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Clinical indications for musculoskeletal ultrasound updated in 2017 by European Society of Musculoskeletal Radiology (ESSR) consensus

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Abstract

Objectives To update the 2012 European Society of Musculoskeletal Radiology (ESSR) clinical consensus guidelines for musculoskeletal ultrasound referral in Europe.

Methods Twenty-one musculoskeletal imaging experts from the ESSR participated in a consensus study based on a Delphic process. Two independent (non-voting) authors facilitated the procedure and resolved doubtful issues. Updated musculoskeletal ultrasound literature up to July 2017 was scored for shoulder, elbow, wrist/hand, hip, knee, and ankle/foot. Scoring of ultrasound elastography was included. The strength of the recommendation and level of evidence was scored by consensus greater than 67% or considered uncertain when the consensus was consensus less than 67%.

Results A total of 123 new papers were reviewed. No evidence change was found regarding the shoulder. There were no new relevant articles for the shoulder, 10 new articles for the elbow, 28 for the hand/wrist, 3 for the hip, 7 for the knee, and 4 for the ankle/foot. Four new evidence levels of A were determined, one for the hip (gluteal tendons tears), one for the knee (meniscal cysts), one for the ankle (ankle joint instability), and one for the foot (plantar plate tear). There was no level A evidence for elastography, although for Achilles tendinopathy and lateral epicondylitis evidence level was B with grade 3 indication.

Conclusions Four new areas of level A evidence were included in the guidelines. Elastography did not reach level A evidence. Whilst ultrasound is of increasing importance in musculoskeletal medical practice, the evidence for elastography remains moderate.

Key Points

• *Evidence and expert consensus shows an increase of musculoskeletal ultrasound indications.*
• *Four new A evidence levels were found for the hip, knee, ankle, and foot.*
• *There was no level A evidence for elastography.*

Keywords Ultrasonography · Musculoskeletal system · Elasticity imaging techniques · Guideline · Delphi technique

Abbreviations

ESSR European Society of Musculoskeletal Radiology

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Introduction

In 2012, the European Society of Musculoskeletal Radiology (ESSR) published Delphi-based consensus guidelines on the clinical indications of musculoskeletal ultrasound in European Radiology [1]. Given the increased use of musculoskeletal ultrasound in medical practice and emphasis on "evidence-based imaging" and precision medicine [2], we have prepared an update to the existing evidence on the clinical indications for musculoskeletal ultrasound. Musculoskeletal ultrasound,

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including Doppler and ultrasound-guided intervention, is often supplemented by ultrasound elastography, a new technique that provides information about the elasticity and stiffness of the tissues with the potential to differentiate healthy and diseased soft tissues [2]. The aim of this article is to offer an expert consensus on the clinical indications for musculoskeletal ultrasound updated to 2017 literature evidence.

Materials and methods

As in the 2012 consensus guidelines [1], a Delphic approach was employed. This method provides a collective review considered by many to be more trustworthy than the opinions of a single expert and is an efficient method of determining group knowledge [3]. To assure the quality of this guideline, AGREE II instruments were employed [4]. The process can be summarised as follows:

Step 1: Expert selection

Ultrasound experts were chosen by the ESSR for proven experience in clinical practice, research and teaching for musculoskeletal ultrasound diagnostic and interventional procedures. They were of proven experience in the scientific assessment of medical literature. We included 23 radiologists, members of the ESSR, and/or ESR experts in musculoskeletal ultrasound and/or the production of clinical guidelines with a minimum of 4 years of experience in clinical and research activities. They represented nine European countries (Austria, Belgium, Ireland, Lithuania, Poland, Spain, Slovenia, Italy, The Netherlands and the UK).

Step 2: Anatomical area/technique selection, literature search, and questionnaire preparation

The regions studied were the hand/wrist, elbow, shoulder, hip, knee, and ankle/foot, corresponding to those previously identified by the ESSR in the previous version of clinical indications for musculoskeletal ultrasound. For this edition, we included ultrasound elastography of the musculoskeletal system.

Step 3: Literature search and evaluation

Two authors (LMS and AST) performed a systematic literature search on PubMed on the seven topics for publications between August 2011 to March 2017. Each author was asked to include any other relevant papers they felt deserved inclusion. We repeated the review for major clinical conditions with a new assessment for ultrasound elastography [1]. New clinical conditions were included when relevant. We considered scientific papers to be relevant if they could potentially increase the level of evidence previously determined by the ESSR panel [1]. Papers likely to provide evidence equal or inferior to our previous guidelines were not included nor reviewed. Each expert was assigned at least two topics plus a section of the ultrasound elastography to review.

Step 4: Literature review

As for our first publication, we used the following criteria to assess the level of evidence [1]:

1: Consistent randomised controlled clinical trial, cohort study, and clinical decision rules validated in different populations
2: Consistent retrospective cohort, exploratory cohort, outcomes research, case-control study, or extrapolations from level A studies
3: Case series study or extrapolations from level B studies
4: Expert opinion without explicit critical appraisal based on physiology or bench research from first principles

Each clinical indication was graded according to the Oxford Centre for Evidence-Based Medicine level of evidence criteria [5].

The following grading system was used to define clinical indication for musculoskeletal ultrasound:

0: ultrasound examination not indicated
1: ultrasound examination indicated if other imaging techniques are not appropriate
2: ultrasound examination indication is equivalent to other imaging modalities (other imaging might provide significant information)
3: ultrasound examination is the first-choice level technique (other imaging rarely provides more information)

Statistical analysis

Group agreement for a clinical condition was defined as cumulative agreement > 67% after arbitration by non-voting members. Group consensus was confirmed when the consensus level of agreement was > 90% for each anatomical area and for elastography. Lack of consensus was assigned if cumulative agreement was < 67%.

Editorial independence, funding source, and ethical aspects

The study did not receive any financial support. No participant declared competing or conflicting interests regarding the development of the present guidelines. No Ethical Committee approval was required for this article, as it does not involve patients directly.

Results

A total of 123 new articles were found and reviewed with the following results:

Shoulder

No relevant articles likely to produce an alteration of the previous guidelines were found for the shoulder (Table 1).

Elbow

Ten [6–15] new relevant articles were reviewed. Updated clinical conditions with group consensus are reported in Table 2. No new evidence level of A was reported for the elbow.

Hand/wrist

Twenty-eight [16–43] new articles were reviewed. Updated and new clinical conditions with group agreement are reported in Table 3. There are no level A reports for the hand/wrist area.

Hip

Three new articles were reviewed for the hip [44–46]. Group agreement was reached for gluteal tendon tears with level A evidence and an indication grade of 2 [46]. An example of gluteal tendon tear is shown in Fig. 1. Tendon gluteal examination was not included in the previous guidelines where only trochanteric pain was reported (evidence level of C and indication grade of 1 for diagnosis and 2 for injection). Labral tears were upgraded from an evidence level of C to level B and an indication grade of 0 to an indication grade of 1 (Table 4).

Table 1 Shoulder: Detailed results for evidence levels and final consensus, a comparison between 2012 and 2017

Clinical indication	Evidence level 2012	Final consensus 2012	Evidence level 2017	Final consensus 2017
Tendons and soft tissue				
Bursitis	C	3	Unchanged	Unchanged
Full thickness cuff tear	A	3	Unchanged	Unchanged
Partial thickness cuff tear	A	2	Unchanged	Unchanged
Rotator cuff muscle atrophy	B	1	Unchanged	Unchanged
Postoperative cuff failure	B	2	Unchanged	Unchanged
Calcific tendonitis	B	3	Unchanged	Unchanged
Long head biceps tendon: rupture	B	3	Unchanged	Unchanged
Long head biceps tendon: dislocation	B	3	Unchanged	Unchanged
Long head biceps tendon: tendinopathy	B	2	Unchanged	Unchanged
Adhesive capsulitis	B	0	Unchanged	1
Pectoralis/deltoid tears	C	2	Unchanged	Unchanged
Septic arthritis	C	3	Unchanged	Unchanged
Bones				
Loose bodies	C	1	Unchanged	Unchanged
Acromion-clavicular joint osteoarthritis	C	2	Unchanged	Unchanged
Acromion-clavicular joint trauma/instability	B	2	Unchanged	Unchanged
Sterno-clavicular joint disease	C	2	Unchanged	Unchanged
Occult tuberosity fracture	C	2	Unchanged	Unchanged
Gleno-humeral joint: traumatic instability	B	0	Unchanged	Unchanged
Gleno-humeral joint: dynamic instability	B	0	Unchanged	Unchanged
Nerves				
Suprascapular nerve entrapment	C	2	Unchanged	Unchanged
Quadrilateral space syndrome	C	1	Unchanged	Unchanged
Parsonage-Turner syndrome	C	0	Unchanged	Unchanged
Thoracic outlet syndrome	C	1	Unchanged	Unchanged

Grade 0: not indicated; grade 1: if other imaging techniques are not appropriate; grade 2: equivalent to other imaging techniques (other techniques might provide significant information); grade 3: first choice level technique, other techniques rarely provide more information

Table 2 Elbow: Detailed results for evidence levels and final consensus, a comparison between 2012 and 2017

Clinical indication	Evidence level 2012	Final consensus 2012	Evidence level 2017	Final consensus 2017
Tendons and soft tissues				
Lateral epicondylitis	A	3	Unchanged	Unchanged
Lateral collateral ligament	D	0	C	2
Medial epicondylitis	No	3	Unchanged	Unchanged
Medial collateral ligament	C	2	B	Unchanged
Biceps tendon insertion	No	2	Unchanged	Unchanged
Bicipitoradial bursitis	No	2	Unchanged	Unchanged
Synovitis	B	3	Unchanged	Unchanged
Septic arthritis/effusion	B	3	Unchanged	Unchanged
Triceps tendon injury	C	3	Unchanged	Unchanged
Snapping triceps injury	C	3	Unchanged	Unchanged
Olecranon bursitis	D	3	Unchanged	Unchanged
Bones				
Loose bodies	C	1	Unchanged	Unchanged
Lateral condyle fracture in children/fractures	C	0 to 1	Unchanged	1
Radial head subluxation/fracture	D	1	Unchanged	Unchanged
Screening trauma	C	2	B	Unchanged
Supracondylar elbow fracture; postoperative positioning	B	0	Unchanged	Unchanged
Osteochondral injury	No	1	Unchanged	Unchanged
Nerves				
Radial nerve compression	No	3	Unchanged	Unchanged
Median nerve entrapment, pronator syndrome	No	3	Unchanged	Unchanged
Ulnar nerve neuropathy	B	3	Unchanged	Unchanged
Ulnar nerve subluxation	D	3	C	Unchanged

Grade 0: not indicated; grade 1: if other imaging techniques are not appropriate; grade 2: equivalent to other imaging techniques (other techniques might provide significant information); grade 3: first choice level technique, other techniques rarely provide more information

Knee

Seven [47–53] new relevant articles were reviewed. Updated clinical conditions with group agreement are reported in Table 5. Two new papers with evidence level of A were reported for the ultrasound examination of meniscal tears and cysts; however, we recommend caution before considering ultrasound for the examination of menisci. An example of a meniscal tear associated with a meniscal cyst is shown in Fig. 2. Ultrasound examination for knee osteoarthritis was included with an evidence level of B and indication grade of 1.

Ankle/foot

Four [54–57] new relevant articles were reviewed. Updated clinical conditions with group consensus are reported in Table 6. No new evidence level A papers were reported for the ankle/foot in respect to the previous topics. Plantar plate and ankle instability assessment are new conditions not present in the previous guidelines, and both had level A evidence. Examples of lateral ankle instability and plantar plate tear are shown in Figs. 3 and 4, respectively.

Elastography

Seventy-one articles were reviewed for ultrasound elastography [58–129]. For Achilles tendinopathy, lateral and medial epicondylitis, and ultrasound elastography increased the level of evidence from D to B with an indication grade of 3. For other regions, ultrasound elastography did not increase the evidence level or indication grade compared with standard musculoskeletal ultrasound, but it confirmed the results of musculoskeletal ultrasound. The use of ultrasound elastography was scored with evidence level B and indication grade of 1 for soft tissue tumour examination and carpal tunnel syndrome assessment by group consensus.

Discussion

This article represents a comprehensive update of the clinical indications for musculoskeletal ultrasound [1] with a strong focus on a practical approach. Musculoskeletal ultrasound is widely employed for a wide spectrum of musculoskeletal diseases affecting soft tissues structures. Well-recognised

Table 3 Wrist: Detailed results for evidence levels and final consensus, a comparison between 2012 and 2017

Clinical indication	Evidence level 2012	Final consensus 2012	Evidence level 2018	Final consensus 2017
Tendons and soft tissues				
Tenosynovitis/rupture	C	3	B	Unchanged
Mass	C	3	Unchanged	Unchanged
Joint synovitis	B	3	Unchanged	Unchanged
Pulley/sagittal band/central slip injury-ruptures	C	3	Unchanged	Unchanged
Central slip injury	C	3	Unchanged	Unchanged
Finger collateral ligament injury except gamekeeper's thumb and Stener lesion	C	2	Unchanged	Unchanged
Gamekeeper's thumb and Stener lesion	C	2	Unchanged	3
Trigger finger	C	3	Unchanged	Unchanged
Ganglion	C	3	Unchanged	Unchanged
Rugby/jersey finger	C	3	Unchanged	Unchanged
Flexor carpi ulnaris/flexor carpi radialis tendinopathy	D	3	Unchanged	Unchanged
Extensor carpi ulnaris/estensor carpi radialis tendinopathy	C	3	B	Unchanged
Foreign body	C	3	Unchanged	Unchanged
De Quervain disease	C	3	Unchanged	Unchanged
Intersection	C	2	Unchanged	Unchanged
Bones				
Hamate	C	0	Unchanged	Unchanged
Pisiform triquetral osteoarthritis	C	2	Unchanged	Unchanged
Capitate	C	1	Unchanged	Unchanged
Volar plate avulsion (X-ray negative)	C	2	Unchanged	3
Finger fracture	C	1	B	2
Triangular fibrocartilage complex lesions	C	0	Unchanged	Unchanged
Abutment syndromes	D	0	Unchanged	Unchanged
Hammer hand	C	3	Unchanged	Unchanged
Kienbock's disease	C	0	Unchanged	Unchanged
HL impingement	C	0	Unchanged	Unchanged
Scaphoid	C	1	Unchanged	Unchanged
Trapezium	C	0	Unchanged	1
Scapho-trapezio trapezoidal osteoarthritis	C	2	Unchanged	Unchanged
Scapho-lunate ligament	C	1	Unchanged	Unchanged
Nerves				
Carpal tunnel syndrome	C	3	B	Unchanged
Guyons canal	C	3	Unchanged	Unchanged
Wartenberg syndrome	C	3	Unchanged	Unchanged
Muscle	No	No	C	1

Grade 0: not indicated; grade 1: if other imaging techniques are not appropriate; grade 2: equivalent to other imaging techniques (other techniques might provide significant information); grade 3: first choice level technique, other techniques rarely provide more information

advantages of musculoskeletal ultrasound, compared with other imaging techniques, are the dynamic examination capabilities, relatively low cost, wide availability, and lack of ionising radiation. This update is a reference for daily clinical practice and might be helpful in malpractice litigation.

This 5-year update of the 2012 Guidelines was proposed for two principle reasons. First, in recent years we have seen technical development of ultrasound systems, both software (e.g., algorithms to improve contrast resolution and colour Doppler) [130] and transducers (e.g., introduction of matrix probes, frequencies > 20 MHz, and new focusing systems) [131]. These significant technical improvements are particularly important in musculoskeletal imaging, where the study of very superficial structures is challenging. Second, the literature search included in the first issue [1] was up to August 2011. Evidence on the use of elastography in the musculoskeletal system was limited to a small number of papers [70–73, 111, 112]. Recently, there has been an increase in the number

Fig. 1 Longitudinal scan of the gluteus medius tendon (arrows) with a hypoechoic tear (asterisks). GT = greater trochanter

of papers on elastography, mainly because this tool is now more widely available on commercial ultrasound systems. Thus, a consensus paper based on newer literature evidence was needed to guide clinical practice [132, 133].

We employed the AGREE II (Appraisal of Guidelines for Research & Evaluation) instrument, which is a validated tool created to assess the quality of guidelines and to provide a strategy for the development of guidelines [134]. The ESSR 2012 guidelines [1] had a high overall score according to the AGREE II criteria [4]. In this update, we employ a similar method.

The number of experts was increased from 16 to 21 and some experts were replaced. These changes in personnel should increase the reliability and external validity of results. In addition, each expert was free to contribute to the literature search and review, potentially reducing bias and paper selection oversights. The ESSR maintained complete editorial independence for this paper, a feature critical to guideline development for musculoskeletal ultrasound [4], further reducing the risk of bias.

For single anatomical areas and ultrasound elastography, group consensus of agreement was achieved. For the hand/wrist area, the consensus was that the use of musculoskeletal ultrasound showed an increased evidence level for tenosynovitis and rupture, extensor carpi ulnaris/ulnar collateral ligament, and carpal tunnel syndrome, all common clinical indications for musculoskeletal ultrasound. For these

Table 4 Hip: Detailed results for evidence levels and final consensus, a comparison between 2012 and 2017

Clinical indication	Evidence level 2012	Final consensus 2012	Evidence level 2017	Final consensus 2017
Tendons, soft tissue, and bones				
Fluid detection	A	3	Unchanged	Unchanged
Snapping hip:				
Extra-articular	A	3	Unchanged	Unchanged
Intra-articular	D	0	Unchanged	Unchanged
Intra-articular pathology				
Osteoarthritis	A	0	Unchanged	Unchanged
Synovitis/effusion/synovial or labral cysts	A	3	Unchanged	Unchanged
Labral tears	C	0	B	0
Septic effusion	D	0	Unchanged	Unchanged
Sports hernias	D	3	Unchanged	2
Morel-Lavallee lesions	C	3	Unchanged	Unchanged
Muscle injuries low grade	B	1	Unchanged	Unchanged
Muscle injuries high grade	B	3	Unchanged	Unchanged
Sciatic nerve-intrapelvic course	D	1	Unchanged	0
Sciatic nerve - thigh	D	2	Unchanged	3
Anterior tendinopathy	D	2	Unchanged	Unchanged
Bursitis	D	2	Unchanged	Unchanged
Psoas tendon pathology	C	1	Unchanged	2
Hamstrings	B	2	Unchanged	Unchanged
Trochanteric pain	C	1	Unchanged	Unchanged
Growing pain	C	1	Unchanged	Unchanged
Nerves				
Lateral femoral cutaneous	C	3	Unchanged	Unchanged
Femoral	D	3	Unchanged	Unchanged
Gluteal tendon tears	No	No	A	2

Grade 0: not indicated; grade 1: if other imaging techniques are not appropriate; grade 2: equivalent to other imaging techniques (other techniques might provide significant information); grade 3: first choice level technique, other techniques rarely provide more information

Table 5 Knee: Detailed results for evidence levels and final consensus, a comparison between 2012 and 2017

Clinical indication	Evidence level 2012	Final consensus 2012	Evidence level 2017	Final consensus 2017
Tendons and soft tissues				
Patellar tendinopathy/tear	A	3	Unchanged	Unchanged
Quadriceps tendinosis/tear	A	3	Unchanged	Unchanged
Pes anserinus tendinobursitis	C	3	Unchanged	Unchanged
Semitendinosus tendon	C	2	Unchanged	3
Semimembranosus tendon	C	2	Unchanged	3
Medial collateral ligament	A	2	Unchanged	Unchanged
Iliotibial band friction	C	2	Unchanged	Unchanged
Posterolateral corner (biceps femoris tendon, lateral collateral ligament, popliteus tendon)	B-C	1	Unchanged	Unchanged
Gastrocnemius origins and insertions	C	2	Unchanged	Unchanged
Baker's cyst	A	3	Unchanged	Unchanged
Periarticular bursitis	A	3	Unchanged	Unchanged
Extra-articular ganglion	A	3	Unchanged	Unchanged
Intra-articular ganglion	A	1	Unchanged	Unchanged
Osgood-Schlatter, Sinding-Larsen	A	3	Unchanged	Unchanged
Synovitis, effusion	A	3	Unchanged	Unchanged
Retinacula pathology	B	2	Unchanged	Unchanged
Hoffa's fat pad syndrome	D	1	Unchanged	Unchanged
Plica syndrome	C	0	Unchanged	Unchanged
Anterior cruciate ligament tears	A	0	Unchanged	Unchanged
Posterior cruciate ligament tears	B-C	0	Unchanged	Unchanged
Meniscal tears	A	0	Unchanged	Unchanged
Meniscal cysts	B	2	A	2
Synovial tumours	B	0	Unchanged	Unchanged
Bones				
Septic arthritis	A-B	3	Unchanged	Unchanged
Osteochondritis dissecans	C	0	Unchanged	Unchanged
Knee arthroplasty infection	B	2	Unchanged	Unchanged
Loose bodies	B	1	Unchanged	Unchanged
Knee fractures	B	0	Unchanged	Unchanged
Nerves	A	3	Unchanged	Unchanged
Osteoarthritis	No	No	B	0

Grade 0: not indicated; grade 1: if other imaging techniques are not appropriate; grade 2: equivalent to other imaging techniques (other techniques might provide significant information); grade 3: first choice level technique, other techniques rarely provide more information

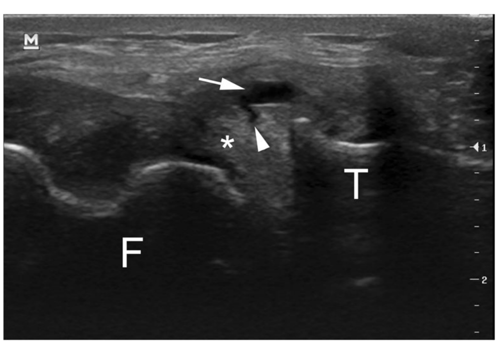

Fig. 2 Coronal scan of the medial aspect of the knee. The meniscus (asterisk) is partially extruded. A thin meniscal tear (arrowhead) with a small meniscal cyst (arrow) can be seen. F = femur; T = tibia

conditions, musculoskeletal ultrasound remains the first-choice technique, but with a higher level of evidence provided by more consistent studies. On the other hand, although evaluation of finger fracture had increased evidence, this is a less common application of ultrasound. Similarly, for what concerns labral tears, magnetic resonance arthrography remains the modality of choice. It was found that musculoskeletal ultrasound can be used to assess the intrinsic muscles of the hands and the bones if other imaging techniques cannot be used [36]. For the elbow, the evidence level for trauma, ligaments, and nerves was increased. For trauma, it is likely that the use of musculoskeletal ultrasound is still limited by logistical obstacles. Examination for ulnar nerve subluxation was

Table 6 Ankle/foot: Detailed results for evidence levels and final consensus, a comparison between 2012 and 2017

Clinical indication	Evidence level 2012	Final consensus 2012	Evidence level 2017	Final consensus 2017
Tendons and soft tissues				
Tendinopathy	D	3	C	Unchanged
Tears	A	3	Unchanged	Unchanged
Sheath effusions	A	3	Unchanged	Unchanged
Peroneal dislocation	A	3	Unchanged	Unchanged
Calcific tendinitis	A	3	Unchanged	Unchanged
Retrocalcaneal bursitis	A	3	Unchanged	Unchanged
Haglund disease	A-B	2	Unchanged	Unchanged
Postoperative tendon tear	B	3	Unchanged	Unchanged
Anterior talo-fibular ligament	A	3	Unchanged	Unchanged
Posterior talo-fibular ligament	D	0	Unchanged	Unchanged
Calcaneo-fibular ligament	A	3	Unchanged	Unchanged
Deltoid ligament	A-B	1	Unchanged	2
Spring ligament	D	1	Unchanged	2
Joint effusions	C-D	3	Unchanged	Unchanged
Intra-articular disease	D	0	Unchanged	Unchanged
Cartilage lesions	D	0	Unchanged	1
Synovitis	A	3	Unchanged	Unchanged
Plantar fasciitis	A	3	Unchanged	Unchanged
Retinacula	D	3	Unchanged	Unchanged
Ganglion cysts	A	3	Unchanged	Unchanged
Bones				
Distal tibia	B-C	0	Unchanged	Unchanged
Loose bodies	D	1	Unchanged	2
Talus	D	0	Unchanged	Unchanged
Bony avulsion	B	1	Unchanged	2
Coalitions	D	0	Unchanged	Unchanged
Nerves				
Entrapment	A	3	Unchanged	Unchanged
Morton neuroma	A	2	Unchanged	3
Plantar plate	No	No	A	2
Ankle joint instability	No	No	A	2

Grade 0: not indicated; grade 1: if other imaging techniques are not appropriate; grade 2: equivalent to other imaging techniques (other techniques might provide significant information); grade 3: first choice level technique, other techniques rarely provide more information

updated from an evidence level of C to B, reflecting a growing interest in nerve ultrasound. However, there is still a lack of thorough studies of nerve ultrasound examination. For the shoulder, there were no studies identified with a potential to increase the evidence level. This is not surprising, as the level A evidence and grade 3 indication for tendon tears would be difficult to improve upon, especially as the indications are rare in clinical practice.

For the lower limb, two new clinical indications were included for ankle and foot examination: plantar plate tears and ankle instability. These conditions, especially ankle instability, are particularly suited to dynamic ultrasound examination. For the knee, some medical literature offered an update for meniscal examination; however, the ESSR recommends caution before using ultrasound examination to assess meniscal integrity given the high specificity and accuracy of MRI.

The indications for hip examination were updated with encouraging results regarding ultrasound examination of labral tears and with the adjunct of gluteal tendon assessment to study greater trochanter pain.

Regarding ultrasound elastography, despite the high number of articles reviewed, we observed only a limited increase in evidence level. For Achilles tendinopathy, ultrasound elastography increased in evidence level from D to B with an indication grade of 3. In addition, the use of ultrasound elastography was scored with an evidence level of B and an indication grade of 1 for soft tissue tumour examination. This

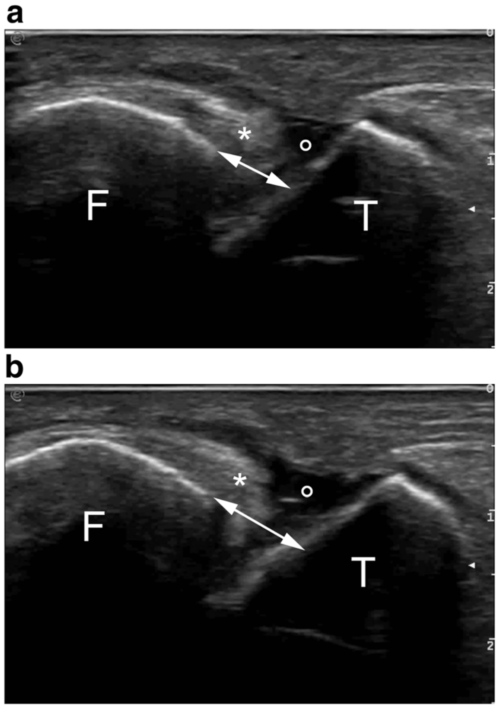

Fig. 3 Dynamic evaluation of lateral ankle instability in a patient with complete anterior talofibular ligament (asterisk) tear. Images are extracted from a video and represent scans performed (a) at rest and (b) in inversion stress. Note the increased distance (double-headed arrow) between the fibula (F) and the talus (T) when the ankle is in inversion stress. Similarly, note the increased amount of fluid in the anterior talofibular recess (circle)

is understandable as ultrasound elastography is designed to distinguish tissues with different stiffnesses and we believe that ultrasound elastography for soft tissue masses and nerve entrapment is a promising technique. We acknowledge that most published studies related to ultrasound elastography are pre-clinical or feasibility studies currently insufficient to increase the evidence level. However, the progressive implementation of musculoskeletal ultrasound with ultrasound elastography should produce studies with the potential to impact clinical practice.

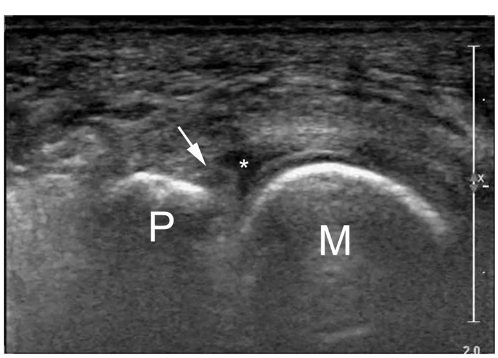

Fig. 4 Longitudinal scan of the second metatarso-phalangeal joint (M = metacarpal head; P = proximal phalanx). A plantar plate tear (asterisk) can be seen. (Arrow = distal insertion of the plantar plate)

In conclusion, this update shows increased evidence supporting ultrasound examination of degenerative and traumatic tendon disorders in both the upper and lower limbs. Ultrasound examination was found to be useful in the assessment of the plantar plate, ankle instability, and the gluteal tendon. Ultrasound elastography has the potential to improve ultrasound examination assessment of soft tissue masses and tendon disorders.

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Compliance with ethical standards

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

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

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

Methodology
• Literature systematic review

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