.4 ±1.0	3.1 ±1.4	< 0.001
ASDAS	4.2 ±1.0	1.7 ±0.8	< 0.001
SPARCC	15.4 ±9.4	6.2 ±4.3	< 0.001
Number of patients with active disease (BASDAI ≥ 4), *n* (%)	31 (100)	8 (26)	< 0.001
Number of patients with at least high disease activity (ASDAS > 2.1), *n* (%)	31 (100)	6 (19)	< 0.001
Number of patients with active SIJ inflammation (SPARCC ≥ 2), *n* (%)	31 (100)	30 (97)	0.317

ASDAS – Ankylosing Spondylitis Disease Activity Score, BASDAI – Bath Ankylosing Spondylitis Disease Activity Index, CRP – C-reactive protein, ESR – erythrocyte sedimentation rate, SIJ – sacroiliac joints, SPARCC – Spondyloarthritis Research Consortium of Canada, VAS – Visual Analogue Scale.

6 patients; in 5 of these, improvement was found in both ASDAS and SPARCC evaluations. On the SPARCC scale, no improvement was found in 4 patients; in 3 of these, improvement was found in both ASDAS and BASDAI.

Table III shows the number of patients with a confirmed clinical improvement in relation to disease evaluation method during V2.

No meaningful difference was found in the clinical response to the treatment, regardless of the disease activity evaluation employed.

With both V1 and V2 there was a small positive correlation between the clinical evaluation of disease activity and laboratory parameters, and evaluation on the SPARCC scale. Nevertheless, in no case was a meaningful relation found between the evaluated parameters.

Table III. Number of patients with confirmed clinical improvement in relation to disease evaluation method during V2

	Clinical improvement	No clinical improvement	*p*
ASDAS, *n* (%)	30 (97)	1 (3)	0.141
BASDAI, *n* (%)	25 (81)	6 (19)	
SPARCC, *n* (%)	27 (87)	4 (13)	

ASDAS – Ankylosing Spondylitis Disease Activity Score, BASDAI – Bath Ankylosing Spondylitis Disease Activity Index, SPARCC – Spondyloarthritis Research Consortium of Canada.

Discussion

No substantial correlation between disease activity evaluation on the SPARCC scale and clinical disease indicators was discovered in the study. The obtained results can be considered in line with the results of other studies [21, 22].

The lack of correlation between the clinical evaluation and the SPARCC scale could stem from the differences in approaches in assessing the disease. In the case of BASDAI, it should be noted that it is an evaluation based entirely on the patient's feelings, making it inherently subjective [23]. The ASDAS also factors in laboratory parameters, i.e., CRP and ESR, rendering the evaluation more objective. The SPARCC evaluation, however, assesses the inflammation within the SIJ, an entirely separate, and independent, aspect in evaluating disease activity.

The pain experienced by the patient, considered in clinical evaluation, may be related to irreversible destructive changes brought about by the progression of the disease, and not the inflammation itself. Chronic pain may also lead to the development of depression, which would increase the subjectivity of the evaluation even further. Regrettably, depression in the course of axSpA is a relatively frequent concomitant disease, particularly in patients with high disease activity [24]. In the study group there was a large gap between the mean time of developing symptoms and diagnosis (Table I). In a portion of the patients, this may have resulted in irreversible destructive changes, and it may explain the lack of correlation between the SPARCC and clinical evaluations, regardless of the fulfillment of the conditions for improvement in either method.

Despite the lack of correlation between the clinical methods of evaluating disease activity and SPARCC, the percentage of the patients who achieved improvement was, in fact, close. Modern forms of therapy are highly effective and boast a broad spectrum of activity. Even with a relatively short administration period, both laboratory and clinical parameters improve, and so does the active SIJ inflammation in the form of reduced bone marrow edema in MRI examination.

To achieve a substantial improvement from a clinical standpoint is a core aim of the treat to target (T2T) strategy. In evaluating the efficacy of medication, the response in month 3 of the treatment is often the primary

target [25–27]. The evaluation of the patient in month 3 of the treatment may also serve as a predictive factor for the efficacy of long-term therapy. The decrease in the mean SPARCC score observed in month 3 suggests that this method for evaluating disease activity may hold significant value from a clinical standpoint. This is consistent with the T2T treatment strategy and is an independent measure of the efficacy of the administered treatment.

It can be concluded that the MRI sacroiliac joint examination not only allows one to evaluate and monitor aspects of disease activity other than clinical indicators, but is also a highly objective method of evaluating the extent of active SIJ inflammation for both the rheumatologist and the radiologist [21, 28, 29]. As mentioned previously, in the clinical evaluation, pain and the perception of the disease by the patient may be related to both the inflammation and irreversible radiological changes. Additionally, the patient's mental condition, e.g., concomitant depression or symptoms of fibromyalgia, which often accompany rheumatic diseases, may also affect his perception of pain [30, 31]. In some cases, this may lead to a reduced therapeutic effect in the clinical evaluation.

Considering all the above factors, it cannot be said that radiological evaluation would eventually supplant clinical evaluation of disease activity. On the contrary, it ought to be approached as an extension of the clinical evaluation, as it provides additional information on disease activity. MRI examination does not need to be a routine part of the treatment when using biological drugs following the T2T strategy. In fact, MRI examination, like any other radiological examination, ought to be used only when its results could have a real impact on the diagnosis or further therapeutic decisions.

The assessment of cost-effectiveness is an extremely important issue; however, in the case of monitoring patients with axSpA, it is challenging to evaluate [32]. In the studied patient group, this evaluation would need to be conducted over a period longer than 3 months.

Compared to X-ray, MRI provides higher sensitivity, while in relation to computed tomography (CT), it is not associated with exposing the patient to ionizing radiation [33]. This represents a significant advantage over CT, which may be performed in axSpA patients for other medical reasons.

The present study results indicate that MRI can be a valuable tool for assessing axSpA activity, providing a level of accuracy comparable to routinely used evaluation methods. Therefore, it would be worth considering longer-term patient follow-ups to evaluate the predictive value of this examination. If MRI could effectively identify patients at high risk of increased disease activity over the coming months, it could have a significant impact on therapeutic decision-making and improve patients' QoL. Additionally, such findings could address the question of the cost-effectiveness of using MRI in routine clinical practice.

It seems that MRI's greatest added value in monitoring axSpA patients is the comprehensive evaluation of the patients at the time of making therapeutic decisions, assessing the risk of flare or progression of radiological changes [33–36].

Conclusions

Magnetic resonance imaging examination is an independent tool for evaluating disease activity in patients with axSpA compared to clinical evaluation. It can also be used to monitor the efficacy of administered treatment. The lack of correlation between individual clinical evaluation parameters and imaging evaluation indicates that MRI examination assesses active SIJ inflammation independently, as one of the symptoms of the disease. Therefore, it ought to be treated as an additional test in the diagnostics and monitoring of the efficacy of axSpA treatment – one used in conjunction with, not in place of, clinical evaluation.

Disclosures

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Ethics: This study was approved by the Bioethical Committee of the Collegium Medicum in Bydgoszcz, Poland (approval no. KB 640/2017).
Data availability: The data that support the findings of this study are available on request from the corresponding author (R.W.).

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