



Clinical indications for image guided interventional procedures in the musculoskeletal system: a Delphi-based consensus paper from the European Society of Musculoskeletal Radiology (ESSR)—part III, nerves of the upper limb

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Abstract

Background Image-guided interventional procedures of the nerves are commonly performed by physicians from different medical specialties, although there is a lack of clinical indications for these types of procedures. This Delphi-based consensus provided a list of indications on image-guided interventional procedures for nerves of the upper limb based on updated published evidence.

Methods An expert panel of 45 members of the Ultrasound and Interventional Subcommittees of the ESSR participated in this Delphi-based consensus study. After revision of the published papers on image-guided interventional procedures for nerves of the upper limb updated to September 2018, the experts drafted a list of statements according to the Oxford Centre for evidence-based medicine levels of evidence. Consensus on statements regarding clinical indications was considered as strong when more than 95% of experts agreed, and broad if more than 80% agreed.

Results Ten statements were drafted on procedures for nerves of the upper limb. Only two statements reached the highest level of evidence (ultrasound guidance is a safe and effective method for brachial plexus block; ultrasound-guided non-surgical approaches are safe and effective methods to treat carpal tunnel syndrome in the short term, but there is sparse evidence on the mid- and long-term effectiveness of these interventions). Strong consensus was obtained on 6/10 statements (60%), while 4/10 statements reached broad consensus (40%).

Conclusions This Delphi-based consensus study reported poor evidence on image-guided interventional procedures for nerves of the upper limb. Sixty percent of statements on clinical indications provided by the expert board reached a strong consensus.

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Key Points

- An expert panel of the ESSR provided 10 evidence-based statements on clinical indications for image-guided interventional procedures for nerves of the upper limb
- Two statements reached the highest level of evidence
- Strong consensus was obtained on 6/10 statements (60%), while 4/10 statements reached broad consensus (40%)

Keywords Radiology, interventional · Ultrasonography · Peripheral nerves · Injections; Steroids

Abbreviations

ESSR European Society of Musculoskeletal Radiology

Introduction

There is a growing interest in image-guided interventional procedures for musculoskeletal applications, with widespread use of imaging guidance to inject therapeutic agents into the soft tissues [1–3]. Furthermore, advancements in ultrasound technology and the emergence of high-frequency probes have resulted in significant improvements in image resolution for the study of superficial structures [4, 5]. Ultrasound evaluation of peripheral nerves is in a “golden era” where this imaging modality has obtained a well-established primary role as a diagnostic tool and a reliable guide to treat neuropathies which are more suitable for non-surgical therapy [4, 6–8]. These procedures mostly include perineural injection of lidocaine and/or steroid to obtain nerve blocks or to treat neuropathies related to peripheral entrapment [8, 9]. Nevertheless, there are no widely accepted clinical indications for peripheral nerve interventional procedures due to unclear evidence regarding accuracy and clinical implications, especially when dealing with procedures, which have only just been recently tested.

With the purpose of clarifying the actual clinical role of image-guided procedures on peripheral nerves of the upper limb, an expert panel from the Ultrasound and the Interventional Subcommittees of the European Society of Musculoskeletal Radiology (ESSR) performed a Delphi-based consensus to evaluate the updated published evidence on these procedures, thereby providing a list of clinical indications on this topic.

Materials and methods

Institutional Review Board approval was not needed as no patients were directly involved in this study. This paper reports only the results regarding nerve procedures derived from a larger Delphi-based consensus on image-guided interventional procedures in the upper limb [10].

A Delphi-based literature review and expert consensus was used, similar to previously published ESSR consensus papers [10–12] with a series of discussion rounds to obtain the opinion of proven experts on the topic, stated on the basis of the updated literature, to reach a final shared consensus [13]. We also used the AGREE II tool to guarantee the quality of this work [14, 15].

The Delphi process included the following steps:

1. Expert selection

The consensus study was performed by an expert panel of 45 radiologists from 11 European Countries (Austria, Belgium, Greece, Italy, Lithuania, North Macedonia, Poland, Slovenia, Spain, The Netherlands, and UK) with proven and well-established experience and research in interventional musculoskeletal procedures. All experts were selected from the Ultrasound and Interventional Subcommittees of the ESSR. All were divided into different groups to assess specific topics on image-guided interventional procedures of upper limb nerves.

2. Literature search, statement drafting, and level of evidence

A literature search was performed on the major online databases including published articles up to September 2018 (MEDLINE, Web of Science, EMBASE, and Google) using the relevant search words on the basis of the assigned topic. Each group included all papers that were considered worthy of inclusion (i.e., papers providing original data about ultrasound-guided nerves procedures in the upper limb) while assessing the references of all selected papers to evaluate any further additional papers on the specific topic. Narrative reviews not providing original data were not included. All groups drafted a list of statements for their assigned topic. Then, each statement received a level of evidence based on the criteria of the Oxford Centre of Evidence-Based Medicine in 2011 [16]. When needed, evidence was downgraded by one level due to methodological limitations (e.g., small sample size or short follow-up).

3. Questionnaire preparation and consensus process

All drafted statements were then revised by the coordinator, who prepared and sent via email an online questionnaire (Google Forms, Google LLC) to all members of the expert panel. In the questionnaire, the experts were asked to provide any comments and to agree, disagree, or abstain with the drafted statements. All comments and answers were added to the online questionnaire by the experts who were blinded to each other's responses and were collected in an electronic spreadsheet (Microsoft Excel, Microsoft). Subsequently, the coordinator analyzed and modified the drafted statements according to the reviewers' comments. Finally, a second round of evaluation with the same technique was performed.

4. Data analysis and paper drafting

After the two rounds of evaluation of the Delphi process, the consensus for each statement was obtained and considered as strong when more than 95% of experts agreed. If less than 95% but more than 80% of experts agreed on the statement, the expert consensus was considered broad [17, 18]. Then, the article was drafted on the basis of the results of the Delphi-based consensus and sent via email to the entire panel of experts for individual approval.

Results

Statement no. 1

Ultrasound guidance is a safe and effective method for brachial plexus block.

Level of evidence: 1 Ultrasound-guided brachial plexus injection is a safe and effective method used to provide anesthesia during upper limb surgery, as reported in several randomized studies and in a meta-analysis of clinically controlled trials. Using ultrasound guidance, the incidence of complication is lower as ultrasound provides real-time visualization of underlying structures and as a result the flow of local anesthetic is injected into the correct anatomical site [19–26].

Agree, n = 44; abstain, n = 1; disagree, n = 0. Level of agreement: 97.8%

Statement no. 2

Ultrasound-guided selective brachial plexus block seems to provide effective analgesia for surgery of the upper limb, with potential prolonged motor paralysis after surgery.

Level of evidence: 3 Proximal approaches to brachial plexus blocks can provide effective anesthesia for surgical procedures in the upper limb [27]. However, this kind of block may lead to a prolonged period of motor paralysis and reduced patient satisfaction. A randomized cohort study on 24 patients showed that selective ultrasound-guided block of upper limb nerves allowed improved retention of motor function compared to an axillary block [28].

Agree, n = 43; abstain, n = 1; disagree, n = 1. Level of agreement: 95.6%

Statement no. 3

Ultrasound-guided suprascapular nerve block results in pain relief and improves range of motion in patients with chronic shoulder pain, without clear superiority compared to a palpation-guided procedure.

Level of evidence: 3 Ultrasound-guided suprascapular nerve block with anesthetic and steroid is a safe and effective method for the management of chronic shoulder pain. Clinical trials [29] and cadaveric studies [30] supported the feasibility of this technique and compared accuracy and efficacy of an ultrasound-guided group versus a palpation-guided group.

Agree, n = 44; abstain, n = 0; disagree, n = 1. Level of agreement: 97.8%

Statement no. 4

Ultrasound-guided pulsed radiofrequency ablation of the suprascapular nerve for adhesive capsulitis combined with physical therapy provides good clinical outcome at 12 weeks follow-up.

Level of evidence: 2 Clinical trials demonstrate that the application of pulsed radiofrequency stimulation on the suprascapular nerve under ultrasound guidance reduces pain intensity, improves shoulder range of movement, and can enhance quality of life at 12 weeks follow-up [31, 32]. The combination of physical therapy and radiofrequency is reported as more effective when compared with physical therapy alone [33].

Agree, n = 40; abstain, n = 5; disagree, n = 0. Level of agreement: 88.9%

Statement no. 5

Ultrasound-guided suprascapular nerve block provides better pain relief and better functional results compared with subacromial injection in patients with symptomatic rotator cuff tears.

Level of evidence: 3 Full-thickness rotator cuff tears cause traction and tension on the suprascapular nerve, which is the

dominant motor supply of the supraspinatus and infraspinatus muscles. A single randomized, double-blinded, controlled trial on 42 patients with rotator cuff tears demonstrated the superiority of ultrasound-guided suprascapular nerve block compared with ultrasound-guided subacromial steroid injection.

Agree, n = 40; abstain, n = 3; disagree, n = 2. Level of agreement: 88.9%

Statement no. 6

Ultrasound-guided injection of the axillary nerve is a feasible procedure for the treatment of quadrilateral space syndrome.

Level of evidence: 5 Quadrilateral space syndrome is a rare condition caused by compression of the axillary nerve. Only a few case reports have described the efficacy of corticosteroid and anesthetic injection around the nerve [34–36]. This procedure can be considered for temporary pain relief in patients with a diagnosis of quadrilateral space syndrome.

Agree, n = 43; abstain, n = 1; disagree, n = 1. Level of agreement: 95.6%

Statement no. 7

Ultrasound-guided steroid injection is feasible in patients with ulnar neuropathy at the elbow but is not superior to placebo.

Level of evidence: 2 Most studies consider the feasibility of ultrasound-guided steroid injections at the elbow [37–43], while only one randomized controlled trial by Van Veen et al [44] assessed the effect of ultrasound-guided steroid injection in patients with ulnar neuropathy at the elbow. This study did not demonstrate a positive effect on symptoms compared with placebo (30% vs 28%).

Agree, n = 42; abstain, n = 3; disagree, n = 0. Level of agreement: 93.3%

Statement no. 8

Ultrasound-guided radiofrequency treatment for ulnar neuropathy produces more complete improvement in clinical and electrophysiological parameters than low-level laser therapy.

Level of evidence: 3 Both techniques improve clinical and electrophysiological parameters and represent a promising alternative for the treatment of ulnar neuropathy at the elbow [45]. A randomized trial on 32 patients divided patients into those treated with ultrasound-guided radiofrequency and those treated with low-level laser therapy. At 3 months, patients treated with ultrasound-guided radiofrequency reported improvement of all parameters,

while others demonstrated only changes in grip strength and potential latency at electromyography.

Agree, n = 40; abstain, n = 4; disagree, n = 1. Level of agreement: 88.9%

Statement no. 9

Ultrasound-guided non-surgical approaches are safe and effective methods to treat carpal tunnel syndrome in the short term, but there is sparse evidence in the mid- and long-term effectiveness of these interventions.

Level of evidence: 1 Ultrasound-guided injection to treat carpal tunnel syndrome is a feasible procedure [46–49] and, although not necessarily superior to palpation guidance in the long term [46], has demonstrated more effective short-term clinical outcomes [50]. A review of 2018 showed that ultrasound-guided injection was more effective than palpation-guided injection for symptom severity improvement in patients with carpal tunnel syndrome: however, no significant differences were observed in functional status or electrodiagnostic improvements between the two methods [51, 52]. Although both methods have been shown to be effective in reducing symptoms of carpal tunnel syndrome and improving function, earlier onset and better overall improvement of symptoms suggest that ultrasound-guided steroid injection may be more effective than palpation-guided injections [53]. A network meta-analysis on 10 studies with 633 patients utilizing an ultrasound-guided in-plane injection approach showed that local corticosteroid injections are the most clinically effective treatment for carpal tunnel syndrome [52]. In addition, injecting steroid either above or below the median nerve with ultrasound guidance was effective in reducing symptoms and improving function, and electrodiagnostic and sonographic findings of carpal tunnel syndrome [51]. Ultrasound-guided steroid injection in combination with percutaneous needle release of the transverse carpal ligament has been shown to be superior in the short term to ultrasound-guided steroid injection alone [54]. At 6 months follow-up, there was symptom improvement, a smaller nerve cross-sectional area (measured with ultrasound), and negative carpal tunnel clinical tests, although the grip strength was significantly lower compared with that of the control group [55]. There is, however, limited evidence on the use of platelet-rich plasma [56] and ultrasound-guided pulsed radiofrequency [56, 57]. Minimally invasive ultrasound-guided percutaneous carpal tunnel release (resulting in 1–2-mm scars), utilizing a hook knife, in the outpatient setting, is a feasible method for median nerve decompression and transverse carpal ligament section. It is comparable to open and endoscopic carpal tunnel surgery, demonstrating similar results up to 6 months, but with reduced postoperative morbidity and more timely return to work [58–60]. Cadaveric studies demonstrate that the technique is

reproducible, even when performed by ultrasound-skilled doctors without any previous experience of the method [61].

Agree, n = 45; abstain, n = 0; disagree, n = 0. Level of agreement: 100%

Statement no. 10

Ultrasound-guided perineural circumferential hydrodissection is a feasible procedure to treat median nerve entrapment.

Level of evidence: 2 Cadaveric studies and clinical trials state that ultrasound-guided perineural circumferential hydrodissection is a feasible technique for nerve block procedures, potentially reducing the risk of intraneural injection. Hydrodissection with lidocaine and normal saline is as effective as hydrodissection with low- and high-dose steroid medications in elderly patients with carpal tunnel syndrome [62]. Ultrasound-guided perineural median nerve injection using 5% dextrose has been shown to be more effective than steroid in mild-to-moderate carpal tunnel syndrome at 6 months [48, 63]. Systemic toxicity however remains unproven [64–67].

Agree, n = 45; abstain, n = 0; disagree, n = 0. Level of agreement: 100%

Discussion

The Delphi-based consensus of the expert panel composed of the Ultrasound and Interventional Subcommittees of the ESSR led to 10 statements regarding clinical indications on image-guided interventional procedures for upper limb nerves.

Ultrasound is the most widely available and feasible imaging guidance technique to target peripheral nerves and has become a well-established method for nerve blocks, being helpful to obtain effective analgesia for upper limb surgery and also for pain relief. Conversely, entrapment neuropathies (e.g., cubital and carpal tunnel syndromes) are often directly treated with surgery. However, image-guided interventional procedures may have a significant role in the management of these conditions, particularly in patients not suitable/not willing to undergo surgery. Thus, further studies are needed to demonstrate whether ultrasound-guided perineural injections should be a conservative first step approach to treat entrapment neuropathies of the upper limb.

As a result of this study, the evidence on these interventional procedures is still low, with only two statements having reached level 1 evidence. In some randomized controlled trials, evidence was downgraded by one level due to methodological limitations (e.g., small sample size or short follow-up). Although some robust papers have been published on ultrasound-guided interventional

approaches to suprascapular, ulnar, and median nerves, only a few case reports have reported the efficacy of ultrasound-guided injection around the axillary nerve. Regarding the radial nerve, there is only a single paper published on radial nerve blocks in cats [68], while no data is available for humans.

Regarding the degree of consensus, the expert panel strongly agreed on 6 (60%) statements, while a broad consensus was reached on 4 of them (40%). This relatively low consensus may be explained by the fact that most interventional procedures around the nerves are generally performed by anesthesiologists or pain physicians. In those topics where evidence is not robust enough, some panellists may not have been confident in supporting specific procedures.

In conclusion, 10 statements regarding image-guided interventional procedures on the peripheral nerves of the upper limb have been produced by an expert panel from the ESSR. Although ultrasound-guided peripheral nerve blocks have proven to be safe and effective procedures for analgesia prior to surgery or pain relief, there is still low evidence in published papers on these interventional procedures to treat entrapment neuropathies. The ESSR supports and encourages future prospective longitudinal studies and high-quality randomized clinical trials that should focus on the clinical impact of image-guided interventional procedures to understand how to incorporate these treatments optimally in patient management [69].

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Compliance with Ethical Standards

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Informed consent Written informed consent was not required for this study because it does not involve patients.

Ethical approval Institutional Review Board approval was not required because it does not involve patients.

Methodology

• Literature-based Delphi process

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