Ultrasound imaging for the rheumatologist

XVI. Ultrasound-guided procedures

O. Epis¹, A. Iagnocco², G. Meenagh³, L. Riente⁴, A. Delle Sedie⁴, E. Filippucci⁵, C.A. Scirè¹, G. Valesini², W. Grassi⁵, S. Bombardieri⁴, C. Montecucco¹

ABSTRACT

Ultrasoundography (US) has proved to be a useful tool for the clinical evaluation of patients with rheumatic diseases. It is also recognised as a useful imaging technique in interventional radiology. In the last few years, a number of rheumatologists have also described and advocated the use of US guidance in joint and soft tissue aspiration and injection technique in clinical practice. Moreover, US-guided synovial biopsy methods have been proposed as an interesting and reliable method for the histopathological assessment of small and large joint synovium.

The present review provides an update of the available data regarding the use of US in interventional procedures in clinical rheumatology.

Introduction

In recent years, several papers have described the fundamental role of ultrasonography (US) in patients with rheumatic disorders (1-10), predominantly rheumatoid arthritis (11) but also spondyloarthritides (12), osteoarthritis (13, 14), crystal-related arthritis (15, 16), connective tissue diseases (17, 18) and vasculitis (19). Musculoskeletal US has already proved to be an excellent, non-invasive and economic instrument to detect joint and tendon involvement (20) and US guiding can improve the efficacy of joint fluid aspiration and local corticosteroid (CS) injection (21-23).

Furthermore, the recent development of US-guided synovial biopsy methods has provided an interesting and reliable tool for obtaining synovial samples from small and large joints. In the present review, an update of the available data about the use of US in interventional procedures is provided and a brief research agenda related to this topic is discussed.

Clinical needs

The aspiration of joint effusion is a routine diagnostic and therapeutic procedure in clinical rheumatology. When performing intra-articular injection of CS, confirmation of accurate needle placement was usually obtained by successful aspiration of synovial fluid. However, synovial fluid aspiration is not always a valuable predictor of the correct intra-articular placement of the drug. In 1993 Jones et al. (24) studied the accuracy of 109 injections into different joints, by mixing CS with a radiographic contrast medium; they found that almost half of extra-articular injections have been associated with successful aspiration of synovial fluid.

Actually, aspiration or injection performed without imaging guidance is often unsuccessful as for the target, particularly for small joints. In 3 studies that used radiographic contrast analysis to confirm accurate intra- and peri-articular needle placement, the successful injection rates were as low as 42% for glenohumeral joint injections and 32% for tendon sheath injections (24-26). Thus a variety of imaging methods, including x-ray screening, computed tomography (CT) scanning and magnetic resonance imaging (MRI) have been used to better localize needle placement (27).

Sonographic findings

Real-time imaging performances of US are a relevant advantage for interventional procedures in the musculoskeletal system, since it allows monitoring of the needle at all times. High frequency US allows careful intra- or peri-lesional placement of the tip of the needle, into a joint or a tendon sheath (28).

Air is a very effective contrast medium in US; the sterile air that is contained in the capped vial with lidocain or CS can

¹Cattedra di Reumatologia, Fondazione IRCCS Policlinico S. Matteo, Università di Pavia, Pavia, Italy; ²Cattedra di Reumatologia, Sanpier Damaso Università di Roma, Italy; ³Department of Rheumatology, Antrim Hospital, Antrim, United Kingdom; ⁴Cattedra di Reumatologia, Università di Pisa, Pisa, Italy; ⁵Cattedra di Reumatologia, Università Politecnica delle Marche, Jesi, Italy.

Oscar Epis, MD; Annamaria Iagnocco, MD; Gary Meenagh, MD; Lucrezia Riente, MD; Andrea Delle Sedie, MD; Emilio Filippucci, MD; Carlo Alberto Scirè, MD; Guido Valesini, MD, Professor of Rheumatology; Walter Grassi, MD, Professor of Rheumatology; Stefano Bombardieri, MD, Professor of Rheumatology; Carlomaurizio Montecucco, MD, Professor of Rheumatology.

Please address correspondence and reprint requests to:
Dr. Oscar Epis, S.C. Reumatologia, A.O. Ospedale Niguarda, Piazza Ospedale Maggiore 3, 20162 Milano, Italy.
E-mail: o.epis@ospedaleniguarda.it
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be used as contrast medium to confirm the correct placement of the needle into the joint before injecting the drug (29-30).

When CS or other drugs are injected into the synovial space, the drug flow and air bubbles can be seen on the monitor in real time. Due to its crystal-line structure, the suspension generates hyperechoic foci or lines, thus, the operator can verify accurately where the needle is and where the drug is going. A little amount of air, together with CS and saline has been demonstrated to be an excellent contrast medium in grey scale US imaging (31).

Palpation or clinical examination are the approaches traditionally used by rheumatologists and orthopedics to guide needle placement. The operator uses superficial skin and body landmarks to decide the most suitable entry point. However, the accuracy of this approach is poor, even for the knee (32).

The method of non-direct guidance is made by sonographic evaluation, which can depict the position and the depth of the fluid collection from the skin surface; then, the skin surface is marked, and aspiration without direct needle visualization is performed. The advantage of this method is that the procedure is quick, and technically simple.

The method of direct needle guidance under US visualization is preferred when the fluid collection is closely related to nerves or vascular structures, and allows the spatial relationship between needle and vessels or nerves to be monitored during aspiration/injection (22). For the best needle visualization, the needle should be positioned as perpendicular as possible to the US beam. The needle will be seen as a hyperechoic line, often having a strong ring-down artifact.

The direct method can be performed as a freehand method, or with the use of interventional kits for biopsy guidance. The freehand method requires skilled operators, while the use of an interventional kit is technically simpler, thanks to the precise installation on the transducers, ensuring time-saving, safe and reliable procedures. Stainless steel-made devices, can be fully sterilized by using the autoclave method, even though disposable interventional kits are now available. The needle guide is easily removable allowing it to be correctly positioned, even after the needle has been inserted. The needle remains perfectly positioned on the target-of-interest, thus avoiding any problem due to incorrect movements of the needle. Multiple angles of insertion are available and procedures can be performed both in the near and far field.

**Ultrasound-guided aspiration and injection**

US-guided aspirations and injections produce a significantly different result from procedures administrated using anatomical landmarks.

Balint et al. (21) found that US improved the overall success of joint fluid aspiration from 32% to 97%. Recently, Naredo and colleagues (33) studied 41 patients who were randomised to receive either a blind or sonographic-guided steroid injection for painful shoulder. Significantly greater improvements in both shoulder function and pain were observed in the group of patients who had received sonographic-guided CS injection, allowing the correct placement of the drug within the subacromial-subdeltoid bursa.

US assessment can reveal different pathological conditions, which may be targets for specific therapy, for example at the carpal tunnel (34) or the ankle and foot (35). US guidance is particularly important in small joints; the study of Raza et al. (36) demonstrated that US-guided needle placement resulted in significantly greater accuracy than a palpation-guided approach for injection of the small joint of the hand in early rheumatoid arthritis.

The exact placement of injection of both CS and hyaluronan may be important for the effect of the therapy, as well

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**Fig 1.** (A) Hip joint placement of the needle using an interventional kit. The arrow head indicates the needle. FH = femoral head. Image taken using a Nemo (Toshiba, America Medical System, Tustin, CA, USA) equipped with a 3.75 MHz convex probe. (B) US-guided synovial biopsy of a knee using a 1.9 mm forceps. The arrow indicates the forceps. The asterisk indicates joint effusion. “=” synovitis. (C) Correct placement of the needle into the knee joint. Suprapatellar transverse scan. The arrow head indicates the needle. The asterisk indicates joint effusion. (D) Placement of the portal for US-guided synovial biopsy of the III proximal interphalangeal joint. Images B and C taken using a Logiq 9 (General Electric Medical Systems, Milwaukee, WI) equipped with an 8-10 MHz linear probe.

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as avoiding local adverse effects of the medication or the procedure. In particular, intra-articular injection of the hip is at great risk of injecting outside the joint cavity. Fluoroscopy allows the introduction of the needle into the joint space but does not allow the identification of vascular and nervous structures that can be easily detected by sonographic monitoring along with the needle placement. Furthermore ultrasound guidance does not require contrast medium, can be repeated without the problems of radiation load and is cheaper and faster in comparison to fluoroscopic guidance. No systemic or local side effects have been reported (37-39).

Sonographic guidance can be effective even for the closed needle tidal joint irrigation, a procedure which has been proposed in knee osteoarthritis (40), in septic arthritis (41), and in patients with crystal related arthritis such as Milwaukee shoulder syndrome (42-44). Ultrasound evaluation discloses the presence of fluid as well as of synovial proliferation and vascularisation, and allows the operator to choose the best site to introduce the cannula, making the procedure more effective, quicker and safer. The joint is evacuated and then reinstilled with fresh saline (30-120 ml) which is then removed. The irrigation is continued until 1500-2000 ml of saline solution passes through the joint; the residual amount of fluid in the joint after the procedure can be checked by US.

Ultrasound-guided synovial biopsy

The synovial membrane is the primary site of inflammation, and an important target of arthritis research. Analysis of synovial tissue can provide relevant information about the pathophysiological mechanism, the degree of inflammation and prognosis. There are several possible approaches to synovial tissue sampling, but arthroscopic biopsy is generally accepted as the gold standard both for the quality and size of specimens. The knee joint has been the favourite biopsy site owing to the ease of arthroscopic access (45). Ultrasound can be used to obtain synovial samples, both for large and small joints, because of the ability of the ultrasound to detect the needle and all types of instruments, which appear hyperechoic on sonography evaluation. Koski et al. (46) report their experience of a method for synovial biopsy under ultrasound guidance, using an introducing set and forceps, which can be performed on most joints and even bursae and tendon sheaths. Thus, the development of US-guided synovial biopsy may help to overcome the blindness of the needle biopsy and the invasiveness of arthroscopic biopsy.

Recently, a minimally invasive US-guided procedure, for small joint synovial biopsy has been described (47). This procedure can be performed by a portal and rigid forceps technique and it represents a reliable tool for obtaining valuable synovial samples for the assessment of the histopathological features of rheumatoid arthritis patients.

Research agenda

Exciting areas for future research include:

- Definition and standardisation of all those procedures, e.g., joint/bursal or perilesional injections, which, at present, need a US-guided approach in routine clinical practice.
- Standardisation of US evaluation of the short-term effect of local therapy.
- Investigation of the potential of 3D-ultrasonography with the volumetric probe and/or fusion imaging techniques in sonographically-guided procedures.
- Exploitation of the minimally invasive US-guided biotic procedures for multiple assessments, thus allowing the analysis of different joints at a single time point as well as the analysis of the same joint at different points during the course of the disease or treatment.

Link

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References

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