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International Recommendations for the Use of Imaging in the Diagnosis and Assessment of Polymyalgia Rheumatica

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Abstract

Objectives. To develop international recommendations for the use of imaging in the diagnosis and assessment of polymyalgia rheumatica (PMR).

Methods. An international, multidisciplinary task force of 30 members from 12 countries was convened; the EULAR standard operating procedures were followed. Six clinical key questions addressing the role of imaging (ultrasound, magnetic resonance imaging, ^{18}F-fluorodeoxyglucose positron emission tomography) in diagnosis, monitoring, outcome prediction, and technical aspects in PMR were the basis for a systematic literature review. Recommendations were formulated based on evidence and expert opinion and refined iteratively until consensus was achieved. The level of agreement was assessed by voting.

Results. Three overarching principles and seven recommendations were developed. PMR remains primarily a clinical diagnosis. Imaging is neither required to confirm PMR in patients with a high-clinical-probability for the disease nor to exclude PMR in case of low-clinical-probability. Imaging is most useful in patients with intermediate pre-test probability (i.e., atypical presentations or suspected alternative/overlapping conditions). No single imaging modality demonstrated sufficient accuracy to be recommended as first-line test; therefore, imaging should be individualised according to clinical presentation, differential diagnoses, access and local expertise. Vascular imaging should be performed when overlap with giant cell arteritis is suspected, while systematic screening for subclinical vasculitis is not supported by current evidence. Utilising imaging for disease monitoring or outcome prediction is currently not recommended.

Conclusions. These recommendations provide the first evidence-based guidance for the use of imaging in PMR, reinforcing clinical assessment as the cornerstone of diagnosis and positioning imaging as a context-driven adjunct.

What is already known on this topic

Imaging is increasingly used in polymyalgia rheumatica (PMR), but its optimal use in diagnosis and disease assessment remains unclear.

What this study adds

These are the first international evidence-based recommendations defining when and how imaging should be used in PMR, introducing a pre-test probability-driven framework and positioning imaging as an adjunct in selected patients rather than as a routine test.

How this study might affect research, practice or policy

These recommendations support a more standardized, yet individualised, use of imaging in clinical practice. Key research priorities have been identified to guide future studies and updates.

Introduction

Polymyalgia rheumatica (PMR) is among the most common inflammatory rheumatological diseases of older adults, with an incidence of up to 113 cases per 100,000 individuals aged ≥ 50 years (1,2). It is characterised by bilateral shoulder and pelvic girdle pain and stiffness, usually accompanied by elevated acute phase reactants. Despite its recognisable clinical phenotype, the diagnosis may be challenging, as no disease-specific diagnostic test exists and the presentation can overlap with a broad spectrum of mimicking or co-existing conditions(1,3). In fact, even in tertiary referral centres, approximately 30% of patients initially diagnosed with PMR ultimately receive an alternative diagnosis(4,5), reflecting the multifaceted nature of this disease. Diagnostic uncertainty may be even greater in primary care settings,(6) where PMR is commonly first evaluated. Among the conditions that may overlap with PMR, giant cell arteritis (GCA) deserves particular attention, as imaging evidence of subclinical vascular inflammation has been reported in approximately 10-30% of patients presenting with PMR(7–9).

Over recent years, imaging modalities, particularly ^{18}F-fluorodeoxyglucose positron emission tomography/computed tomography ([^{18}F]FDG-PET/CT), ultrasound (US) and magnetic resonance imaging (MRI), have contributed to a deeper understanding of the inflammatory anatomical lesions underlying this disease(10–13).

US is part of the 2012 American College of Rheumatology (ACR)/European Alliance of Associations for Rheumatology (EULAR) classification criteria for PMR(14), and imaging plays an increasing role in differentiating PMR from other rheumatological and non-rheumatological diseases. Furthermore, vascular imaging is used to detect subclinical GCA, as no universally reliable clinical red flags exist(7–9).

Considerable uncertainties persist about when imaging should be performed, which modality to use, and how to interpret the diagnostic accuracy of each modality. Consequently, in clinical practice, there is substantial variability in the use of imaging in patients with PMR. In contrast to large vessel vasculitis, for which the role for imaging is clearly defined by current EULAR recommendations(15), no such international guidance exists for PMR. To address this gap, an international, multidisciplinary task force was convened to develop evidence-based recommendations for the use of imaging in the diagnosis and assessment of PMR. These aim to support clinicians caring for adults with suspected or established PMR across different clinical settings.

Methods

A multidisciplinary international task force was assembled by the convenors (MB, CD) and the methodologist (SR). The development of the recommendations followed the EULAR Standard Operating Procedures (SOPs) for Task Forces(16).

The task force consisted of 30 members from Europe (n=15), North America (n=10), South America (n=2), Australia (n=2), and Japan (n=1), including rheumatologists, radiologists and nuclear medicine specialists, a general practitioner, a rheumatology nurse specialist, and patient research partners (PRPs [CJ, LN]). PRPs were supported by a designated coordinator (MB) in accordance with the 2024 EULAR recommendations on patients involvement(17). All members disclosed their potential conflicts of interest before starting the process; no conflict was deemed of sufficient magnitude to warrant abstention from participation or voting on any specific recommendation. The steering committee (MB, CD, KvdG, EH, VK, SR, SS) and the task force agreed on six key clinical questions, which were subsequently transformed into the Population, Intervention, Comparator, Outcome (PICO) format. Two questions addressed the role of imaging ([^{18}F]FDG-PET/CT, US and MRI) in diagnosis, one on monitoring, two on outcome prediction, and one on technical aspects. Computed tomography and conventional radiography were not included among the imaging modalities as it does

not allow the evaluation of periarticular soft-tissue inflammation characteristic of PMR(11). The six PICO questions formed the basis for the systematic literature review (SLR)(18), which was conducted by two fellows (VK and EH) under the supervision of the methodologist. A comprehensive search strategy was developed with the support of an experienced librarian (LF) and applied to Ovid MEDLINE, Ovid EMBASE, Epistemonikos, and the Cochrane Library from database inception to July 18, 2025. Peer-reviewed manuscripts and relevant abstracts from the 2023 and 2024 EULAR and ACR Congresses were included. Evidence was summarised narratively and, where feasible, pooled for meta-analysis favouring studies with a lower risk of bias (RoB). The SLR is published separately(18); however, the SLR and the present recommendations form an integral and inseparable whole and should be read as such.

Based on evidence and expert opinion, the steering committee developed preliminary proposals for statements through several online meetings. These were subsequently discussed and refined by the whole task force during two online meetings (7 and 21 October 2025), where the experts reviewed the evidence and formulated the overarching principles and specific recommendations. All statements were interactively refined and subsequently voted on. In accordance with the EULAR SOPs(16), consensus was defined as >75% agreement in the first voting round, >66% in the second, and >50% in the third.

The 2011 Oxford Centre for Evidence Based Medicine levels of evidence (LoE)(19) derived from the SLR were added to each recommendation. Finally, each task force member anonymously indicated the level of agreement with each statement using Survey Monkey (LoA, 0-10 numeric rating scale with 0=do not agree and 10=fully agree). The mean and standard deviation of the LoA, as well as the percentage of task force members with an agreement ≥8 are presented.

Finally, the task force also formulated a research agenda to highlight knowledge gaps and to prioritise areas where further research is needed.

Results

The task force agreed on three overarching principles and seven specific recommendations as depicted in **Table 1** and detailed below.

Overarching principles

The overarching principles outline the fundamental tenets of good clinical practice in PMR. While not always directly based on evidence, these statements establish the framework for the interpretation and implementation of subsequent specific recommendations.

Overarching principle A. *History, clinical examination, and laboratory testing form the basis for the diagnosis of PMR, considering also potential mimicking and overlapping conditions.*

In individuals aged 50 years or older with suspected PMR, clinicians should carefully evaluate the presence of its characteristic symptoms, including bilateral shoulder and hip girdle pain and prolonged morning stiffness, as well as elevated erythrocyte sedimentation rate or C-reactive protein (CRP)(20–22,14). This assessment provides the basis for estimating the clinical probability of a diagnosis of PMR and identifies potential clues for mimicking or overlapping conditions, thereby defining when imaging may be helpful, as outlined below. Polymyalgic symptoms may in fact represent the initial manifestation of several other conditions, both rheumatological (e.g., late-onset rheumatoid arthritis, spondyloarthritis, chondrocalcinosis, osteoarthritis, GCA, inflammatory myopathies) and non-rheumatological (e.g., malignancies, infections as well as endocrine, neurological or metabolic diseases)(3). Additional diagnostic tests (beyond those addressed by the

recommendations below) may be needed in these cases, particularly when patients present with atypical features, an unusual disease course, or discordant laboratory findings raise diagnostic uncertainty or suspicion of alternative conditions (also see recommendation 1-3).

Overarching principle B. *If imaging is performed, it complements but does not replace clinical and laboratory evaluation.*
When imaging is deemed necessary, it should not be used as a stand-alone tool but rather requested and interpreted within the full clinical-laboratory context. The term "complements" was deliberately chosen to emphasise that imaging may add value in selected situations without replacing core clinical judgement. Interpretation of imaging findings is facilitated by discussion between clinicians and radiologists or nuclear medicine physicians.

Overarching principle C. *If imaging is conducted, it should be performed using appropriate equipment, standardised operational procedures and settings, and interpreted by a trained specialist in PMR. Suggested technical and operational parameters are provided in* ***Box 1****.*
Although studies dedicated at assessing the impact of operator expertise on imaging performance in PMR or at the training required to qualify as a specialist are lacking, the task force agreed on the need for adequate technical standards, appropriate expertise and standardised procedures when performing and interpreting imaging in this setting, as reported in **Box 1**. The term "specialist" was deliberately chosen to encompass all professionals involved in imaging acquisition and interpretation, who should be familiar with PMR-specific patterns and pitfalls, and whose competence should extend beyond general musculoskeletal imaging to include disease-specific knowledge of PMR. This includes radiologists, nuclear medicine physicians, rheumatologists, internal medicine physicians, general practitioners as well as other trained health professionals, recognising that image quality and diagnostic accuracy depend on specific training in inflammatory musculoskeletal disorders. The task force also highlighted that imaging in PMR is frequently multidisciplinary and that close collaboration among specialists plays a central role to ensure high-quality imaging and appropriate integration of results into clinical decision-making across diverse healthcare settings.

Recommendations
Recommendations 1-3 define the role of imaging in the diagnostic pathway according to the pre-test probability (**Figure 1**) in suspected new-onset or relapsing PMR. They should not be interpreted as discouraging additional investigations when differential diagnoses are considered. Subsequent recommendations address the practical application of imaging, including modality selection, evaluation of GCA overlap, optimal timing in relation to glucocorticoid (GC) therapy, monitoring and outcome prediction (**Table 1**).

Recommendation 1. *In people with suspected PMR, the diagnosis can be made without imaging if typical clinical and laboratory features are present.*
PMR is characterised by an acute or subacute onset of bilateral shoulder and pelvic girdle pain and stiffness, more prominent after immobilisation (e.g., early morning), together with elevated inflammatory markers, in individuals aged 50 years or older(1). The task force agreed that, in most patients with suspected PMR presenting with typical clinical features, imaging is not required to confirm the diagnosis. In addition, it remains unclear whether routine baseline imaging in patients

with a high clinical probability of PMR reduces the likelihood of subsequent diagnostic reclassification.

One prospective(23) and two retrospective studies on [^{18}F]FDG-PET/CT(24,25) explored whether adding imaging to clinical evaluation could improve diagnostic accuracy in patients with suspected PMR. In the prospective study from Nielsen et al.(23) (RoB: some concerns) data from the investigation cohort of treatment-naïve patients showed that clinical assessment alone already had high diagnostic performance (specificity 82% and sensitivity 94%). Adding [^{18}F]FDG-PET/CT findings increased specificity (to 93%) but reduced sensitivity (to ~80%) when the final follow-up diagnosis was used as the reference standard. Similar findings were confirmed retrospectively by Wang et al.(24). Consistently, Lee et al.(26) reported that incorporating US (evidence of inflammation in ≥1 shoulder and ≥1 hip) in the 2012 EULAR/ACR criteria increased specificity from 74 to 95%, but markedly reduced sensitivity (from 89 to 45%) when using the final diagnosis at 12 months as the reference standard. Taken together, these findings indicate that the overall diagnostic benefit of performing imaging upfront in all patients with suspected PMR and typical clinical presentations is limited: while imaging may increase diagnostic specificity and help avoid overtreatment of patients without PMR, it may also reduce sensitivity and therefore miss some true cases at initial presentation. Although the vast majority of the studies included only patients with newly suspected PMR, and only two specifically evaluated relapsing patients(27,28), the task force agreed that the same principles should be applied in new cases as well as in those with a suspected relapse.

Recommendation 2. *In people with a low clinical probability of PMR (non-inflammatory clinical and laboratory features), the diagnosis can be excluded without imaging.*

In people presenting with non-inflammatory symptoms (e.g., mechanical shoulder or lumbar spine pain and normal inflammatory markers) or having clinical features suggestive of an alternative diagnosis (e.g. rheumatoid nodules or bone erosions), the likelihood of PMR is low. Considering the available evidence, imaging is usually unnecessary to rule out the diagnosis in this clinical scenario. Although some experts did not believe this assertion was necessary (particularly given the absence of specific studies)(18), it was retained for two reasons. First, in an era when referral practices for individuals with suspected PMR are not standardized, people with a low likelihood of PMR and a high suspicion of alternative non-inflammatory conditions (e.g., osteoarthritis, fibromyalgia) should not be referred for imaging solely to "rule out" PMR. This also applies to clear non-inflammatory cases in which GC have been erroneously initiated, as treatment can be safely discontinued after clinical reassessment alone. Second, the task force intended to emphasise the importance of the clinical pre-test probability for decision on and interpretation of diagnostic tests, and to clarify that imaging is pertinent only when diagnostic uncertainty exists (see recommendation 3). Unnecessary use of imaging may expose people to needless procedures and may lead to avoidable healthcare resource consumption and medical costs.

Recommendation 3. *In people with suspected, relapsing, or refractory PMR who present with atypical clinical or laboratory features, imaging may be used to support the diagnosis or evaluate for other conditions.*

The task force agreed that imaging plays a central role in more complex scenarios with an intermediate pre-test probability for PMR (e.g., when clinical features and laboratory findings are discordant or when alternative diagnoses are being considered). In such situations, imaging can help refine and expedite the diagnostic pathway, although its findings must always be interpreted within the clinical context. In other words, imaging may be useful not only to support a diagnosis of PMR in uncertain cases, but also to identify mimicking or overlapping conditions(3). For the diagnostic

confirmation of overlapping conditions or mimickers, which lie beyond the scope of this work, clinicians should refer to relevant international recommendations(15,29–31).

For the diagnosis of PMR, the more substantial body of evidence results from [^{18}F]FDG-PET/CT studies(18,23–25,27,32–48). Diagnostic accuracy of this method, according to the meta-analysis of studies with "some concerns" RoB, demonstrated a pooled sensitivity of 89-93% and a specificity of 88-93%. However, the diagnostic performance declined substantially when comparator groups of patients with other inflammatory (rather than a mix of inflammatory and non-inflammatory) musculoskeletal diseases were considered(33,34). The pooled specificity dropped to 47%, while the sensitivity remained high at 88%. This marked reduction in specificity is particularly relevant for clinical practice, as these comparators closely reflect the differential diagnoses that are commonly seen in routine care. Therefore, this limitation should be considered when using [^{18}F]FDG-PET/CT in daily clinical practice as a means of confirming or ruling out PMR. Limited evidence is available on the accuracy of [^{18}F]FDG-PET/CT in distinguishing PMR from secondary forms such as those linked to occult malignancy or chronic infections, which account for approximately 3-8% of PMR-like presentations(49,50). The task force was nevertheless of the opinion that [^{18}F]FDG-PET/CT may be particularly useful in patients with atypical presentations (e.g., fever/night sweats, diffuse myalgia and arthralgias, marked weight loss or limited response to GC therapy) in whom these alternative diagnoses are suspected(51).

US consistently identified the characteristic extracapsular inflammatory pattern of PMR, particularly involving subacromial-subdeltoid bursitis and long-head biceps tenosynovitis, whereas hip synovitis or trochanteric bursitis were reported only in a subset of studies(26,28,52–56). The task force agreed that, while no single US elementary lesion provides sufficient diagnostic accuracy on its own, the strength of US lies in the integration of multiple sites(26,54,55), which substantially increases the diagnostic yield, its dynamic real-time integration with clinical findings, absence of radiation, wide availability, and low cost. Importantly, US may reveal findings consistent with alternative diagnoses, such as rotator cuff tears, erosive arthritis and enthesitis, as well as calcium pyrophosphate deposition(52,53).

MRI provides high-resolution anatomical details and has contributed to characterising a distinctive extra-articular inflammatory pattern in PMR. Across the studies included in the SLR, MRI consistently demonstrated inflammation of periarticular soft tissues (particularly capsulitis, peritendinitis, peri-trochanteric bursitis, and bone marrow oedema) rather than primary joint synovitis, reinforcing the concept that PMR is primarily an inflammatory disease of periarticular structures(12,13,57,58). A prospective study with "some concerns" RoB(57) revealed that individual shoulder MRI findings had only moderate diagnostic accuracy (sensitivity 59-72% and specificity 56-81%), whereas their combination markedly improved diagnostic performance (sensitivity 76% and specificity 85%). This mirrors observations from US studies, highlighting that combining different lesions provides substantially higher diagnostic utility than single abnormalities. Notably, these lesions were substantially less frequent in mimicking diseases, such as rheumatoid arthritis or degenerative shoulder disease, where capsulitis and peritendinitis were observed in ≤35% of cases.

Overall, imaging may provide supportive information in selected cases with diagnostic uncertainty, when integrated with clinical and laboratory findings. No single imaging modality can be considered superior to another, and when one technique is inconclusive, different imaging modalities may offer complementary information and may be used in an integrated manner.

Recommendation 4. *The use of imaging should be individualised, considering clinical presentation, laboratory results, access and potential differential diagnoses.*

The task force agreed that the selection of the imaging modality in PMR should be guided by the individual clinical situation, such as the specific symptoms, the expected diagnostic gain, the competing diagnostic hypotheses, and all other patient-based considerations (e.g., claustrophobia, metallic implants/devices). From the SLR, it was concluded that no imaging modality demonstrated sufficient accuracy to serve as a universal first-line test, and no direct comparative studies between techniques are available(18). Across [^{18}F]FDG-PET/CT, MRI and US, diagnostic performance depended on the clinical context and improved when multiple anatomical sites were assessed, supporting a complementary rather than hierarchical use of imaging modalities. The term "access" encompasses not only local availability but also centre expertise and organisational factors influencing timeliness and interpretation, noting that training and standardisation in PMR imaging remain relatively early compared with those in many other rheumatic diseases.

Recommendation 5. *In patients with PMR, vascular imaging to screen for large vessel vasculitis is not routinely recommended; imaging should be obtained if there is clinical suspicion of large vessel vasculitis.*

The task force agreed that vascular imaging should be performed in people with PMR whenever there is suspicion of overlap with GCA. Importantly, suspicion should not rely solely on classical cranial or systemic symptoms, rather it should be actively sought through careful clinical assessment, including a thorough physical examination with evaluation of peripheral pulses, vascular bruits and bilateral blood pressure measurement. In case vascular imaging is conducted, it should follow the respective EULAR recommendations(15).

A major area of discussion concerned whether vascular imaging should be used routinely to screen for subclinical vasculitis in all people with PMR. Subclinical vasculitis, defined as imaging evidence of cranial or extra-cranial vessel inflammation in the absence of typical clinical signs or symptoms of GCA, has been reported in approximately 10-30% of people with PMR(7,8). In the absence of reliable clinical predictors, routine vascular imaging has been proposed by some task force members as a strategy to detect these cases. However, after thorough discussion, it was decided against recommending routine screening, as the clinical and prognostic significance of subclinical vascular inflammation remains at the moment uncertain, and no "low" RoB studies have demonstrated a benefit of systematic screening over a clinically driven approach. This gap was therefore identified as a priority for future research.

A prospective multicentre US study(59), rated as having "some concerns" RoB, revealed a higher relapse rate in people with subclinical GCA compared to those with negative vascular US (62 vs 16%), despite higher baseline GC doses in the former group. In contrast, four [^{18}F]FDG-PET/CT studies(9,37,60,61) (rated from "some concerns" to "high" RoB) suggested that baseline low-grade vascular [^{18}F]FDG uptake, although often influencing initial treatment decisions, did not reliably predict disease course, including relapse risk or long-term outcomes. Only well-designed prospective studies comparing routine screening with vascular imaging against an approach where imaging is requested in case of clinical suspicion for GCA will clarify whether the former provides a true clinical benefit over the latter.

Recommendation 6. *If imaging is performed, it should ideally be undertaken before the initiation of glucocorticoid therapy in new patients, and before dose escalation in cases of relapse.*

The task force agreed that imaging should ideally be performed before initiation of GC therapy (or GC escalation in relapsing patients), as GC exposure can rapidly reduce the sensitivity of imaging modalities and compromise diagnostic accuracy in a dose- and time-dependent manner(27,33,39,45–47,62,63). Evidence from the SLR(18) consistently indicated that [^{18}F]FDG-PET/CT is particularly affected by GC treatment, with a marked and early decline in diagnostic performance after treatment. [^{18}F]FDG-PET/CT sensitivity decreased from 86% at baseline to 36% after 8 weeks of GC exposure(33), with partial recovery after GC tapering or discontinuation(27,33).

MRI findings appeared less susceptible to GCs than [^{18}F]FDG-PET/CT results(63), but reductions in sensitivity were still reported, particularly concerning the detection of vascular inflammation. No data assessing the impact of GC exposure on the diagnostic performance of US were found(18).
At the same time, the group acknowledged important real-world constraints, including delayed referral pathways, variability in primary care management, and the need to initiate treatment promptly in symptomatic patients. In individuals already receiving GC therapy, a dose reduction or temporary discontinuation before imaging, even if theoretically desirable, may not be feasible, as it can lead to recrudescence of symptoms or, in cases of concomitant GCA, to ischaemic complications.

Recommendation 7. *Routine imaging is not recommended for monitoring disease activity in patients with PMR.*
The task force agreed that imaging should not be used routinely to monitor disease activity in people with PMR, and that clinical assessment and laboratory parameters should remain the primary monitoring tools. There is no evidence that imaging improves the diagnostic assessment of relapse or reliably informs treatment decisions, such as GC tapering or the use of GC-sparing agents. Moreover, only a limited number of heterogeneous studies have investigated the responsiveness, sensitivity to change, or association of imaging findings with clinical and laboratory parameters during follow-up, with largely inconsistent and inconclusive results(33,64–68). Overall, US and [^{18}F]FDG-PET/CT studies demonstrated a rapid reduction of inflammatory lesions under GC treatment, revealing good sensitivity to change that was comparable to, or even better than that of inflammatory markers(33,67,68).
Under tocilizumab treatment, where conventional inflammatory markers are unreliable and imaging would theoretically be expected to provide additional information (particularly in the case of a suspected relapse), available data do not support a meaningful role for imaging, as both US and [^{18}F]FDG-PET/CT frequently showed persistent inflammatory abnormalities or low-grade uptake, respectively, despite stable clinical remission. Besides, there was no consistent correlation of imaging with clinical disease activity(65,66).
The task force further agreed that imaging, either at baseline or during follow-up, is currently not indicated for outcome prediction in PMR, given the preliminary and conflicting evidence available in the literature(18,33,37,57,60,67,69–73).

Research agenda
The SLR(18) informing these recommendations identified key gaps in the literature, which, together with task force discussions, informed the proposed research agenda (**Box 2**).

Discussion
These are the first international recommendations specifically addressing the use of imaging in PMR. A central message emerging from this work is that PMR (new-onset and relapsing) remains primarily a clinical diagnosis, with imaging used in selected cases according to the expected incremental diagnostic gain. Accordingly, these recommendations define three distinct clinical scenarios: high, intermediate, and low pre-test clinical probability (contrasting with the two-level approach used in large vessel vasculitis)(15). Although no standardised tool exists to assess such categories, this probability-driven framework is particularly relevant given that polymyalgic symptoms may reflect

a wide range of mimicking or overlapping conditions(3) and the development and validation of a model for pre-test probability stratification represents a priority item of the research agenda.

The task force believes that imaging has its highest utility in patients with an intermediate pre-test probability, including those with atypical presentations, discordant laboratory findings, relapsing or refractory disease. The slightly lower level of agreement observed for Recommendations 2 and 3 likely reflects the challenges inherent to defining the role of imaging across different pre-test probability scenarios, particularly in a field where evidence remains limited and clinical practice is highly variable.

Vascular imaging represents a highly debated aspect of PMR assessment. The task force agreed that vascular imaging should be performed promptly whenever there is clinical suspicion of GCA, even at a low threshold. However, current evidence does not support routine screening for subclinical vasculitis in all patients with PMR.

Regarding disease monitoring, the available evidence(18) does not support routine imaging to assess disease activity or to predict outcomes in PMR. Persistent imaging abnormalities are frequently observed despite clinical remission and have not been shown to reliably predict outcomes. It remains unclear whether these findings reflect ongoing inflammation or other processes such as tissue remodelling, a limitation also recognised in other diseases including GCA(74,75), but the clinical relevance of these findings is still unclear. Histological studies, targeted molecular imaging of immune cells and long-term clinical follow-up studies are needed to clarify these issues.

Similar to the first EULAR imaging recommendations for LVV(15), these PMR recommendations were developed in the context of a limited, heterogeneous and overall low-quality evidence base. While imaging has provided important pathophysiological insights, the available data were less robust than initially anticipated, precluding more specific or prescriptive guidance and necessitating a cautious, principle-based approach. As observed in LVV, where subsequent evidence enabled more refined recommendations in later updates, the proposed research agenda aims to stimulate high-quality studies that will allow future revisions that are based on more solid evidence.

Although the task force included members from four continents, European and North American representatives accounted for the majority of participants (n=25 out of 30), which may limit the generalisability of these recommendations to other healthcare systems. This geographical distribution of task force members largely reflects the current concentration of expertise in the field, where most research output and recognised experts are based in Europe and North America. Another consideration is the fact that most evidence on imaging in PMR has been generated in specialist settings, while a substantial proportion of patients are managed in primary care. Future studies should therefore include more diverse healthcare environments, particularly primary care settings, as well as different referral pathways to improve external validity. Another important limitation is the lack of direct head-to-head comparisons between imaging modalities. Consequently, no imaging technique could be recommended as a universal first-line test, and modality selection remains dependent on the clinical context, local expertise, and availability. In addition, the proposed framework is based on clinical pre-test probability, yet no validated tool currently exists to formally categorise patients into low-, intermediate-, or high-probability groups. This highlights an important area for future research.

Overall, these recommendations represent an important first step toward defining the role of imaging in PMR. Until more robust evidence becomes available, they provide a structured, evidence-informed framework to support context-driven and judicious use of imaging in daily clinical practice.

Table 1. International recommendations for the use of imaging in polymyalgia rheumatica.

	LoE	LoA (0-10)	% with LoA≥8
Overarching principles			
A. History, clinical examination, and laboratory testing form the basis for the diagnosis of polymyalgia rheumatica (PMR), considering also potential mimicking and overlapping conditions.	n.a.	9.6 (0.9)	93.1
B. If imaging is performed, it complements but does not replace clinical and laboratory evaluation.	n.a.	9.4 (1.2)	89.6
C. If imaging is conducted, it should be performed using appropriate equipment, standardized operational procedures and settings, and interpreted by a trained specialist in PMR. Suggested technical and operational parameters are provided in **Box 1**.	n.a.	9.7 (0.7)	96.5
Recommendations			
1. In people with suspected PMR, the diagnosis can be made without imaging if typical clinical and laboratory features are present.	3	9.3 (1.4)	89.6
2. In people with a low clinical probability of PMR (non-inflammatory clinical and laboratory features), the diagnosis can be excluded without imaging.	3	9.1 (1.8)	86.2
3. In people with suspected, relapsing, or refractory PMR, who present with atypical clinical or laboratory features, imaging may be used to support the diagnosis or evaluate for other conditions.	4	9.3 (1.2)	86.2
4. The use of imaging should be individualised, considering clinical presentation, laboratory results, access and potential differential diagnoses.	5	9.4 (1.1)	96.5
5. In patients with PMR, vascular imaging to screen for large vessel vasculitis is not routinely recommended; imaging should be obtained if there is clinical suspicion of large vessel vasculitis.	3	9.6 (0.8)	96.7
6. If imaging is performed, it should ideally be undertaken before the initiation of glucocorticoid therapy in new patients, and before dose escalation in cases of relapse.	2	9.8 (0.6)	100
7. Routine imaging is not recommended for monitoring disease activity in patients with PMR.	3	9.8 (0.8)	96.5

Numbers in the columns “level of agreement” (LoA) indicate the mean and standard deviation (SD, in parenthesis) of the LoA (assessed on a scale from 0=no agreement to 10=full agreement), and the proportion of task force members with a score of at least 8/10. The level of evidence (LoE) was assessed according to the Oxford Centre for Evidence-Based Medicine 2011(19).

Box 1. Suggestions for technical and operational parameters on imaging modalities in PMR.
All imaging modalities should be performed as early as possible, ideally before or shortly after initiation of glucocorticoid therapy.

Musculoskeletal ultrasound ⇒ High-quality, modern ultrasound equipment with appropriate frequency linear transducers is recommended (e.g. 7.5-14MHz for deep and >12MHz for more superficial structures), with optimized grey scale settings. ⇒ Linear probes with high frequencies should be used for superficial periarticular structures of the shoulder and pelvic girdle; lower frequencies may be required for deeper structures. ⇒ Key anatomical sites to be assessed bilaterally include subacromial-subdeltoid bursae, long-head biceps tendon, glenohumeral joint, trochanteric bursae and peri-tendinous/peri-articular soft tissues of hips. ⇒ Grey-scale and, if possible, Colour or Power Doppler imaging should be performed at each site, with Doppler settings optimised to detect low-velocity flow. ⇒ Gain and pulse repetition frequency should be adjusted to avoid under- or overestimation of Doppler signal.
Magnetic resonance imaging (MRI) ⇒ MRI examinations should preferably be performed on 1.5 T or 3.0 T scanners using dedicated surface coils. ⇒ Bilateral imaging of shoulders and/or pelvic girdle is recommended using a large field of view. ⇒ Sequences should include T1-weighted and fluid-sensitive fat-suppressed sequences (e.g., STIR or SPAIR) in at least two orthogonal planes. ⇒ Gadolinium-enhanced T1-weighted fat-suppressed sequences are recommended to improve detection of inflammatory changes. ⇒ MRI should assess periarticular and extra-articular inflammatory changes, including bursitis, tenosynovitis, peritendinous and pericapsular inflammation, and joint synovitis.
^{18}F-fluorodeoxyglucose positron emission tomography ([^{18}F]FDG-PET/CT)* ⇒ Patients should be positioned supine, with arms down. ⇒ Imaging should extend from the skull base to at least mid-thigh, preferably to below the knee. ⇒ Blood glucose levels should preferably be <7 mmol/L (126 mg/dL); values <10 mmol/L (180 mg/dL) are acceptable. ⇒ The interval between [^{18}F]FDG injection and image acquisition should be ≥60 min, preferably 90-120 min. ⇒ Visual qualitative assessment is recommended; if uptake is equivocal, comparison with liver uptake may be used (visual grading 0–3, with 2=liver uptake). Further scan interpretation can be guided by the Leuven Score(32) or the Leuven/Groningen(34) score. ⇒ [^{18}F]FDG-PET/CT is usually combined with low-dose CT; it may also be combined with MRI where available (for both musculoskeletal and vascular sites).
Vascular imaging ⇒ If vascular imaging is indicated, technical and operational parameters should follow the current EULAR recommendations for imaging in large vessel vasculitis(15).

CT, computed tomography; EULAR, European Alliance of Associations for Rheumatology; [^{18}F]FDG-PET/CT, ^{18}F-fluorodeoxyglucose positron emission tomography/computed tomography; MRI, magnetic resonance imaging; MSK US, musculoskeletal ultrasound; STIR, short tau inversion recovery; SPAIR, spectral attenuated inversion recovery; T, tesla.
*, full procedural recommendations are reported elsewhere(15,76).

Box 2. Research agenda

1. Diagnosis and differential diagnosis

- Development and validation of a prediction model for pre-test clinical probability stratification in suspected PMR and PMR relapse, to operationalise the three-tier framework (low, intermediate, high) proposed in these recommendations and guide the targeted use of imaging in clinical practice.
- Prospective, adequately powered studies to determine the diagnostic accuracy and yield of individual imaging findings and composite imaging patterns across ultrasound, MRI, and [^{18}F]FDG-PET (performed as PET/CT or PET/MRI) in real-world populations with suspected PMR, using appropriate comparators, robust reference standards, and predefined follow-up.
- To clarify the ability of imaging to differentiate PMR from key mimicking and overlapping conditions, including late-onset rheumatoid arthritis, spondyloarthritis, crystal-associated disease, degenerative disorders, malignancies, drug-induced myopathies and infection.
- Direct comparisons of imaging modalities, assessing incremental diagnostic value over clinical and laboratory assessment alone, across different pre-test probability scenarios.

2. Imaging in relapse and refractory disease

- Prospective cohorts enrolling patients with suspected relapsing or refractory PMR to evaluate the diagnostic accuracy of US, MRI and [^{18}F]FDG-PET (performed as PET/CT or PET/MRI) after treatment initiation.

3. Timing of imaging and treatment effects

- Prospective studies to better define the impact of glucocorticoid dose and timing on the sensitivity of different imaging modalities.
- Comparative studies evaluating the relative performance of ultrasound, MRI and [18F]FDG-PET (performed as PET/CT or PET/MRI) at different time points following treatment initiation, to identify the most appropriate imaging modality according to treatment duration.
- Determination of the optimal glucocorticoid tapering or washout period to restore imaging sensitivity across different modalities.
- To identify the optimal time window for imaging after immunosuppressive treatment initiation/tapering/discontinuation.

4. Prognostic value, monitoring and imaging-guided management

- Longitudinal studies assessing whether baseline imaging findings predict outcomes (e.g., relapse risk, glucocorticoid dependence).
- Studies clarifying the clinical significance of persistent imaging abnormalities in patients in clinical remission; and correlating these abnormalities with immunological responses in the affected tissues.
- Determine whether defining "imaging remission" is clinically meaningful in PMR, by assessing the relationship between changes in imaging findings (e.g., [^{18}F]FDG-PET uptake, US bursitis or Doppler signal) and patient-relevant outcomes, including relapse risk, glucocorticoid requirements and long-term disease control, before developing standardized imaging-based response or remission criteria.
- Randomized, pragmatic or comparative studies evaluating imaging-guided versus clinically guided management strategies in PMR, including effects on treatment trajectories, outcomes and cumulative glucocorticoid exposure.

5. Vascular imaging and PMR-GCA spectrum

- Comparative studies evaluating the diagnostic performance of vascular US, [^{18}F]FDG-PET (performed as PET/CT or PET/MRI), CT angiography and MRI for the detection of large-vessel involvement in PMR.
- Prospective studies assessing the prognostic relevance of subclinical or incidentally detected large-vessel inflammation by imaging in PMR, including associations with adverse outcomes such as cardiovascular events or aortic dilatation.
- To investigate whether patients with PMR and subclinical GCA should be treated as PMR or as GCA with respective treatment regimens.

6. Technical standardisation and methodological aspects

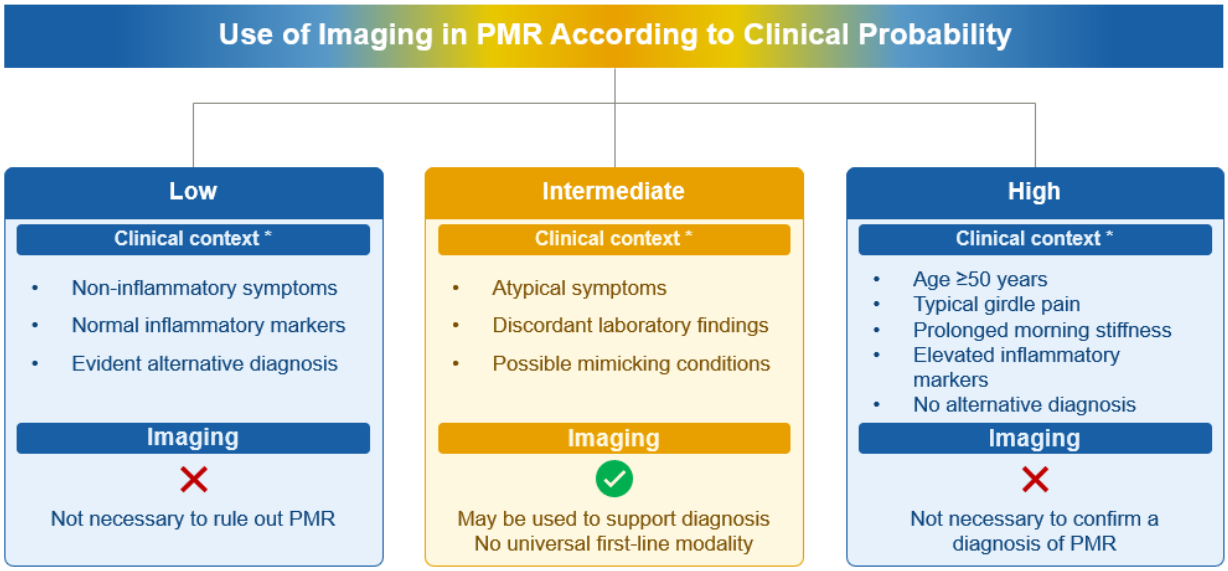
- Development (US, MRI) and validation (US, MRI, [^{18}F]FDG-PET) of PMR-specific imaging scoring systems, and definition of which scores should be used in clinical trials.
- Investigation of alternative PET tracers beyond [^{18}F]FDG for disease activity or relapse assessment.
- International consensus on image acquisition protocols across imaging modalities.
- Studies assessing inter- and intra-reader reliability, learning curves and impact of structured training for the different imaging modalities
- Exploration of automated and artificial intelligence (AI)-assisted image analysis methods to support standardisation, improve reproducibility, and reduce reader dependency across imaging modalities to improve the accuracy of the test for diagnosis and monitoring.

7. Patient-centred and health system outcomes

- Research should assess patient-reported outcomes, cost-effectiveness, accessibility and healthcare utilisation associated with different imaging strategies.
- To further explore the role of imaging within multidisciplinary care pathways and fast-track models.

[^{18}F]FDG-PET, ^{18}F-fluorodeoxyglucose positron emission tomography; CT, computed tomography; GC, glucocorticoids; MRI, magnetic resonance imaging; PMR, polymyalgia rheumatica; US, ultrasound; GCA, giant cell arteritis.

Figure 1. Conceptual framework for the use of imaging in the diagnostic work-up of suspected new-onset or relapsing PMR according to pre-test clinical probability.
In patients with a low clinical probability (orange box), imaging is not required to rule out PMR. In patients with an intermediate clinical probability (yellow box), imaging may be useful to support the diagnosis and/or evaluate alternative or overlapping conditions, with no universal first-line modality. In patients with a high clinical probability (green box), imaging is not required to confirm the diagnosis. This framework does not discourage the use of imaging when clinically indicated to investigate potential differential diagnoses.



Bibliography

1. Espígol-Frigolé G, Dejaco C, Mackie SL, Salvarani C, Matteson EL, Cid MC. Polymyalgia rheumatica. The Lancet. 2023 Oct;402(10411):1459–72. doi:10.1016/S0140-6736(23)01310-7

2. Sharma A, Mohammad AJ, Turesson C. Incidence and prevalence of giant cell arteritis and polymyalgia rheumatica: A systematic literature review. Semin Arthritis Rheum. 2020 Oct;50(5):1040–8. doi:10.1016/j.semarthrit.2020.07.005 PubMed PMID: 32911281.

3. Bond M, Dejaco C. Polymyalgia rheumatica: crafting the future of a simple (but not easy!) clinical syndrome. Ann Rheum Dis. 2023 Dec 8;ard-2023-225192. doi:10.1136/ard-2023-225192 PubMed PMID: 38071513.

4. Caporali R, Montecucco C, Epis O, Bobbio-Pallavicini F, Maio T, Cimmino MA. Presenting features of polymyalgia rheumatica (PMR) and rheumatoid arthritis with PMR-like onset: a prospective study. Ann Rheum Dis. 2001 Nov;60(11):1021–4. doi:10.1136/ard.60.11.1021 PubMed PMID: 11602472; PubMed Central PMCID: PMC1753411.

5. Paltta J, Suuronen S, Pirilä L, Palomäki A. Differential diagnostics of polymyalgia rheumatica in a university hospital in Finland. Scandinavian Journal of Rheumatology. 2023 Nov 2;52(6):689–95. doi:10.1080/03009742.2023.2215044 PubMed PMID: 37335188.

6. Fors C, Bergström U, Willim M, Pilman E, Turesson C. Validity of polymyalgia rheumatica diagnoses and classification criteria in primary health care. Rheumatol Adv Pract. 2019 Aug 27;3(2):rkz033. doi:10.1093/rap/rkz033 PubMed PMID: 31660474; PubMed Central PMCID: PMC6799851.

7. Hemmig AK, Gozzoli D, Werlen L, Ewald H, Aschwanden M, Blockmans D, et al. Subclinical giant cell arteritis in new onset polymyalgia rheumatica A systematic review and meta-analysis of individual patient data. Semin Arthritis Rheum. 2022 Aug;55:152017. doi:10.1016/j.semarthrit.2022.152017 PubMed PMID: 35537222.

8. De Miguel E, Macchioni P, Conticini E, Campochiaro C, Karalilova R, Monti S, et al. Prevalence and characteristics of subclinical giant cell arteritis in polymyalgia rheumatica. Rheumatology. 2023 May 2;kead189. doi:10.1093/rheumatology/kead189

9. Moreel L, Boeckxstaens L, Betrains A, Smans T, Molenberghs G, Van Laere K, et al. Prevalence, characteristics, and outcome of subclinical vasculitis in polymyalgia rheumatica: a retrospective cohort study. Rheumatology. 2024 Dec 1;63(12):3331–6. doi:10.1093/rheumatology/keae208

10. Liu B, Hendrikse E, van der Geest KSM, Brouwer E, Glaudemans AWJM, Slart RHJA. PET imaging of polymyalgia rheumatica: update and future trends. Semin Nucl Med. 2026 Apr 7;S0001-2998(26)00077-2. doi:10.1053/j.semnuclmed.2026.03.008 PubMed PMID: 41951496.

11. Owen CE, Poon AMT, Liu B, Liew DFL, Yap LP, Yang V, et al. Characterising polymyalgia rheumatica on whole-body 18F-FDG PET/CT: an atlas. Rheumatol Adv Pract. 2024;8(1):rkae003. doi:10.1093/rap/rkae003 PubMed PMID: 38375531; PubMed Central PMCID: PMC10876394.

12. Fruth M, Seggewiss A, Kozik J, Martin-Seidel P, Baraliakos X, Braun J. Diagnostic capability of contrast-enhanced pelvic girdle magnetic resonance imaging in polymyalgia rheumatica. Rheumatology. 2020 Oct 1;59(10):2864–71. doi:10.1093/rheumatology/keaa014

13. Fruth M, Künitz L, Martin-Seidel P, Tsiami S, Baraliakos X. MRI of shoulder girdle in polymyalgia rheumatica: inflammatory findings and their diagnostic value. RMD Open. 2024 May;10(2):e004169. doi:10.1136/rmdopen-2024-004169

14. Dasgupta B, Cimmino MA, Maradit-Kremers H, Schmidt WA, Schirmer M, Salvarani C, et al. 2012 provisional classification criteria for polymyalgia rheumatica: a European League Against Rheumatism/American College of Rheumatology collaborative initiative. Annals of the Rheumatic Diseases. 2012 Apr;71(4):484–92. doi:10.1136/annrheumdis-2011-200329

15. Dejaco C, Ramiro S, Bond M, Bosch P, Ponte C, Mackie SL, et al. EULAR recommendations for the use of imaging in large vessel vasculitis in clinical practice: 2023 update. Ann Rheum Dis. 2023 Aug 7;ard-2023-224543. doi:10.1136/ard-2023-224543 PubMed PMID: 37550004.

16. SPOs concerning EULAR task forces v. 28.06.2022 - Update_EULAR SOPs_vs56_ 03102025 _final official approved with cover.pdf [Internet]. [cited 2025 Dec 1]. Available from: https://www.eular.org/web/static/lib/pdfjs/web/viewer.html?file=https://www.eular.org/document/download/1320/348a05f7-bb0f-497d-aba5-1d8351e00aba/1228

17. Wit M de, Aouad K, Elhai M, Benavent D, Bertheussen H, Blackburn S, et al. EULAR recommendations for the involvement of patient research partners in rheumatology research: 2023 update. Annals of the Rheumatic Diseases. 2024 Nov 1;83(11):1443–53. doi:10.1136/ard-2024-225566 PubMed PMID: 38876509.

18. Victoria Konzett andElvis Hysa. Imaging for diagnosis, monitoring and outcome prediction of polymyalgia rheumatica: a systematic literature review and meta- analysis informing an international task force.

19. OCEBM Levels of Evidence [Web Page] [Internet]. [cited 2025 Dec 14]. Available from: https://www.cebm.ox.ac.uk/resources/levels-of-evidence/ocebm-levels-of-evidence

20. Bird HA, Esselinckx W, Dixon AS, Mowat AG, Wood PH. An evaluation of criteria for polymyalgia rheumatica. Annals of the Rheumatic Diseases. 1979 Oct;38(5):434–9. doi:10.1136/ard.38.5.434

21. CHUANG TY, HUNDER GG, ILSTRUP DM, KURLAND LT. Polymyalgia Rheumatica. Ann Intern Med. 1982 Nov;97(5):672–80. doi:10.7326/0003-4819-97-5-672

22. Healey LA. Long-term follow-up of polymyalgia rheumatica: Evidence for synovitis. Seminars in Arthritis and Rheumatism. 1984 May;13(4):322–8. doi:10.1016/0049-0172(84)90012-X

23. Nielsen AW, Van Der Geest KSM, Hansen IT, Nielsen BD, Kjær SG, Blegvad-Nissen J, et al. Improved diagnostic accuracy for polymyalgia rheumatica using FDG-PET/CT with clinical diagnosis or 2012 ACR/EULAR classification criteria. Rheumatology. 2025 Apr 1;64(4):2050–8. doi:10.1093/rheumatology/keae377

24. Wang G, Liu X, Chen J, Zhang F, Xu X, Wang Y, et al. The Combination of ^{18}F-Fluorodeoxyglucose Positron Emission Tomography Metabolic and Clinical Parameters Can Effectively Distinguish Rheumatoid Arthritis and Polymyalgia Rheumatic. Filippi L, editor. Contrast Media & Molecular Imaging. 2022 Jan;2022(1). doi:10.1155/2022/9614678

25. Li Z, Chen K, Wu Y, Wu M. Development of a new simplified comprehensive scoring system for polymyalgia rheumatica: Integration of PET/CT findings and clinical features. Semin Arthritis Rheum. 2025 Oct;74:152767. doi:10.1016/j.semarthrit.2025.152767 PubMed PMID: 40499500.

26. Lee K, Kim H, Lee S, Kim H. Diagnostic performance of the 2012 EULAR/ACR classification criteria for polymyalgia rheumatica in Korean patients. Int J of Rheum Dis. 2020 Oct;23(10):1311–7. doi:10.1111/1756-185x.13923

27. van der Geest KSM, Grootelaar RGJ, Bouwman K, Sandovici M, Glaudemans AWJM, Brouwer E, et al. 18F-FDG-PET/CT for polymyalgia rheumatica: agreement and diagnostic accuracy of routine PET scan report vs. standardized PMR PET scores. Front Nucl Med. 2025 Mar 10;5:1550881. doi:10.3389/fnume.2025.1550881 PubMed PMID: 40130067; PubMed Central PMCID: PMC11931067.

28. Nawata M, Someya K, Kosaka S, Aritomi T, Funada M, Fujita Y, et al. Usefulness of ultrasound as a predictor of elderly-onset rheumatoid arthritis with polymyalgia rheumatica-like onset. Mod Rheumatol. 2023 Mar 2;33(2):318–22. doi:10.1093/mr/roac024 PubMed PMID: 35286376.

29. Colebatch AN, Edwards CJ, Østergaard M, Heijde D van der, Balint PV, D'Agostino MA, et al. EULAR recommendations for the use of imaging of the joints in the clinical management of rheumatoid arthritis. Annals of the Rheumatic Diseases. 2013 Jun 1;72(6):804–14. doi:10.1136/annrheumdis-2012-203158 PubMed PMID: 23520036.

30. Mandl P, Navarro-Compán V, Terslev L, Aegerter P, Heijde D van der, D'Agostino MA, et al. EULAR recommendations for the use of imaging in the diagnosis and management of spondyloarthritis in clinical practice. Annals of the Rheumatic Diseases. 2015 Jul 1;74(7):1327–39. doi:10.1136/annrheumdis-2014-206971

31. Mandl P, D'Agostino MA, Navarro-Compán V, Geßl I, Sakellariou G, Abhishek A, et al. 2023 EULAR recommendations on imaging in diagnosis and management of crystal-induced arthropathies in clinical practice. Annals of the Rheumatic Diseases. 2024 Jun 1;83(6):752–9. doi:10.1136/ard-2023-224771 PubMed PMID: 38320811.

32. Henckaerts L, Gheysens O, Vanderschueren S, Goffin K, Blockmans D. Use of 18F-fluorodeoxyglucose positron emission tomography in the diagnosis of polymyalgia rheumatica—A prospective study of 99 patients. Rheumatology. 2018 Nov 1;57(11):1908–16. doi:10.1093/rheumatology/kex376

33. Nielsen AW, Hansen IT, Nielsen BD, Kjær SG, Blegvad-Nissen J, Rewers K, et al. The effect of prednisolone and a short-term prednisolone discontinuation for the diagnostic accuracy of FDG-PET/CT in polymyalgia rheumatica—a prospective study of 101 patients. Eur J Nucl Med Mol Imaging. 2024 Jul;51(9):2614–24. doi:10.1007/s00259-024-06697-8

34. Van Der Geest KSM, Van Sleen Y, Nienhuis P, Sandovici M, Westerdijk N, Glaudemans AWJM, et al. Comparison and validation of FDG-PET/CT scores for polymyalgia rheumatica. Rheumatology. 2022 Mar 2;61(3):1072–82. doi:10.1093/rheumatology/keab483

35. Moreel L, Boeckxstaens L, Betrains A, Van Hemelen M, Vanderschueren S, Van Laere K, et al. Diagnostic accuracy and validation of 18F-fluorodeoxyglucose positron emission tomography scores in a large cohort of patients with polymyalgia rheumatica. Front Med. 2022 Sep 21;9. doi:10.3389/fmed.2022.1026944

36. Owen CE, Poon AMT, Yang V, McMaster C, Lee ST, Liew DFL, et al. Abnormalities at three musculoskeletal sites on whole-body positron emission tomography/computed tomography can diagnose polymyalgia rheumatica with high sensitivity and specificity. Eur J Nucl Med Mol Imaging. 2020 Sep;47(10):2461–8. doi:10.1007/s00259-020-04731-z PubMed PMID: 32090280.

37. Emamifar A, Ellingsen T, Hess S, Gerke O, Hviid Larsen R, Ahangarani Farahani Z, et al. The Utility of 18F-FDG PET/CT in Patients With Clinical Suspicion of Polymyalgia Rheumatica and Giant Cell Arteritis: A Prospective, Observational, and Cross-sectional Study. ACR Open Rheumatology. 2020 Aug;2(8):478–90. doi:10.1002/acr2.11163

38. Takahashi H, Yamashita H, Kubota K, Miyata Y, Okasaki M, Morooka M, et al. Differences in fluorodeoxyglucose positron emission tomography/computed tomography findings between elderly onset rheumatoid arthritis and polymyalgia rheumatica. Mod Rheumatol. 2015 Jul;25(4):546–51. doi:10.3109/14397595.2014.978936 PubMed PMID: 25401232.

39. Sondag M, Guillot X, Verhoeven F, Blagosklonov O, Prati C, Boulahdour H, et al. Utility of 18F-fluoro-dexoxyglucose positron emission tomography for the diagnosis of polymyalgia rheumatica: a controlled study. Rheumatology. 2016 Aug;55(8):1452–7. doi:10.1093/rheumatology/kew202

40. Yuge S, Nakatani K, Yoshino K, Koyama T. Diagnosing polymyalgia rheumatica on 18F-FDG PET/CT: typical uptake patterns. Ann Nucl Med. 2018 Oct;32(8):573–7. doi:10.1007/s12149-018-1269-5

41. Horikoshi H, Nakanishi T, Tamura K, Kimura F, Itoh K. 18F-fluorodeoxyglucose–positron emission tomography/computed tomography for the diagnosis of polymyalgia-like illnesses: a retrospective study. BMC Rheumatol. 2020 Dec;4(1). doi:10.1186/s41927-020-00121-y

42. Amat J, Chanchou M, Olagne L, Descamps L, Flaus A, Bouvet C, et al. Utility of 18F-Fluorodeoxyglucose Positron Emission Tomography in Inflammatory Rheumatism, Particularly Polymyalgia Rheumatica: A Retrospective Study of 222 PET/CT. Front Med. 2020 Aug 13;7. doi:10.3389/fmed.2020.00394

43. Flaus A, Amat J, Prevot N, Olagne L, Descamps L, Bouvet C, et al. Decision Tree With Only Two Musculoskeletal Sites to Diagnose Polymyalgia Rheumatica Using [18F]FDG PET-CT. Front Med. 2021 Feb 17;8. doi:10.3389/fmed.2021.646974

44. Pean de Ponfilly-Sotier M, Besson FL, Gomez L, Ottaviani S, Dieudé P, Pavy S, et al. Use of 18F FDG PET-CT to discriminate polymyalgia rheumatica and atypical spondylarthritis in clinical practice. Joint Bone Spine. 2022 May;89(3):105325. doi:10.1016/j.jbspin.2021.105325 PubMed PMID: 34915108.

45. Brinth LS, Hansen A, Jensen DV, Madsen OR, Broholm R, Krakauer M. Diagnostic Value of Composite and Simplified FDG-PET/CT Scores in Polymyalgia Rheumatica and the Influence of Recent Glucocorticoid Treatment—A Retrospective Diagnostic Cohort Study. Diagnostics. 2023 Jan 31;13(3):514. doi:10.3390/diagnostics13030514

46. Desvages A, Hives F, Deprez X, Pierache A, Béhal H, Flipo RM, et al. Usefulness of 18F-Fluorodeoxyglucose Positron Emission Tomography in Diagnosing Polymyalgia Rheumatica and Large-Vessel Vasculitis: A Case-Control Study. J Clin Med. 2023 Apr 13;12(8):2844. doi:10.3390/jcm12082844 PubMed PMID: 37109181; PubMed Central PMCID: PMC10141365.

47. Casadepax-Soulet C, Benali K, Crestani B, Piekarski E, Mahida B, Ebstein E, et al. Fluorine-18 fluorodeoxyglucose positron emission tomography/computed tomography in polymyalgia rheumatica: an observational study. Clinical and Experimental Rheumatology. 2022 Aug 16. doi:10.55563/clinexprheumatol/kqyki5

48. Sun S, Shao X, Liu X, Jiang W, Zhang L, Chen J, et al. Assessing the feasibility of SUVindex (a metric derived from FDG PET/CT) for the diagnosis of polymyalgia rheumatica. Clinical Radiology. 2023 Oct;78(10):737–45. doi:10.1016/j.crad.2023.06.007

49. Gorlen TF, Brittain JM, Østergaard M, Fischer BM, Døhn UM, Terslev L. Low incidence of malignancy in patients with suspected polymyalgia rheumatica or giant cell arteritis, examined with FDG-PET/CT. Front Med. 2024 Feb 21;11:1309905. doi:10.3389/fmed.2024.1309905

50. Ramon A, Guillibert-Karras C, Milas-Julien L, Garrot JF, Maillefert JF, Ornetti P. The frequency of occult solid malignancy in patients with polymyalgia rheumatica-like symptoms. Ther Adv Musculoskelet Dis. 2021 Jan 26;13:1759720X20984275. doi:10.1177/1759720X20984275 PubMed PMID: 33552239; PubMed Central PMCID: PMC7844447.

51. Hess S, Noriega-Álvarez E, Leccisotti L, Treglia G, Albano D, Roivainen A, et al. EANM consensus document on the use of [18F]FDG PET/CT in fever and inflammation of unknown origin. Eur J Nucl Med Mol Imaging. 2024 Jul 1;51(9):2597–613. doi:10.1007/s00259-024-06732-8

52. Ottaviani S, Goossens J, Demaria L, Forien M, Palazzo E, Dieudé P. Ultrasound shoulder assessment of calcium pyrophosphate disease with suspected polymyalgia rheumatic. Clinical and Experimental Rheumatology. 2020.

53. Falsetti P, Frediani B, Storri L, Bisogno S, Baldi F, Campanella V, et al. Evidence for Synovitis in Active Polymyalgia Rheumatica: Sonographic Study in a Large Series of Patients. The Journal of Rheumatology.

54. Kobayashi K, Nakagomi D, Kobayashi Y, Ajima C, Hanai S, Koyama K, et al. Ultrasound of shoulder and knee improves the accuracy of the 2012 EULAR/ACR provisional classification criteria for polymyalgia rheumatica. Rheumatology. 2022 Mar 2;61(3):1185–94. doi:10.1093/rheumatology/keab506

55. Cantini F, Salvarani C, Olivieri I, Niccoli L, Padula A, Boiardi L, et al. Shoulder Ultrasonography in the Diagnosis of Polymyalgia Rheumatica: A Case-Control Study. The Journal of Rheumatology.

56. Frediani B, Falsetti P, Storri L, Bisogno S, Baldi F, Campanella V, et al. Evidence for synovitis in active polymyalgia rheumatica: sonographic study in a large series of patients. J Rheumatol. 2002 Jan;29(1):123–30. PubMed PMID: 11824948.

57. Nakamura H, Kamada K, Tarumi M, Tanimura S, Shibata Y, Horita T. Gadolinium-enhanced magnetic resonance imaging in shoulders contributes accurate diagnosis and predicting recurrence to patients with polymyalgia rheumatica. Clinical and Experimental Rheumatology. 2021 Feb 5;39(1):84–90. doi:10.55563/clinexprheumatol/l0jndl

58. Cantini F, Niccoli L, Nannini C, Padula A, Olivieri I, Boiardi L, et al. Inflammatory changes of hip synovial structures in polymyalgia rheumatica. Clin Exp Rheumatol. 2005;23(4):462–8. PubMed PMID: 16095113.

59. De Miguel E, Karalilova R, Macchioni P, Ponte C, Conticini E, Cowley S, et al. Subclinical giant cell arteritis increases the risk of relapse in polymyalgia rheumatica. Ann Rheum Dis. 2023 Nov 6;ard-2023-224768. doi:10.1136/ard-2023-224768 PubMed PMID: 37932008.

60. Blockmans D, De Ceuninck L, Vanderschueren S, Knockaert D, Mortelmans L, Bobbaers H. Repetitive 18-fluorodeoxyglucose positron emission tomography in isolated polymyalgia rheumatica: a prospective study in 35 patients. Rheumatology (Oxford). 2007 Apr;46(4):672–7. doi:10.1093/rheumatology/kel376 PubMed PMID: 17114803.

61. Lavado-Pérez C, Martínez-Rodríguez I, Martínez-Amador N, Banzo I, Quirce R, Jiménez-Bonilla J, et al. (18)F-FDG PET/CT for the detection of large vessel vasculitis in patients with polymyalgia rheumatica. Rev Esp Med Nucl Imagen Mol. 2015;34(5):275–81. doi:10.1016/j.remn.2015.05.011 PubMed PMID: 26159505.

62. Prieto-Peña D, Calderón-Goercke M, Martínez-Rodríguez I, Banzo JI, González-Gay MA, Blanco R. Fri0646 Effect of Long-Term Medium-Dose Steroid Treatment on 18f-Fdg Pet/Ct Findings to Assess

Vascular and Musculoeskeletal Involvement in Patientswith Polymyalgia Reumatica. Annals of the Rheumatic Diseases. 2019 Jun 1;78(Suppl 2):1020–1. doi:10.1136/annrheumdis-2019-eular.3619

63. Fruth M, Seggewiss A, Kozik J, Martin-Seidel P, Baraliakos X, Braun J. Magnetic resonance imaging in polymyalgia rheumatica-contrast enhancement is not always needed. Z Rheumatol. 2024 May;83(4):269–76. doi:10.1007/s00393-023-01394-7 PubMed PMID: 37566119; PubMed Central PMCID: PMC11058766.

64. Allard B, Devauchelle-Pensec V, Saraux A, Nowak E, Tison A, Boukhlal S, et al. [18F]FDG PET/CT for therapeutic assessment of Abatacept in early-onset polymyalgia rheumatica. Eur J Nucl Med Mol Imaging. 2024 Apr;51(5):1297–309. doi:10.1007/s00259-023-06557-x PubMed PMID: 38095675.

65. Palard-Novello X, Querellou S, Gouillou M, Saraux A, Marhadour T, Garrigues F, et al. Value of (18)F-FDG PET/CT for therapeutic assessment of patients with polymyalgia rheumatica receiving tocilizumab as first-line treatment. Eur J Nucl Med Mol Imaging. 2016 Apr;43(4):773–9. doi:10.1007/s00259-015-3287-z PubMed PMID: 26753600.

66. Devauchelle-Pensec V, Berthelot JM, Cornec D, Renaudineau Y, Marhadour T, Jousse-Joulin S, et al. Efficacy of first-line tocilizumab therapy in early polymyalgia rheumatica: a prospective longitudinal study. Ann Rheum Dis. 2016 Aug;75(8):1506–10. doi:10.1136/annrheumdis-2015-208742 PubMed PMID: 26929219; PubMed Central PMCID: PMC4975852.

67. Macchioni P, Catanoso MG, Pipitone N, Boiardi L, Salvarani C. Longitudinal examination with shoulder ultrasound of patients with polymyalgia rheumatica. Rheumatology (Oxford). 2009 Dec;48(12):1566–9. doi:10.1093/rheumatology/kep286 PubMed PMID: 19808693.

68. Jiménez-Palop M, Naredo E, Humbrado L, Medina J, Uson J, Francisco F, et al. Ultrasonographic monitoring of response to therapy in polymyalgia rheumatica. Ann Rheum Dis. 2010 May;69(5):879–82. doi:10.1136/ard.2009.113555 PubMed PMID: 19773289.

69. Conticini E, Falsetti P, d'Alessandro M, Al Khayyat SG, Grazzini S, Baldi C, et al. Clinical, laboratory and ultrasonographic findings at baseline predict long-term outcome of polymyalgia rheumatica: a multicentric retrospective study : Polymyalgia rheumatica predicted by ultrasonographic findings polymyalgia rheumatica outcome predicted early by ultrasound. Intern Emerg Med. 2023 Oct;18(7):1929–39. doi:10.1007/s11739-023-03373-x PubMed PMID: 37498353; PubMed Central PMCID: PMC10543828.

70. Miceli MC, Zoli A, Peluso G, Bosello S, Gremese E, Ferraccioli G. Baseline Shoulder Ultrasonography Is Not a Predictive Marker of Response to Glucocorticoids in Patients with Polymyalgia Rheumatica: A 12-month Followup Study. J Rheumatol. 2017 Feb;44(2):241–7. doi:10.3899/jrheum.160090 PubMed PMID: 27980012.

71. Ayano M, Arinobu Y, Tsukamoto H, Ota SI, Misaki K, Nishimura K, et al. Shoulder ultrasound and serum lactate dehydrogenase predict inadequate response to glucocorticoid treatment in patients with polymyalgia rheumatica. Rheumatol Int. 2020 Jul;40(7):1101–9. doi:10.1007/s00296-020-04512-9 PubMed PMID: 32062696.

72. Mackie SL, Pease CT, Fukuba E, Harris E, Emery P, Hodgson R, et al. Whole-body MRI of patients with polymyalgia rheumatica identifies a distinct subset with complete patient-reported response to glucocorticoids. Ann Rheum Dis. 2015 Dec;74(12):2188–92. doi:10.1136/annrheumdis-2015-207395 PubMed PMID: 26376658; PubMed Central PMCID: PMC4680120.

73. Giraud N, Prati C, Wendling D, Verhoeven F. Prognostic value of 18F-fluorodeoxyglucose PET-CT score at baseline on the therapeutic response to prednisone in patients with polymyalgia

rheumatica. Joint Bone Spine. 2021 Jan;88(1):105093. doi:10.1016/j.jbspin.2020.105093 PubMed PMID: 33130234.

74. Billet AC, Thibault T, Liozon É, De Boysson H, Perard L, Espitia O, et al. Prognostic value of 18 FDG-PET at diagnosis and follow-up in giant cell arteritis: An observational restrospective study. European Journal of Internal Medicine. 2024 Aug;126:69–76. doi:10.1016/j.ejim.2024.03.037

75. Quinn KA, Ahlman MA, Grayson PC. Use of ^{18}F -fluorodeoxyglucose Positron Emission Tomography to Monitor Disease Activity in Patients With Giant Cell Arteritis on Tocilizumab. ACR Open Rheumatology. 2025 Feb;7(2):e11797. doi:10.1002/acr2.11797

76. Slart RHJA. FDG-PET/CT(A) imaging in large vessel vasculitis and polymyalgia rheumatica: joint procedural recommendation of the EANM, SNMMI, and the PET Interest Group (PIG), and endorsed by the ASNC. Eur J Nucl Med Mol Imaging. 2018;45(7):1250–69. doi:10.1007/s00259-018-3973-8 PubMed PMID: 29637252; PubMed Central PMCID: PMC5954002.

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