EULAR Points to Consider for the use of imaging to guide interventional procedures in patients with rheumatic and musculoskeletal diseases (RMDs)

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ABSTRACT

Objectives To develop evidence-based Points to Consider (PtC) for the use of imaging modalities to guide interventional procedures in patients with rheumatic and musculoskeletal diseases (RMDs).

Methods European Alliance of Associations for Rheumatology (EULAR) standardised operating procedures were followed. A systematic literature review was conducted to retrieve data on the role of imaging modalities including ultrasound (US), fluoroscopy, MRI, CT and fusion imaging to guide interventional procedures. Based on evidence and expert opinion, the task force (25 participants consisting of physicians, healthcare professionals and patients from 11 countries) developed PtC, with consensus obtained through voting. The final level of agreement was provided anonymously.

Results A total of three overarching principles and six specific PtC were formulated. The task force recommends preference of imaging over palpation to guide targeted interventional procedures at peripheral joints, periarticular musculoskeletal structures, nerves and the spine. While US is the favoured imaging technique for peripheral joints and nerves, the choice of the imaging method for the spine and sacroiliac joints has to be individualised according to the target, procedure, expertise, availability and radiation exposure. All imaging guided interventions should be performed by a trained specialist using appropriate operational procedures, settings and assistance by technical personnel.

Conclusion These are the first EULAR PtC to provide guidance on the role of imaging to guide interventional procedures in patients with RMDs.

INTRODUCTION

Interventional procedures such as fluid aspiration, injections and biopsies are conducted for diagnostic and therapeutic purposes in patients with different rheumatic and musculoskeletal diseases (RMDs). Imaging guided procedures require additional preparation and training as compared with palpation guided interventions. Imaging guided procedures may have a higher diagnostic value compared with palpation guided interventions. The choice of imaging technique is based on the target, procedure, expertise, availability, radiation exposure and radiation dose. All imaging guided interventions should be performed by a trained specialist using appropriate operational procedures, settings and assistance by technical personnel.

What is already known about this subject?

► Imaging is increasingly used to guide interventional procedures in patients with rheumatic and musculoskeletal diseases (RMDs).

► Imaging guided procedures require additional preparation and training as compared with palpation guided interventions.

► Uncertainty persist among clinicians on which imaging technique should be used to optimally guide interventional procedures.

What does this study add?

► These are the first European Alliance of Associations for Rheumatology endorsed Points to Consider (PtC) for the use of imaging to guide interventional procedures in patients with RMDs.

How might this impact on clinical practice or future developments?

► These PtC give advice to clinicians in which clinical situation, for which intervention, and in which anatomical area imaging should be used to guide interventional procedures.

► The research agenda highlights the gaps in evidence and areas of future studies.

Key messages

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Box 1 Preparations to conduct interventions with direct imaging guidance in situations of low (L) and high risk of infection (H)

- Disinfection of the hands (L) or handwashing and disinfection (H).
- Gloves (L), alternatively sterile gloves (H).
- Sterile preparation of equipment (L, H).
- Disinfection of the injection site (L, H).
- For US guided interventions.
  - Maintenance of at least 0.5 cm between the probe/gel* and the needle (L) or
  - Extensive disinfection of the probe and use of antiseptic instead of gel (L).
  - Sterile vinyl foil cover for the US probe and sterile gel (H).
- Face mask† and cap (H).
- Sterilised wraps with opening to expose the applicable site only (H).

*Use of sterile gel for ultrasound guided interventions is recommended by some national authorities.
†Obligatory for patients and healthcare provider in several countries during the COVID-19 pandemic.

A single systematic literature review (SLR) was conducted by two fellows (PB and FC) under the guidance of the methodologist (PMM). The convenors, together with the methodologist and fellows translated the research questions in the PICO (Population, Intervention, Comparator, Outcome) format (see online supplemental table 1). The search strings were developed by an experienced librarian (LF) and applied to MEDLINE, EMBASE, the Cochrane Library and Epistemonikos databases (through 10/21). Prospective and retrospective full research articles, short reports and letters including original (patient) data, published in English and comparing different (imaging) techniques, different settings and procedural protocols to guide interventions in patients with RMDs were retrieved. Risk of bias (RoB) was assessed using the Cochrane RoB tool for randomised trials version 2 (ROB2), the RoB tool for Non-randomized Studies of Interventions and the Appraisal Tool for Cross-Sectional Studies. The evidence summarised in the SLR was presented during the second and third task force meetings. Data were summarised in the form of tables including the RoB assessment. The SLR is published separately; however, it forms an integral and inseparable part of the present PtC manuscript and should be read as such.

At the second meeting (virtual), the task force formulated the PtC based on the evidence and expert opinion in a process of discussion and consensus. Subsequently, the draft PtC underwent structured written feedback from the task force members. At the third meeting (virtual), the PtC were refined based on the updated evidence (ie, articles published between second and third task force meeting) and feedback received, followed by voting on the PtC. Consensus was accepted if >75% of the members voted in favour of the PtC at the first round, ≥67% at the second round and at a third round >50% was accepted. The Oxford centre for evidence based medicine 2011 levels of evidence (LoE) derived from the SLR were added to each PtC.

Subsequently, each task force member anonymously indicated the level of agreement via Survey Monkey (LoA, 0–10 numeric rating scale ranging from 0=‘completely disagree’ to 10=‘completely agree’). The mean and SD of the LoA, as well as the percentage of task force members with an agreement ≥8 are presented.

Based on the gaps in the evidence and controversial points, a research agenda was formulated. The manuscript was reviewed by the EULAR Council and a revised version was finally approved by all task force members and the EULAR Council.

RESULTS

General aspects

These PtC are intended to advise qualified (physician and non-physician) healthcare professionals including rheumatologists, paediatricians, orthopaedic surgeons, neurosurgeons, radiologists, specialists in physical medicine and rehabilitation or sports medicine, general practitioners, anaesthesiologists and physical therapists on the use of imaging modalities to guide interventional procedures in patients with RMDs.

These PtC are not intended to cover all aspects of interventional procedures; we explicitly excluded interventions with the purpose of local or regional anaesthesia before surgery, interventions concerning tumours, vessels or glands as well as arthroplasty and vertebroplasty.

The task force defined ‘targeted’ interventions as procedures requiring a high level of precision to reach a specific anatomical area such as injection of small ganglia, cysts or tenosynovitis, aspiration of small amounts of fluid or synovial biopsy.
The population of interest is patients with RMDs (degenerative, inflammatory or autoimmune) including patients with painful joints, tendons, entheses and/or muscles, as well as neuropathic pain or discomfort.

These PtC may also inform patients participating in shared-decision making and healthcare provider organisations arranging care for patients with RMD.

A total of three overarching principles and six specific PtC have been formulated. They are summarised in table 1 (including the LoE and LoA) and are discussed in detail below.

### Overarching principles

These refer to principles of a generic nature. They are not necessarily based on specific LoE but reflect issues of good clinical practice and the task force considered them as a framework for the subsequent, specific PtC.

A. **The imaging technique should be optimised according to the procedure and the anatomical site taking into account potential side effects, radiation exposure, availability, expertise and costs.**

B. **Imaging guided interventional procedures should be conducted under adequate aseptic conditions (as detailed in box 1).**

C. **Complex imaging guided interventional procedures should be conducted with adequate assistance by technical personnel.**

### Specific Points to Consider

1. **Imaging should be preferred over palpation to guide targeted* interventional procedures at peripheral joints and periarticular structures in patients with RMDs.**

2. **Ultrasound should be used as the first imaging modality for interventional procedures at peripheral joints. Fluoroscopy may be used as an alternative.**

3. **Imaging should be preferred over palpation to guide targeted* injections at structures encompassing peripheral nerves. Ultrasound should be the preferred imaging modality.**

4. **Imaging should be used to guide targeted* injections at the spine.**

5. **Imaging should be preferred over palpation for targeted* injections of the sacroiliac joint(s).**

6. **Healthcare professionals performing imaging guided interventional procedures must have adequate skills in the respective imaging technique and the interventional procedure.**

### Table 1: EULAR Points to Consider (PtC) for the use of imaging to guide interventional procedures in patients with rheumatic and musculoskeletal diseases (RMD)

<table>
<thead>
<tr>
<th>Overarching principles</th>
<th>LoE</th>
<th>LoA</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. The imaging technique should be optimised according to the procedure and the anatomical site taking into account potential side effects, radiation exposure, availability, expertise and costs.</td>
<td>n.a.</td>
<td>10.0 (0.2) 100%&gt;8</td>
</tr>
<tr>
<td>B. Imaging guided interventional procedures should be conducted under adequate aseptic conditions (as detailed in box 1).</td>
<td>n.a.</td>
<td>10.0 (0.2) 100%&gt;8</td>
</tr>
<tr>
<td>C. Complex imaging guided interventional procedures should be conducted with adequate assistance by technical personnel.</td>
<td>n.a.</td>
<td>9.5 (1.7) 91.7%&gt;8</td>
</tr>
</tbody>
</table>

**Recommendation**

Numbers in column ‘LoA’ indicate the mean and SD (in parenthesis) of the LoA (range 0–10 with 0='completely disagree' to 10='completely agree'), as well as the percentage of task force members with an agreement ≥8.

*Targeted interventions are defined as procedures requiring a high level of precision to reach a specific anatomical area such as injection of small ganglia, cysts or tenosynovitis, including aspiration of small amounts of fluid or synovial biopsy.

†Levels of evidence were downgraded (from level 2 to level 3) because of bias related to randomisation, outcome assessment (trials and non-randomised studies), the population of interest (cross-sectional studies) and inadequate adjustment of potential confounders.

EULAR, European Alliance of Associations for Rheumatology; LoA, level of agreement; LoE, level of evidence; n.a., not applicable; RMDs, rheumatic and musculoskeletal diseases.
most of the studies retrieved by the SLR were relatively vague in the description of what preparations were made.18 Based on expert opinion, and considering current clinical practice, the task force proposed preparations to conduct interventions with direct imaging guidance under aseptic conditions in relation to the presumed risk of infection (box 1). Preparation of procedures with indirect imaging guidance (ie, conduction of imaging first followed by a blind intervention) are identical to palpation procedures with indirect imaging guidance (ie, conduction of imaging first followed by a blind intervention) are identical to palpation-guided interventions described elsewhere.1 The suggestions in box 1 are not intended to cover every clinical situation nor to reflect all national guidelines. Some authorities for example, recommend using sterile gel for US guided interventions which is not current practice in every EULAR country.20 21 In a severely immunocompromised patient undergoing highly invasive interventions (eg, tissue biopsy at the spine) even more intensive preparations than those listed in box 1 (such as using an operating theatre, surgical aseptic hand washing and wearing surgical gowns) may be required to minimise the risk of infection. Likewise, face masks are obligatory during the COVID-19 pandemic in many countries for patients, physicians and healthcare professionals along with a negative SARS-CoV-2 test for patients, however, it is not clear, whether face masks reduce the risk of infection in simple imaging guided interventions such as joint injections, once the pandemic is over.

C. Complex imaging guided interventional procedures should be conducted with adequate assistance by technical personnel.

The task force agreed that complex imaging guided procedures such as synovial tissue biopsies should be supported by technical personnel. Simple interventions such as US guided intra-articular injections could, at least in theory, be managed without assistance even though the experts were of the opinion that every imaging guided intervention benefit from assistance, particularly to maintain sterility of the setting and to ensure a high accuracy of the procedure. Technical personnel are also required to prepare equipment and drugs, to assist the procedure and to help monitoring of patients’ clinical status during and after the procedure, when needed. Literature is scarce about the possible benefit of technical assistance for the prevention of adverse events as well as for cost-effectiveness; these issues should be clarified by future studies.

The task force recognised that not all interventions at peripheral joints and periarticular structures (which include tendons, ligaments, entheses, pulleys and bursae) require imaging guidance, that imaging is not available in every setting and/or that professionals conducting interventions may not have sufficient expertise with imaging guidance. Synovial fluid aspiration of an extensively swollen knee, non-targeted injection of a metacarpophalangeal joint in a patient with rheumatoid arthritis, injection of the subacromial bursae in a patient with rotator cuff disease, injection of a trigger finger or enthesitis at lateral epicondyle might well be guided by palpation. In contrast, targeted interventions should be conducted under imaging guidance in order to guarantee a high accuracy of the procedure. The absence of immediate access to imaging, however, should not delay an urgent diagnostic procedure such as arthrocentesis in case of suspected septic arthritis.

Evidence from clinical studies indicate a better accuracy (including correct needle placement and superiority in tissue and fluid acquisition) and safety (less procedural and postprocedural pain and discomfort) for imaging than for palpation guided interventions whereas data regarding short-term and long-term efficacy are contrasting.10 The most important limitation of these studies, however, is that they did not detangle easy (eg, subcapsular space of a highly swollen joint) from difficult to reach targets (eg, small ganglion compressing a peripheral nerve). Accordingly, the task force had to extrapolate the evidence to conclude that imaging should be preferred when a high level of precision is needed in order to reach a specific anatomical area.

Studies on costs of imaging guided interventions at peripheral joints are available only for the USA reporting large differences of costs depending on the setting and reimbursement policies of individual insurance companies.22–24 Whether imaging guided interventions are cost-effective in the USA and EULAR countries (eg, by preventing secondary direct and indirect costs due to higher efficacy and/or lower rate of complications) is unclear so far. This aspect has been added to the research agenda.

Point to Consider 2
Ultrasound should be used as the first imaging modality for interventional procedures at peripheral joints. Fluoroscopy may be used as an alternative.

The majority of studies at peripheral joints were available for US and fluoroscopy with comparable results concerning efficacy and accuracy.46 While fluoroscopy is still widely used in clinical practice,25 the task force agreed that US should be preferred over fluoroscopy if both techniques were available with similar

### Table 2 Overview of studies identified by the systematic literature review investigating different procedural protocols for imaging guided interventions in patients with rheumatic and musculoskeletal disease

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Comparator</th>
<th>Results for intervention</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intra-articular injections in sacroiliitis and ACJ arthritis</td>
<td>Periarticular</td>
<td>Superior for short-term and long-term pain</td>
</tr>
<tr>
<td>Shoulder joint injections in adhesive capsulitis</td>
<td>SASD bursa</td>
<td>Superior for short-term and long-term pain</td>
</tr>
<tr>
<td>Subscapularis muscle injection in scapular pain</td>
<td>Scapulothoracic bursa</td>
<td>No difference in safety and efficacy</td>
</tr>
<tr>
<td>Medial access for knee injections in OA</td>
<td>Midlateral/suprolateral access</td>
<td>No difference in safety and accuracy</td>
</tr>
<tr>
<td>US in-plane injection in knee OA</td>
<td>US out-of-plane</td>
<td>No difference in accuracy, adverse events or procedural time</td>
</tr>
<tr>
<td>Bone biopsy in suspected osteomyelitis</td>
<td>Paravertebral soft tissue</td>
<td>No difference in tissue acquisition</td>
</tr>
<tr>
<td>Intra-tendon sheath injection in trigger fingers</td>
<td>Extra tendon sheath</td>
<td>No difference in safety and efficacy</td>
</tr>
<tr>
<td>Intra-epineurium injections in CTS</td>
<td>Extra-epineurium</td>
<td>Superior for symptom severity and efficacy</td>
</tr>
<tr>
<td>Ulnar access for injection in CTS</td>
<td>Midline/radial access</td>
<td>Inferior for long-term pain reduction compared with radial access</td>
</tr>
<tr>
<td>Injection above the median nerve in CTS</td>
<td>Injection under the median nerve</td>
<td>No difference in safety and efficacy</td>
</tr>
</tbody>
</table>

ACJ, acromioclavicular joint; CTS, carpal tunnel syndrome; OA, osteoarthritis; SASD, subacromial/subdeltoid; US, ultrasound.
expertise, because of the absence of radiation, the better visualisation of soft tissue and the lower resource consumption by the former, as well as the fact that US can be used as part of everyday clinical practice.\textsuperscript{24} 26 The European Union directive 2013/59/EURATOM states that if a non-radiating imaging modality is available, it should be invariably used and preferred over a modality which uses ionising radiations.\textsuperscript{27} Fluoroscopy is a valid alternative, particularly if US is not available, for joint aspiration and intra-articular injections.\textsuperscript{28}

Other imaging modalities to guide interventional procedures of peripheral joints such as CT, MRI or fusion imaging are still a matter of research.

Point to Consider 3

Imaging should be preferred over palpation to guide targeted injections at structures encompassing peripheral nerves. Ultrasound should be the preferred imaging modality.

The task force emphasised that imaging is particularly helpful when a specific target, for example, a cyst or ganglion compressing a peripheral nerve, should be injected. One study reported a higher efficacy of intraarticular than extraarticular injection of the median nerve in patients with carpal tunnel syndrome for symptom improvement as well as for reduction of nerve swelling.\textsuperscript{29} It is almost impossible to safely reach such a small anatomical place without imaging, even though a comparison between imaging and palpation guidance for this intervention is still missing.

The highest number of studies, most of them with low quality, were available for the comparison between US and palpation guided injections at the carpal tunnel.\textsuperscript{10} Some of them reported more adverse events in patients undergoing palpation guided injections (eg, hand weakness, finger numbness, skin discoloration or subcutaneous fat atrophy)\textsuperscript{30} 31 whereas others found no difference in terms of safety and efficacy.\textsuperscript{10} The task force members recognised that most studies might have been underpowered to detect rare adverse events such as accidental nerve puncture or injury of the persistent median artery, particularly in patients with anatomical variants of the median nerve. Based on clinical experience, such adverse events can easily be avoided if imaging is used to guide the injections. A bifid median nerve is the most common anatomical variant occurring in 15%–20% of the population, 11% have a persistent median artery.\textsuperscript{32} 33

Evidence on imaging guided injections at peripheral nerves outside the carpal tunnel is scarce and mainly derives from observational and cadaveric studies,\textsuperscript{34} 35 hence, this aspect has been included in the research agenda.

Fluoroscopy is not recommended for this indication because of the absence of data from trials and the fact that nerves cannot be visualised directly with this technique. The value of other imaging methods such as MRI, or CT with/without fusion with CT to conduct biopsies in case of suspected vertebral osteomyelitis revealing a better performance of the former, given its ability to adjust the needle in a vertical plane.\textsuperscript{42} Facet joint injections are sometimes conducted under clinical guidance,\textsuperscript{23} the percentage of in-target administration of the drug, safety and efficacy of this approach as compared with imaging guidance, however, is probably low (even though direct evidence is missing). MRI is rarely used to guide injections at the spine and there are little data from clinical studies to support its use.\textsuperscript{10}

Point to Consider 5

Imaging should be preferred over palpation for targeted injections of the sacroiliac joint(s).

While injections of the sacroiliac joints are sometimes guided by palpation in clinical practice, the probability to reach the joint space is less than 25%.\textsuperscript{40} Using imaging to guide injections and other interventions such as synovial tissue biopsy increases the accuracy of the procedure dramatically. One study reported that the joint space was reached in 85% of cases if US guidance was used,\textsuperscript{14} and others found in-target needle placement in 91% of fluoroscopy guided injections.\textsuperscript{28} Most efficacy and safety outcomes, however, were similar, independent of whether the injection was intra-articular or periarticular.\textsuperscript{8} 18 The follow-up time as well as the power of these studies to detect clinical differences, however, were limited and might thus have underestimated the true benefit of releasing drugs inside rather than outside the joint capsule.

The choice of the most appropriate imaging modality such as US, fluoroscopy, CT and MRI for sacroiliac joint injections is determined by local expertise and availability as well as by considerations of radiation exposure. Fusion imaging between US and CT might be helpful in case bony spurs or other type of joint damage limit the anatomical passage into the joint space.\textsuperscript{45}

Point to Consider 6

Healthcare professionals performing imaging guided interventional procedures must have adequate skills in the respective imaging technique and the interventional procedure.

According to local rules and legal framework, non-physician healthcare professionals may also conduct imaging guided interventions, however, the task force strongly endorses specific training of all professionals performing these procedures. The amount of training depends on the technique and on local training requirements. EULAR has defined competencies in musculoskeletal US, and US guided interventions are part of intermediate and advanced level EULAR US courses, however, the task force considered it beyond the scope of this project to define the specific skills qualifying for imaging guided interventional procedures. Evidence from clinical studies is missing, hence this item has been added to the research agenda.

Based on the discussions and the areas of uncertainty, a research agenda has been proposed, depicted in box 2.

DISCUSSION

These are the first EULAR PtC providing up-to-date guidance for the role of imaging to guide interventional procedures in patients with RMDs.

These principles are reflected in both the PtC and the research agenda, acknowledging also the gaps in evidence that include direct comparisons between different imaging modalities as well
as the low amount of data on imaging guided interventions at peripheral nerves (particularly outside the carpal tunnel) and the spine. Besides, outcomes to measure the success of interventions (eg, amount of fluid or quality of samples in case of arthrocentesis or biopsy, respectively; reduction of damage to surrounding structures, long-term pain reduction by injections), are elusive and should be defined by future research.

Where evidence from clinical trials was controversial or absent, PtC were formulated on the basis of current clinical practice and expert opinion. Good quality studies are now required to answer the numerous questions raised in the research agenda, so that future PtC can be upgraded and based on more solid evidence. The present PtC nevertheless represent a step forward to answer the numerous questions raised in the research agenda.

The present PtC were formulated on the basis of current clinical practice, long-term pain reduction by injections, arthrocentesis or biopsy, respectively, reduction of damage to surrounding structures, long-term pain reduction in case of injections.

Recommendation

Box 2 Future research agenda

- To compare the efficacy and accuracy of interventions guided by US, fluoroscopy, CT, MRI or fusion imaging at peripheral joints, nerves and the spine and for different indications (eg, injections, arthrocentesis or biopsy; inflammatory vs non-inflammatory conditions).
- To compare imaging versus palpation guided interventions at different anatomical sites.
- To compare the safety and accuracy of imaging guided interventions conducted with and without technical personnel assisting the procedure.
- To develop and use outcome measures with importance to society including assessment of sick-leave days, cost-effectiveness and health resource consumption in studies on interventional procedures.
- To identify and agree on outcomes measuring the success of interventional procedures (eg, amount of fluid aspiration, quality of the samples in case of biopsies, long-term pain reduction in case of injections).
- To study the value of MRI, CT and/or fusion imaging for interventions at peripheral nerves, to study the value of US for interventions at nerves outside the carpal tunnel.
- To study the value of imaging to avoid accidental nerve trauma as compared with palpation guided injections.
- To investigate the effect of specific training programmes on the accuracy of imaging guided interventional procedures and to assess the learning curve of professionals conducting imaging guided interventions.
- To define standard procedural protocols for imaging guided interventions.
- To investigate the effect of different levels of aseptic conditions on the prevalence of infections in imaging guided interventions.
- To evaluate the effect of echo-tip needles and needle visualisation US software for the accuracy of imaging guided interventions.
- To compare different techniques and equipment for imaging guided interventions at different anatomical sites.

US, ultrasound.

as composed of specialists using imaging regularly, even though they also conduct palpation guided interventions routinely. Expert opinion might nevertheless be biased towards a preference of imaging over clinical guidance of interventions.

In summary, we developed three overarching principles and six specific PtC on the use of imaging for interventional procedures in RMD. These PtC are supported by evidence along with expert consensus. Unresolved issues and areas of further study have been depicted in the research agenda. We expect that much progress continues taking place in the area of imaging in RMDs, and we will carefully follow developments in the field, assuming that an amendment of these PtC may be needed within a few years.

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Contributors All authors were involved in the discussion and formulation of the Points to Consider. CDejaico wrote the first version of the manuscript. All authors reviewed it and made extensive comments and appropriate changes to it. All authors approved the final version of the manuscript.
**Recommendation**


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