RHEUMATOLOGY

Rheumatology 2020;59:2864–2871
doi:10.1093/rheumatology/keaa014
Advance Access publication 20 February 2020

Original article

Diagnostic capability of contrast-enhanced pelvic girdle magnetic resonance imaging in polymyalgia rheumatica

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Abstract

Objective. There is currently no diagnostic test for PMR. A characteristic pattern of extracapsular inflammation as assessed by contrast-enhanced MRI (ceMRI) has recently been described in the pelvis of patients with PMR. We aimed to evaluate the performance of inflammatory ceMRI signals at predefined pelvic sites as a diagnostic test for PMR.

Methods. Pelvic MRI scans of patients with pelvic girdle pain ($n = 120$), including 40 patients with an expert diagnosis of PMR and 80 controls with other reasons for pelvic pain were scored by three blinded radiologists, who evaluated the degree of contrast enhancement at 19 predefined tendinous and capsular pelvic structures. Different patterns of involvement were analysed statistically.

Results. The frequency of bilateral peritendinitis and pericapsulitis including less common sites, such as the proximal origins of the m. rectus femoris and m. adductor longus, differed significantly between PMR cases and controls: 13.4 ± 2.7 *vs* 4.0 ± 2.3. A cut-off of ≥10 inflamed sites discriminated well between groups (sensitivity 95.8%, specificity 97.1%). Bilateral inflammation of the insertion of the proximal m. rectus femoris or adductor longus tendons together with ≥3 other bilaterally inflamed sites performed even better (sensitivity 100%, specificity 97.5%).

Conclusion. This study confirms that a distinctive MRI pattern of pelvic inflammation (bilateral peritendinitis and pericapsulitis and the proximal origins of the m. rectus femoris and m. adductor longus) is characteristic for PMR. The high sensitivity and specificity of the set of anatomical sites evaluated suggests their clinical usefulness as a confirmatory diagnostic test.

Key words: magnetic resonance imaging, inflammation, polymyalgia rheumatica

CLINICAL SCIENCE

Rheumatology key messages

- Multilocular peritendinous and pericapsular inflammation are the hallmarks of pelvic involvement in PMR.
- Extracapsular inflammation in PMR can be delineated precisely by contrast-enhanced MRI.
- The inflammatory pattern in pelvic MRI could serve as a confirmatory imaging test for PMR.

Introduction

PMR is the most frequent inflammatory rheumatic condition of the elderly. The diagnosis is made solely on clinical grounds based on a patient history of shoulder and/or pelvic pain and laboratory findings, such as elevation of CRP and ESR, flanked by the legendary good response to glucocorticoids [1, 2].

The only established imaging modality for the direct assessment of inflammatory changes that has also made its way to the EULAR classification criteria is US [3]. Using US, extracapsular synovial inflammation, such as bursitis and tenosynovitis in the pelvic and shoulder regions, can be demonstrated. These findings may contribute to the diagnosis in some cases. However, given that inflammatory changes attributable to degeneration and/or stress are also rather common in these locations

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Submitted 7 May 2019; accepted 19 December 2019

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and this age group, these changes are not very specific [4, 5]. Direct imaging of the inflammatory musculoskeletal changes beyond US has not played a role in the assessment of patients with possible PMR to date. However, using fluorodeoxyglucose (FDG)-PET/CT, extracapsular inflammation of entheseal and bursal sites in pelvic and shoulder girdle sites, in addition to lumbar and cervical interspinous bursitis, have been identified as possible correlates of the rather characteristic myalgic pain syndrome of PMR [6–12]; however, routine use of this modality is limited owing to availability, cost and radiation dose. In addition, MRI studies have shown comparable findings, demonstrating peritendinous and pericapsular oedema [13, 14] and contrast enhancement [15] as a correlate of inflammation at these sites. The broad availability of MRI makes it an appropriate modality for demonstrating the rather characteristic inflammation in PMR.

The pathoanatomy of extracapsular inflammation in the pelvis as assessed by contrast-enhanced MRI (ceMRI) has been recently described in a proof-of-concept study in PMR patients [16]. Peritendinitis and pericapsulitis were predominant findings in PMR, whereas low-grade synovitis was also frequent but not an obligatory finding. Multilocular, mostly bilateral pericapsulitis and peritendinitis, particularly at the origins of m. adductor longus and m. rectus femoris, are the hallmarks of MRI findings in PMR.

Based on our experience with PMR and MRI, we decided to perform a retrospective case–control study to investigate whether and how these presumably unique findings in PMR could be translated to a simple diagnostic test and to evaluate the performance of the findings thought to be specific.

Methods

Patients

A total of 120 patients with pelvic girdle pain had undergone pelvic ceMRI in our tertiary centre in the last 3 years. The main indication for performing MRI was the uncertain diagnosis and the possible differential diagnoses; the MRI scans were not intended to diagnose PMR.

A third of these patients were diagnosed with new-onset PMR ($n = 40$); 10 of these patients developed peripheral arthritis of the hands 1–5 years after the initial diagnosis of PMR and were eventually reclassified as PMR-like onset of RA. Given that they were diagnosed as PMR at the time of the MRI, they were included as PMR cases for the purpose of this study. The remaining 80 patients had other inflammatory or non-inflammatory causes to explain their pain. All cases were diagnosed by an expert rheumatologist, including all PMR and PMR-like onset of RA cases. All PMR cases fulfilled the 1979 criteria for PMR [17]. Importantly, the MRI results had no influence on the clinical diagnosis, because MRI is not an established methodology to diagnose PMR to date. Patient characteristics are shown in Table 1.

No ethical approval has been obtained because this is a retrospective analysis of data obtained upon clinical indication. The ethical committee body responsible for our hospital is the Ethical Committee (EC) of the Ruhr-University Bochum, Germany. The EC did not require ethical approval for retrospective studies at the time when the study was conducted.

MRI

All patients underwent pelvic MRI with a weight-adapted i.v.-applied gadolinium-based contrast agent; in all patients, gadoteric acid was used. The scans covered the pelvis from the level of segment L4/5 to the subtrochanteric proximal femur in the transverse plane; the coronal plane typically exceeded this a little. Most patients ($n = 106$) were examined with Siemens Aera, 10 with Siemens Avanto and 4 with Siemens Skyra. Scanning parameters differed slightly owing to individual adjustments and different field strengths. Detailed parameters have been published previously [16].

Investigated sites and image analysis

Images of 120 patients were scored by three experienced radiologists, including the evaluation of contrast enhancement around the 19 predefined tendinous and capsular structures (nine bilateral and one unilateral). Readers were blinded to all demographic, clinical and biometric information. A total of 10 PMR cases and 20 controls were read twice to evaluate the intra-reader reliability. Thus, the radiologists read a total of 150 cases each. The readers had access to all MRI sequences of the examination, but they assessed only the contrast enhancement in coronal and transverse T1 wheighted turbo spin echo with fat suppression (T1w TSE FS) sequences at the predefined regions described. Every reader underwent a short training session of eight cases to get used to the scoring system. Readers were encouraged to rate conservatively in cases of doubtful contrast enhancement to minimize overinterpretation.

The predefined anatomical sites of interest were as follows.

Unilateral:

- the lumbar interspinous bursae and paraspinous origins of deep spinal musculature (SPINE).

Bilateral:

- around the superior anterior iliac spine and anterior iliac crest, representing various muscle origins, such as the abdominal wall musculature, including m. tensor fasciae latae and m. sartorius (ASIS);
- around the proximal origin of the straight and reflected head of the tendon of the m. rectus femoris at the anterior inferior iliac spine and supraacetabular ridge (RFM);
- around the distal part of the m. glutaeus medius and minimus tendon at the trochanteric insertion (TRO);
- around the fibrous hip capsule at the level of the femoral neck (CAP);
- around the tendon of the m. obturator internus at its reflection at the posterior margin of os ischium (OBT);

Table 1 Characteristics of PMR cases and controls

Characteristic	PMR cases	Controls
Quantity, *n*	40	80
Age, mean (S.D.), years	64.2 (9.0)	64.1 (8.8)
Male, *n* (%)	18 (45)	30 (37.5)
CRP, mean (S.D.), mg/dl	3,48 (4.02)	0.44 (0.47)
ESR, mean (S.D.), mm/h	36.6 (21.9)	13.8 (9.4)
RF positive (≥14 IU/ml), *n* (%)	3 (7.5)	16 (20.0)
CCP antibody positive (≥40 IU/ml), *n* (%)	2 (5.0)	10 (12.5)
Leading diagnosis, *n* (%)	PMR, 30 (75.0) PMR-like onset of RA, 10 (25)	Degenerative disc or joint disease, 21 (26.3) RA, 21 (26.3) Axial spondyloarthritis, 16 (20) FM, 7 (8.8) Other autoimmune connective tissue disease, such as SLE, 5 (6.3) PsA, 4 (5) Insufficency fracture, 2 (2.5) SAPHO, 1 (1.3) DISH, 1 (1.3) CPPD arthritis, 1 (1.3) Osteomalacia, 1 (1.3)

- around the m. adductor longus tendon origin at the inferomedial pubic symphysis (SYM);
- around the distal m. iliopsoas tendon at the lower trochanter (IPT);
- around the common ischiocrural origin (hamstring) at the ischial tuberosity (IC);
- around the distal insertional site of the m. glutaeus maximus at the glutaeal tuberosity (MAX).

All sites were scored in a binary fashion, as the absence or presence of peritendinous enhancement, regardless of the individual amount. To be scored positive, a circumferential contrast enhancement at these sites had to be visible in two contiguous slices in one plane or on two perpendicular planes. The readers only rated absence or presence of contrast enhancement at individual sites but made no diagnostic decision regarding the different tests mentioned below.

Statistical analyses

Two different hypotheses were evaluated regarding their ability to identify a PMR case:

- Test A: can a varying quantity of inflamed sites, regardless of bilaterality or individual location, differentiate between cases and controls?
- Test B: can bilateral peritendinous inflammation of m. rectus femoris origins or m. adductor longus origins together with a varying number of further bilateral inflamed sites differentiate between cases and controls?

For both tests, the individual results of all three readers were pooled, giving 360 single results for each test. Receiver operating characteristic (ROC) curves and optimal test criteria were calculated for both tests.

Intra- and inter-reader reliability was evaluated using Fleiss' κ and Cohen's κ correlation, reading point to reading point, giving 2280 reading points for inter-reader correlation and 570 reading points for each intra-reader correlation.

Descriptive demographic and clinical data are presented as the mean (S.D.) when referring to quantitative variables and as absolute frequencies and percentages when referring to the qualitative variables. The Mann–Whitney *U*-test was used to compare the data between subgroups. A value of $P < 0.05$ was considered statistically significant. Statistical analyses were performed using SPSS v.23 (IBM).

Results

Inter- and intra-reader reliability

There was good agreement between readers, with an average pairwise agreement of 88.5% for all 2280 evaluated sites, resulting in a Fleiss' κ value of 0.754. Intra-reader agreements were very good, ranging from 93.5 to 95.4%, resulting in Cohen's κ values of 0.86–0.91 (Table 2).

Distribution of extracapsular inflammation

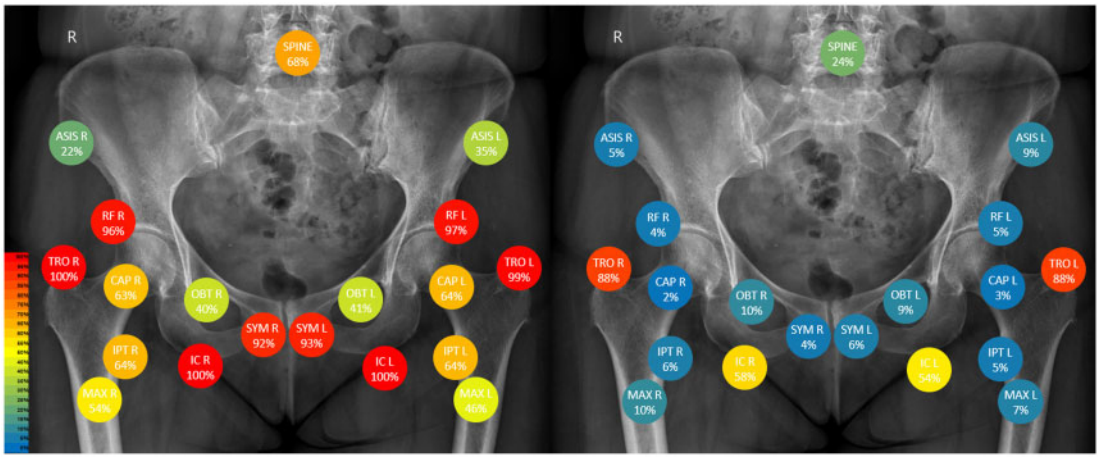
The frequency and distribution of inflamed extracapsular sites were significantly different between controls and PMR cases. On average 4.0 ± 2.3 sites were involved in controls, whereas in PMR cases 13.4 ± 2.7 out of 19 possible sites showed extracapsular inflammation ($P < 0.0001$).

The most frequently involved sites in PMR were the m. glutaeus medius and minimus tendons at the greater trochanter (TRO) and the common ischiocrural tendon origin at the ischial tuberosity (IC), which were affected in nearly all cases, followed by the origin of the m. rectus femoris (RFM; 96% right, 97% left) and m. adductor

TABLE 2 Inter- and intra-reader agreement and κ correlations

Inter-reader	Pairwise agreement (Cohen's κ)		
Average pairwise agreement (Fleiss' κ)	Reader A/C	Reader A/B	Reader B/C
88.5% (0.754)	87.5% (0.73)	91.0% (0.81)	87.0% (0.72)
Intra-reader	**Agreement between two readings (Cohen's κ)**		
	Reader A	**Reader B**	**Reader C**
	95.4% (0.906)	94.2% (0.879)	93.5% (0.855)

FIG. 1 Involvement of 19 extracapsular sites in PMR cases and controls superimposed on pelvic X-ray



The name of the site and the relative frequency of involvement in 40 PMR cases and 80 controls are colour coded and depicted numerically.

longus (SYM; 92% right, 93% left). In most cases, these sites were inflamed bilaterally. Involvement of all other sites was less frequent, ranging from $\geq$22% around the right anterior superior iliac spine (ASIS) to 68% at the interspinous bursae and paraspinous muscle origins (SPINE).

In controls, the common ischiocrural tendon origins (IC; 58% right, 54% left) and tendons of the hip abductors at the greater trochanter (TRO; 88% right, 88% left) were the only frequently inflamed sites, followed by SPINE, which was involved in $\sim$24% of controls. All other sites were infrequently involved in controls; in particular, the m. adductor longus (SYM; 4% right, 6% left) and m. rectus femoris origins (RFM; 4% right, 5% left) were rarely involved in controls, in contrast to their common involvement in PMR cases (Fig. 1).

There was no difference in the distribution and frequency of inflamed sites between the 30 PMR cases and the 10 PMR-like onset of RA cases (13.3 $\pm$ 2.7 *vs* 13.7 $\pm$ 2.6).

Test A

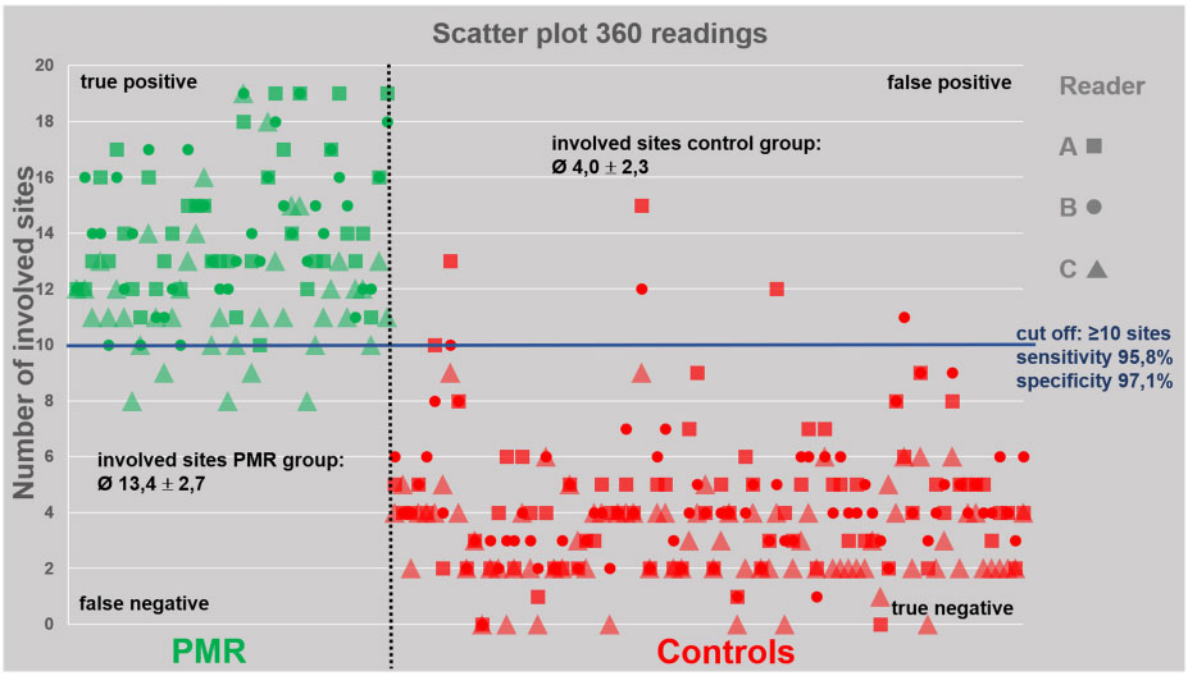
Displaying the quantity of involvement in all 360 ratings (120 cases rated by three readers) dependent on the expert diagnosis (gold standard) as a scatter plot (Fig. 2) resulted in two relatively distinct clusters for PMR cases and controls that could be separated best by proposing an involvement of $\geq$10 sites as a positive test for PMR, with a sensitivity/specificity 95.8%/97.1%. Fig. 3 shows the corresponding ROC curve analysis for test A; sensitivity/specificity ranged between 5.8%/100% for $\geq$19 involved sites and 100%/30.4% for $\geq$3 involved sites as a positive imaging test for PMR, and the best performance was achieved by $\geq$10 involved sites as the criterion for a positive imaging test in PMR.

When the 10 cases with the PMR-like onset of RA were excluded from the ROC analysis, the results changed only marginally. The best performance was again achieved when an involvement of $\geq$10 sites was taken as positive, with a sensitivity of 94.4% and a specificity of 97.1%. When the 10 cases with the PMR-like onset of RA were moved to the control group, the specificity dropped to 86.3% whilst the sensitivity remained constant.

Test B

Bilateral involvement of m. rectus femoris or m. adductor longus origins, test 1, already differentiated PMR cases from controls with a sensitivity of 100% and specificity of 95.4%. The best performance was

Fig. 2 Frequency of sites involved depending on gold-standard diagnosis



An involvement of ≥10 sites discriminated best between PMR cases and controls. Readers are encoded by different icons; green indicates gold-standard diagnosis PMR case, and red indicates control. Two distinct clusters can be differentiated visually, and these clusters can be separated best by proposing an involvement of ≥10 sites as a positive test for PMR.

achieved for bilateral involvement of m. rectus femoris or m. adductor longus origins together with three further bilaterally involved sites (test 4; sensitivity 100% and specificity 97.5%; Fig. 4). Adding more bilaterally involved sites (tests 5–8) rapidly degraded performance by means of a deficit of sensitivity.

When the 10 cases with the PMR-like onset of RA were excluded from the ROC analysis, test 4 still performed best, without a change in sensitivity or specificity. When these 10 cases were added to the control group, the specificity dropped to 86.7% while the sensitivity remained at 100%.

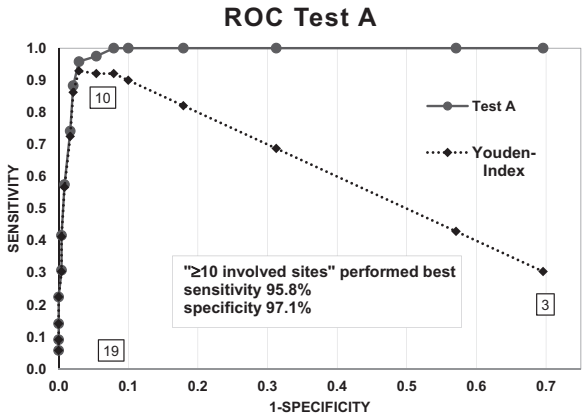
Discussion

In this retrospective case–control study with 120 patients suffering from pelvic girdle pain of unknown origin, we confirmed our previous data [16] showing that, using contrast-enhanced MRI, patients with PMR display a unique pattern of inflammation in specific pelvic tendinous and capsular structures. Furthermore, we showed that these results can be translated into a reliable and feasible imaging test for PMR with high quality. The frequency of involvement of 19 extracapsular sites in standard pelvic MRI discriminated PMR cases from controls very well if evidence of inflammation at ≥10 predefined sites was taken as a positive imaging test result, with a sensitivity of 95.8% and specificity of 97.1%. Inclusion of the unique distributional pattern, which usually meant bilateral involvement and the involvement of unusual sites, such as m. rectus femoris and m. adductor longus origin, improved the performance of the test even further. Clearly, bilateral inflammation of at least four extracapsular sites, including the origin of m. rectus femoris and/or m. adductor longus, performed best as an imaging test. Using this test, all PMR cases were identified, and controls were misinterpreted as false positives only six times, resulting in a sensitivity of 100% and specificity of 97.5%.

This study was targeted especially to assess the capacity of contrast-enhanced pelvic MRI to serve as a feasible imaging test that can easily confirm a clinical diagnosis of PMR. Appropriate images can be obtained on virtually every modern MRI scanner, and the proposed analyses can be performed easily by concentrating on the presence or absence of peritendinous inflammation at key structures using a simple binary coding system. Finally, we showed that investigators with different training levels achieved approximately equivalent results with high intra-observer consistency, suggesting that the proposed system can be implemented in daily clinical practice.

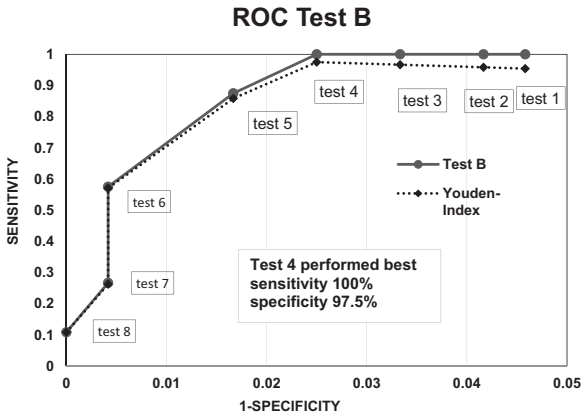
Although pelvic ceMRI provides a more detailed insight into the pathomorphology of extracapsular inflammation in PMR compared with US and FDG-PET/CT, only few studies have recognized the diagnostic value of MRI for PMR. In one study, MRI findings in PMR were compared with RA and a control group with unenhanced MRI of

FIG. 3 Receiver operating characteristic curve analysis of test A



Can a varying quantity of inflamed sites, regardless of bilaterality or individual location, differentiate between cases and controls? Measurement points range from a criterion of ≥3 involved sites to ≥19 involved sites. The local maximum of the Youden index is given for ≥10 involved sites, indicating the best test performance with this criterion. ROC: receiver operating characteristic.

FIG. 4 Receiver operating characteristic curve analysis for test B



Can bilateral peritendinitis of m. rectus femoris or m. adductor longus origins (test 1) together with up to seven further bilateral inflamed sites (tests 2–8) differentiate between cases and controls? The local maximum of the Youden index is given for test 4, indicating the best test performance if four sites are involved bilaterally, including m. rectus femoris and/or m. adductor longus origins. ROC: receiver operating characteristic.

the shoulder and the pelvic girdle [14]. Thickening of the supraspinatus tendon and effusion and periarticular soft tissue oedema in the shoulders were described as most informative imaging features of PMR, whilst periarticular oedema around the hip joint and small effusions in iliopsoas and trochanteric bursae were found to be potentially useful discriminators in the pelvic girdle. Given that we concentrated on contrast-enhanced extracapsular findings, these observations are limited in comparability, but the observed pattern of dominant extracapsular involvement in terms of periarticular oedema, effusion and tendon thickening supports our hypothesis that inflammation of the peritendineum and its correlates in ligamentous and capsular structures is the major imaging feature of PMR, and not intra-articular synovial inflammation. Furthermore, our findings are consistent with the concept that PMR represents a primarily capsular based inflammation, as originally described in an earlier shoulder MRI study, in which extracapsular oedema was found to be the differentiating feature between PMR and RA [13]. The same group identified extracapsular inflammation around metacarpophalangeal joints, as shown by ceMRI, to be more frequent in patients with hand involvement of PMR in comparison to RA [18]. In a multiarticular MRI study, contrast enhancement was studied with emphasis on extracapsular patterns of inflammation as a predictor of glucocorticoid responsiveness [15]. Indeed, in some PMR cases a characteristic extracapsular pattern of inflammation associated with a very good glucocorticoid responsiveness was found. In the pelvic girdle, a pattern of inflammation comparable to our observations was described.

In a very recent study on the effect of the IL-6 receptor antagonist tocilizumab in PMR, unenhanced MRI with T2 short tau inversion recovery (STIR) imaging was used to assess localized myofascial inflammation in pelvic and shoulder girdle sites [19]. That study confirmed myofascial inflammation as a common feature of PMR, and this is again consistent with the hypothesis of primarily extracapsular inflammation in PMR. Furthermore, as reported by the authors, disease monitoring performed by unenhanced MRI convincingly confirmed the expected clinical efficacy of tocilizumab.

Few MRI studies have evaluated the exact localization of inflammation in PMR to date. Different imaging techniques were used, such as showing soft tissue oedema by fat-saturated T2 MRI or using fat-saturated T1 imaging after application of contrast agents as a surrogate for inflammation [13–16, 18, 19]. In our personal experience, the detection of oedema and contrast enhancement is indeed often congruent, especially if severe extracapsular inflammation is present. However, in cases with minor extracapsular inflammation, oedema may not be well detected without contrast application. However, this needs to be studied prospectively and compared directly. A prospective study to shed more light on this will be our next project.

Musculoskeletal US is frequently used in PMR diagnostics, but the technique is greatly dependent on the experience of the examiner, and it is not really used to make a diagnosis of PMR but rather as a supportive imaging test and, using the Doppler technique, for the differential diagnosis of TA [20]. Furthermore, it is

commonly used in the shoulder girdle for detecting synovial inflammation, such as tenosynovitis of the long biceps tendon and subacromial bursitis. In a comprehensive meta-analysis, bilateral subacromial bursitis was found to be the most informative US feature, with a sensitivity of 66% and a specificity of 89%, respectively [21]. Given that the inflammation in PMR does not primarily affect synovial structures, but rather the outer lining of tendons, joint capsules and ligaments, the detection of synovial inflammation by US might well be merely a secondary phenomenon. In addition, subacromial bursitis and long biceps tendon tenosynovitis comprise a frequent epiphenomenon of degenerative glenohumeral joint disease and thus, their specificity is questionable. Finally, given that US is strongly dependent on the experience of the investigator, reproducibility and standardization are more difficult compared with MRI.

Several FDG-PET/CT studies have contributed to the concept of extracapsular inflammation in PMR and detected comparable patterns in the pelvic girdle [6–12]. An advantage of FDG-PET/CT is that owing to its panoramic capability, it is possible to examine many regions that are potentially involved in PMR, and concomitant large vessel vasculitis can be detected en passant. But detailed information in the view of local pathoanatomical information is limited owing to the inferior contrast resolution of the CT component and the low spatial resolution of the PET component. This problem can potentially be overcome by combining FDG-PET/CT with MRI [10]. Using that technique, peritendinitis of the hamstring tendon was found as the local correlate of increased FDG uptake. Although FDG-PET/CT provides largely analogous information regarding the pattern of inflammation seen in PMR in comparison to ceMRI and even outperforms single-region pelvic MRI in terms of providing more general information on the whole body, routine use for a diagnostic work-up for PMR is rather limited owing to availability, radiation exposure and cost.

The limitations of our study are its retrospective nature and the possible imperfections of daily routine imaging. Furthermore, the selection of PMR cases might have been influenced by the availability of pelvic ceMRI, which might result in the selection of more severe cases.

Given that all cases in this study had pelvic girdle pain, we cannot really say anything about patients with predominant shoulder girdle pain, but we intend to study this in more detail in the future.

Clinical data concerning the start of glucocorticoid therapy in relationship to the date of blood sampling and the performance of ceMRI were not precise in a few cases because therapy had already been initiated by a general practitioner. Nevertheless, given that the sensitivity in our data set was rather high, we do not think that some days of glucocorticoid therapy had a major influence on the MRI signals detected.

The classification criteria used in this study are not the most recent ones. In fact, in 2012 a new proposal for classification criteria was published [3, 22]. Given that not all elements of these criteria were available in our charts, we decided not to use them retrospectively. Furthermore, these criteria do not seem to be the last solution [23], and the Bird criteria did not perform badly in a recent trial comparing different criteria [22].

Finally, we can discuss why we included cases of PMR-like onset of RA. These patients were clinically diagnosed with PMR but clinically also had some arthritis and/or developed arthritis at a later time point. Thus, we are not talking about PMR-like RA at time of MRI but PMR that developed later into RA. Of course, whether this really develops into RA or whether it was RA from the beginning cannot be decided finally at the moment. Indeed, whether this not infrequently found clinical feature is more a subtype of RA or a peripheral involvement of PMR has been controversial. As a matter of fact, a recent population-based cohort study showed a significant incidence for the development of polyarthritis in patients diagnosed with PMR [24]. Nevertheless, it was not the aim of the present study to differentiate between pure PMR and PMR-like onset of RA. If one takes this aspect very strictly, it could be argued that PMR-like onset of RA is another disease and that these cases should be part of the control group, but as already stated we took the initial clinical diagnosis of PMR to group the patients. However, as demonstrated in the Results section, this would have only a small effect on the sensitivity and specificity of the proposed system.

Given that we included patients in this study based on the leading clinical symptom of pelvic pain suggestive of PMR and not because the patients had prominent arthritis, we think that it is justified to show the results together. Given that this is a retrospective study, we did not include patients with obvious RA because we would simply not have had MRIs of those patients; there was no clinical reason to ask for that type of imaging. However, a prospective study is needed to confirm that the MRI signal is similar, especially given that an older study, in which no contrast material was used, found differences between patients with pure PMR and RA [13]. Therefore, we propose to study this aspect in more detail prospectively.

Taken together, we think that these results are a solid basis for other groups to test our proposal. However, before they are used in clinical routine practice, a large prospective multicentre study should be performed.

Conclusion

Bilateral inflammation of at least four tendinous or capsular sites, including proximal m. rectus femoris or m. adductor longus origins, in pelvic girdle ceMRI is very characteristic for PMR patients with pelvic girdle involvement and could well be used as a confirmatory test for the clinical diagnosis. Prospective multicentre randomized controlled studies are needed to verify this supposition.

Acknowledgements

Data are available upon reasonable request; all data relevant to the study are included in the article or uploaded as supplementary information.

Funding: No specific funding was received from any funding bodies in the public, commercial or not-for-profit sectors to carry out the work described in this manuscript.

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

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