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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 VII, nerves of the lower limb

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Abstract

Objectives To perform a Delphi-based consensus on published evidence on image-guided interventional procedures for peripheral nerves of the lower limb (excluding Morton's neuroma) and provide clinical indications.

Methods We report the results of a Delphi-based consensus of 53 experts from the European Society of Musculoskeletal Radiology who reviewed the published literature for evidence on image-guided interventional procedures offered around peripheral nerves in the lower limb (excluding Morton's neuroma) to derive their clinical indications. Experts drafted a list of statements and graded them according to the Oxford Centre for evidence-based medicine levels of evidence. Consensus was considered strong when > 95% of experts agreed with the statement or broad when > 80% but < 95% agreed. The results of the Delphi-based consensus were used to write the paper.

Results Nine statements on image-guided interventional procedures for peripheral nerves of the lower limb have been drafted. All of them received strong consensus. Image-guided pudendal nerve block is safe, effective, and well tolerated with few complications. US-guided perisciatic injection of anesthetic provides good symptom relief in patients with piriformis syndrome; however, the addition of corticosteroids to local anesthetics still has an unclear role. US-guided lateral femoral cutaneous nerve block can be used to provide effective post-operative regional analgesia.

Conclusion Despite the promising results reported by published papers on image-guided interventional procedures for peripheral nerves of the lower limb, there is still a lack of evidence on the efficacy of most procedures.

Key Points

- *Image-guided pudendal nerve block is safe, effective, and well tolerated with few complications.*
- *US-guided perisciatic injection of anesthetic provides good symptom relief in patients with piriformis syndrome; however, the addition of corticosteroids to local anesthetics still has an unclear role.*
- *US-guided lateral femoral cutaneous nerve block can be used to provide effective post-operative regional analgesia. The volume of local anesthetic affects the size of the blocked sensory area.*

Keywords Interventional radiology · Ultrasonography · Nerves · Lidocaine · Corticosteroid

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Abbreviations

ESSR European Society of Musculoskeletal Radiology
US Ultrasound

Introduction

Over the last few years, increased interest in imaging the peripheral nerves has been supported by novel and high-performing ultrasound (US) transducers. High- and ultra-high frequency transducers produce high-resolution images, allowing the detection and thorough investigation of pathologic conditions of the peripheral nerves that once could only be evaluated with clinical examination and electroneurography tests [1–4]. Advances in US technology have also opened new frontiers in the management of neural disorders, given that image-guided percutaneous procedures may be considered in some neuropathies that are less suitable for surgical treatment [5, 6]. Specifically, US guidance is the preferred technique for perineural interventional procedures, which mostly consist of peripheral nerve blocks and interventions for entrapment neuropathies [5]. Indeed, despite the fact that unguided perineural interventions can be effective, there is a non-negligible risk of nerve injury or delivery of the medication too far away to have complete efficacy. Currently, several image-guided interventional procedures are routinely performed in clinical practice ranging from perineural corticosteroid injections for entrapment neuropathies to hydrodissection, aspiration of ganglia, phenol ablation, injection of botulinum toxin A, or alcohol blocks, and other minimally invasive procedures. Especially, US-guided treatments of peripheral entrapment neuropathies are rapidly emerging as an alternative option to surgery giving the possibility of symptoms relief comparable to a surgical release. Nevertheless, there is sparse evidence regarding the clinical value of these procedures and no clear guidelines have been produced to standardize how, when, and why image-guided interventions might be used for treating peripheral neuropathies of the lower limb. As already done for interventional procedures on the nerves of the upper limb [7], an expert board of the European Society of Musculoskeletal Radiology (ESSR) reviewed the evidence in the existing literature to compile evidence-based statements on clinical indications of image-guided procedures of the peripheral nerves of the lower extremities.

Materials and methods

Institutional Review Board approval was not required as no patient data was used for this study. This paper is part of a larger project established by the Ultrasound and the Interventional Subcommittees of the ESSR to assess the published evidence on image-guided musculoskeletal interventional procedures in the lower limb and to produce a list of clinical indications [8]. An expert panel, selected from the members of these subcommittees, evaluated the existing literature as previously done in other ESSR consensus papers [7, 9–11]. They used a Delphi method of review, which consisted of rounds of literature evaluations by a panel of experts to state a list of agreed indications on a specific topic [12]. The AGREE II tool was used to ensure the quality of the Delphi method [13], which included the following steps:

1. Expert selection

The expert panel consisted of 53 radiologists from 16 countries (Austria, Belgium, Denmark, Germany, Greece, India, Italy, Lithuania, New Zealand, North Macedonia, Poland, Portugal, Slovenia, Spain, The Netherlands, UK), with established experience (from 5 to 35 years of experience in research activity) in musculoskeletal interventional procedures and in the scientific evaluation of medical literature. All experts were chosen from members of the Ultrasound and Interventional Subcommittees of the ESSR and divided into groups with a specific topic assigned to each group.

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

The literature search was performed on the major online databases (MEDLINE, Web of Science, EMBASE, and Google) including papers published up to the end of 2020, by using all the search terms relevant to the specific topic assigned to each group. The experts could also add papers found by screening the references of retrieved articles if considered relevant for their search. After the search, each group listed the evidence-based statements on their specific topic using the criteria of the Oxford Center of Evidence-Based Medicine in 2011 to identify the correct level of evidence for each statement [14]. The level of evidence may be graded down on the basis of study quality or graded up if there is large effect size, but, as a general rule, the level of evidence is generally identified as follows:

Level 1: Systematic review of randomized trials
Level 2: Prospective randomized trials
Level 3: Non-randomized controlled cohort or follow-up study
Level 4: Case-series, case–control studies, or historically controlled studies
Level 5: Mechanism-based reasoning

3. Questionnaire preparation and consensus process

The drafted statements were revised by the coordinator of this project who disseminated a tool (Google Forms, Google LLC) to all experts sending a link via email. All experts accessed this tool through the link to agree, disagree, or abstain with the drafted statements. They were also invited to add any comments about the level of evidence and content of each statement. All answers were collected in an electronic spreadsheet (Microsoft Excel, Microsoft) and revised by the coordinator who modified the statements according to the experts' comments. This was followed by a second round of discussion, with the same technique as the first. Any conflicts concerning the level of evidence and/or content of the statements that persisted after the second round of discussion were discussed via targeted emails sent to the involved experts and subsequently solved or kept.

Data analysis and paper drafting

After the rounds of discussion, the statements were once again shared with the experts to obtain consensus, which was considered strong when more than 95% of experts agreed with the statement or broad when more than 80% but less than 95% agreed [15]. The results of the Delphi-based consensus were used to write the paper that was shared with all panel members for final approval.

Results

1. **Image-guided pudendal nerve block is safe, effective, and well tolerated with few complications.**

Level of evidence: 2

Agree, $n = 53$; disagree, $n = 0$; abstain, $n = 0$. Agreement = 100%

A successful pudendal nerve block is crucial for the diagnosis of pudendal neuralgia and provides guidance for treatment. Different studies, including two randomized controlled trials, demonstrated the absence of complications for this procedure [5, 16–21]. Furthermore, no significant difference in terms of efficacy was demonstrated between US and fluoroscopic guidance.

2. **US-guided interventional procedures around the genitofemoral nerve are feasible and effective, but evidence is only supported by a small series.**

Level of evidence: 4

Agree, $n = 53$; disagree, $n = 0$; abstain, $n = 0$. Agreement = 100%

US-guided procedures around the genitofemoral nerve are usually performed in conjunction with other nerve procedures (e.g. ilioinguinal, iliohypogastric nerves) [5, 22–28]; thus, in some papers, it is not easy to differentiate the outcomes of the various procedures. Furthermore, the results are reported on small series. Lee et al. reported the results of radiofrequency ablation of the genitofemoral nerve in four patients, with a reported 100% reduction of pain up to 12 months [24].

3. **US-guided perisciatic injection of anesthetic provides good symptom relief in patients with piriformis syndrome; however, the addition of corticosteroids to local anesthetics still has an unclear role.**

Level of evidence: 2

Agree, $n = 53$; disagree, $n = 0$; abstain, $n = 0$. Agreement = 100%

Several studies in patients with piriformis syndrome showed that US-guided perisciatic injection of anesthetic-corticosteroids is a safe procedure that provides good symptom relief [29–32]. In up to 50% of patients, symptoms may relapse, and additional perisciatic injections are warranted [30, 31, 33]. A prospective randomized controlled study in patients with piriformis syndrome showed that the addition of corticosteroid to anesthetic does not provide additional benefit [34]. On the other hand, a recent uncontrolled study on 30 patients showed that US-guided piriformis injection of corticosteroid-anesthetic seems to be effective for both somatic and neuropathic pain in piriformis syndrome patients at 1 week and 1 month [29].

4. **US-guided injection of botulinum toxin A in the piriformis muscle might offer long-term management of piriformis syndrome but evidence is limited; thus, its application in daily practice is still questionable.**

Level of evidence: 4

Agree, $n = 53$; disagree, $n = 0$; abstain, $n = 0$. Agreement = 100%

In the small case series by Rodríguez-Piñero et al., 6 months after the injection three patients were asymptomatic and three were feeling better [35]. Multiple injections may be administered over the course of treatment [36]. It has been shown that symptom relief after US-guided injections of botulinum toxin A into the piriformis muscle may be due to atrophy and fatty infiltration of the muscle [36].

5. **US-guided lateral femoral cutaneous nerve block can be used to provide effective post-operative regional analgesia. The volume of local anesthetic affects the size of the blocked sensory area.**

Level of evidence: 2

Agree, $n = 53$; disagree, $n = 0$; abstain, $n = 0$. Agreement = 100%

In a randomized trial, Nielsen et al. showed that US-guided lateral femoral cutaneous nerve block is safe and

easy to perform with high success of analgesia [37]. Randomized controlled studies have shown improved postoperative experience in patients undergoing reconstructive surgery with lateral/anterolateral skin graft or as postoperative pain management in patients undergoing hip arthroplasty [38, 39]. However, in total hip arthroplasty, there is variability in anatomical placement of incision lines among different surgeons and it must be noted that there is limited analgesic effect if a posterior incision line is made [40]. A randomized study on healthy volunteers showed that the blocked sensory area is significantly larger when lateral femoral cutaneous nerve block is performed with 16 mL ropivacaine 0.75% than when it is performed with 8 mL ropivacaine 0.75% [41]. However, it does not result in greater coverage of the posterior or lateral incision lines used for total hip arthroplasty [41].

6. **US-guided corticosteroid perineural injections of the lateral femoral cutaneous nerve are an effective treatment option in the management of meralgia paresthetica.**

Level of evidence: 4
Agree, $n = 53$; disagree, $n = 0$; abstain, $n = 0$. Agreement = 100%

Two studies, both presenting a case series of 20 patients, showed that US-guided corticosteroid perineural injection is a good treatment option in the management of meralgia paresthetica. Tagliafico et al. showed resolution of symptoms in all patients 2 months after injection [42]; however, Klauser et al. showed complete resolution of symptoms in 75% of patients and partial resolution in 25% of patients at 12-month follow-up [43]. In the study by Klauser et al., a subgroup of patients with meralgia paresthetica underwent multiple sessions of lateral femoral cutaneous nerve corticosteroid injections at different levels (at anterior superior iliac spine, distal inguinal ligament, or lower thigh). The study showed that corticosteroid injections at multiple levels along the lateral femoral cutaneous nerve lead to a significantly better outcome at 12-month follow-up [43].

7. **Lateral femoral cutaneous nerve ablation may be effective in patients with intractable meralgia paresthetica and in patients after skin grafting from the lateral thigh, but further data is needed.**

Level of evidence: 4
Agree, $n = 53$; disagree, $n = 0$; abstain, $n = 0$. Agreement = 100%

Ethanol neurolysis, cryoneurolysis, and pulsed radiofrequency ablation are described in the literature as treatment options in patients with intractable meralgia paresthetica or in patients after skin grafting from the lateral thigh [44–47]. A recent retrospective review of six cases showed a substantial decrease in pain at 1 month (in some cases at 12 months) after US-guided radiofrequency ablation in patients with meralgia paresthetica resistant to conservative management [48]. The evidence is limited due to papers reporting small case series or case reports. No matter the method of ablation used, the papers report prolonged pain relief at follow-up.

8. **US-guided perineural injection of the first branch of the lateral plantar nerve (Baxter nerve) is a feasible procedure.**

Level of evidence: 4.
Agree, $n = 52$; disagree, $n = 1$; abstain, $n = 0$. Agreement = 98%

US-guided injection of the Baxter nerve was feasible in a cadaveric study and it could be considered for diagnostic and therapeutic purposes. No evidence of vascular injury was reported with the posterior-to-anterior approach [49]. During US-guided perineural injection of the Baxter nerve, the lateral plantar (82%), the medial calcaneal (17%), and the medial plantar nerves (8%) can be involved. This could make the procedure unspecific for diagnostic purposes [49].

9. **US-guided infrapatellar nerve block is a feasible, quick, and safe procedure to be used for post-arthroscopy analgesia. US-guided infrapatellar nerve hydro-dissection followed by corticosteroid injection could be useful in patients with persistent medial knee pain after total knee arthroplasty.**

Level of evidence: 4
Agree, $n = 53$; disagree, $n = 0$; abstain, $n = 0$. Agreement = 100%

The adjunct use of an infrapatellar nerve block is associated with improved pain relief after knee arthroscopy [50, 51]. No significant adverse effect or disadvantage was reported [50, 51]. The injection is performed at the level of its origin from the saphenous nerve [52, 53]. In combination with other nerve blocks, this procedure has proven to be useful as a preoperative procedure for patellar fracture surgery [54].

Infrapatellar nerve injury is reported in 55–100% of patients with anterior knee paresthesia following total knee arthroplasty [55, 56]. Nerve hydro-dissection followed by corticosteroid injection may be a treatment option in patients with persistent pain after total knee arthroplasty. Pain relief remains consistent from one month to midterm follow-up; however, long-term outcomes of the treatment are unknown [56, 57].

Discussion

Following a Delphi-based consensus, nine evidence-based statements on clinical indications of image-guided musculoskeletal interventional procedures of peripheral nerves of the lower limb were produced by an expert panel of the ESSR. None of the statements reached the highest level of evidence. Statements regarding image-guided interventional procedures to treat Morton's neuroma have been reported in a separate paper [58].

This consensus paper on the published evidence regarding image-guided procedures of the peripheral nerves of the lower limb offers some interesting insights. Most published papers on this topic concern interventional procedures on the sciatic nerve and lateral femoral cutaneous nerve; for these nerves, prospective randomized clinical trials have shown that US-guided perineural injection of anesthetics provides good pain improvement in piriformis syndrome (statement #3) and effective post-operative analgesia (statement #5), respectively. Several image-guided interventional techniques have been described to treat the piriformis syndrome involving different targets, drugs, and volumes. Most authors agree that US-guided perisciatic injection of local anesthetics alone or combined with corticosteroids is a reasonable and effective option that can be considered as a therapeutic alternative before surgery, especially when the diagnosis is not fully clear, but also as a diagnostic procedure. Turning to the US-guided block of the lateral femoral cutaneus nerve, several authors have investigated the potential application of this procedure reporting its safety and effectiveness for reaching post-operative analgesia after reconstructive surgery with lateral/anterolateral skin graft or hip arthroplasty. This intervention may be considered for optimal comfort throughout the post-operative period improving the management of patients subjected to surgery in the hip/thigh region. However, only small retrospective studies have investigated the efficacy of alternative procedures on these two nerves. Specifically, initial promising results have been obtained by injecting botulinum toxin A under US guidance in patients with piriformis syndrome (statement #4), but this procedure needs to be supported by further data. Also concerning US-guided corticosteroid perineural injections (statement #6) and ablation (statement #7) of the lateral femoral cutaneous nerve in meralgia paresthetica, only a small series have highlighted the effectiveness of these procedures.

Regarding the other perineural procedures of the lower limb, only one statement on the efficacy and safety of image-guided pudendal nerve block reached level of evidence 2 (statement #1). Image-guided pudendal nerve block can be performed under either US or fluoroscopy guidance resulting in a safe and efficacious procedure. It can be used as a diagnostic test in patients with the suspect of pudendal neuralgia to treat pudendal nerve entrapment syndrome and to obtain effective analgesia before in different surgical settings, including pediatric circumcision, perineal surgery, and labour. All the other statements on the genitofemoral (statement #2), Baxter (statement #8), and infrapatellar (statement #9) nerves were supported only by small retrospective series. This confirms the need for further investigations to validate image-guided perineural procedures in clinical practice, similar to what is reported for the peripheral nerves of the upper limb [7].

Some limitations of this paper should be considered. First, this is not a detailed and thorough meta-analysis, the study design is an expert opinion that led us to draft a consensus document. We used a Delphi-based method of review of the existing literature for gathering experts' consensus and establishing what is needed to do in the future to increase evidence on this topic. Then, no meaningful statistical analysis of the data was done; it was not required given that our results are based on statements drafting after literature review, expert' consensus, and grading of the level of evidence.

In conclusion, nine evidence-based statements on image-guided perineural procedures of the lower extremities have been produced by an expert panel of the ESSR. The majority of statements discuss US-guided procedures on the sciatic nerve and lateral femoral cutaneous nerve. Despite the promising results reported by published papers on this topic, the lack of evidence in the existing literature on the efficacy of most procedures highlights the importance of supporting future prospective studies to clarify the clinical role of image-guided interventions on the peripheral nerves in the lower extremity.

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Declarations

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Statistics and biometry No complex statistical methods were necessary for this paper.

Informed consent No informed consent is needed as this paper does not involve patients.

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

Methodology
• Literature-based Delphi process

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