Ultrasound imaging for the rheumatologist XVI. Ultrasound-guided procedures

O. Epis[1], A. Iagnocco[2], G. Meenagh[3], L. Riente[4], A. Delle Sedie[4], E. Filippucci[5], C.A. Scirè[1], G. Valesini[2], W. Grassi[5], S. Bombardieri[4], C. Montecucco[1]

[1]Cattedra di Reumatologia, Fondazione IRCCS Policlinico S. Matteo, Università di Pavia, Pavia, Italy; [2]Cattedra di Reumatologia, Sapienza Università di Roma, Italy; [3]Department of Rheumatology, Antrim Hospital, Antrim, United Kingdom; [4]Cattedra di Reumatologia, Università di Pisa, Pisa, Italy; [5]Cattedra 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

Received and accepted on July 21, 2008.

Clin Exp Rheumatol 2008; 26; 515-518.

Key words: Ultrasound, arthrocentesis, injection, synovial biopsy.

Competing interests: none declared.

ABSTRACT

Ultrasonography (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 sinovium.

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 spondyloarthritis (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

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 crystalline 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

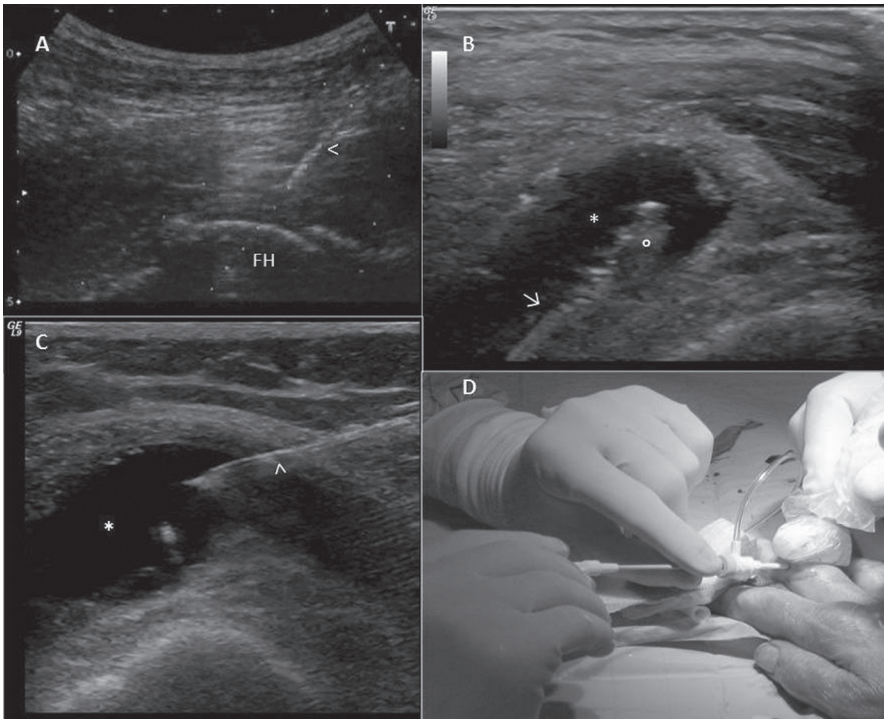

Fig 1. (**A**) Hip joint placement of the needle using an interventional kit. The arrow head indicates the needle. FH = femoral head. Image taken using a Nemio (Toshiba, America Medical System, Tustin, CA, USA) equipped with a 3.75 MHz convex probe. (**B**) US-guided synovial biopsy of a knee using a 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 a 8-10 MHz linear probe.
For further ultrasound images, go to: www.clinexprheumatol.org/ultrasound

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 bioptic 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

For further ultrasound images, go to *www.clinexprheumatol.org/ultrasound*

References

1. FILIPPUCCI E, IAGNOCCO A, MEENAGH G *et al*.: Ultrasound imaging for the rheumatologist. *Clin Exp Rheumatol* 2006; 24: 1-5.
2. IAGNOCCO A, FILIPPUCCI E, MEENAGH G *et al*.: Ultrasound imaging for the rheumatologist I. Ultrasonography of the shoulder. *Clin Exp Rheumatol* 2006; 24: 6-11.
3. FILIPPUCCI E, IAGNOCCO A, MEENAGH G *et al*.: Ultrasound imaging for the rheumatologist: II. Ultrasonography of the hand and wrist. *Clin Exp Rheumatol* 2006; 24: 118-22.
4. IAGNOCCO A, FILIPPUCCI E, MEENAGH G *et al*.: Ultrasound imaging for the rheumatologist: III. Ultrasonography of the hip. *Clin Exp Rheumatol* 2006; 24: 229-32.
5. MEENAGH G, IAGNOCCO A, FILIPPUCCI E *et al*.: Ultrasound imaging for the rheumatologist: IV. Ultrasonography of the knee. *Clin Exp Rheumatol* 2006; 24: 357-60.
6. RIENTE L, DELLE SEDIE A, IAGNOCCO A *et al*.: Ultrasound imaging for the rheumatologist: V. Ultrasonography of the ankle and foot. *Clin Exp Rheumatol* 2006; 24: 493-98.
7. DELLE SEDIE A, RIENTE L, IAGNOCCO A *et al*.: Ultrasound imaging for the rheumatologist: VI. Ultrasonography of the elbow, sacroiliac, parasternal, and temporomandibular joints. *Clin Exp Rheumatol* 2006; 24: 617-21.
8. IAGNOCCO A, FILIPPUCCI E, MEENAGH G *et al*.: Ultrasound imaging for the rheumatologist: XI. Ultrasound imaging in regional pain syndromes. *Clin Exp Rheumatol* 2007; 25: 672-75.
9. FILIPPUCCI E, MEENAGH G, DELLE SEDIE A *et al*.: Ultrasound imaging for the rheumatologist: XII. Ultrasound imaging in sports medicine. *Clin Exp Rheumatol* 2007; 25: 806-09.
10. FILIPPUCCI E, MEENAGH G, EPIS O *et al*.: Ultrasound imaging for the rheumatologist: XIII. New trends. Three-dimensional ultrasonography. *Clin Exp Rheumatol* 2008; 26: 1-4.
11. FILIPPUCCI E, IAGNOCCO A, MEENAGH G *et al*.: Ultrasound imaging for the rheumatologist: VII. Ultrasound imaging in rheumatoid arthritis. *Clin Exp Rheumatol* 2007; 25: 5-10.
12. RIENTE L, DELLE SEDIE A, FILIPPUCCI E *et al*.: Ultrasound imaging for the rheumatologist: IX. Ultrasound imaging in spondyloarthritis. *Clin Exp Rheumatol* 2007; 25: 349-53.
13. MEENAGH G, FILIPPUCCI E, IAGNOCCO A *et al*.: Ultrasound imaging for the rheumatologist: VIII. Ultrasound imaging in osteoarthritis. *Clin Exp Rheumatol* 2007; 25: 172-75.
14. KEEN HI, WAKEFIELD RJ, GRAINGER AJ, HENSOR EM, EMERY P, CONAGHAN PG: Can ultrasonography improve on radiographic assessment in osteoarthritis of the hands? A comparison between radiographic and ultrasonographic detected pathology. *Ann Rheum Dis* 2008; 67: 1116-20.
15. DELLE SEDIE A, RIENTE L, IAGNOCCO A *et al*.: Ultrasound imaging for the rheumatologist: X. Ultrasound imaging in crystal-related arthropaties. *Clin Exp Rheumatol* 2007; 25: 513-17.
16. THIELE RG, SCHLESINGER N: Diagnosis of gout by ultrasound. *Rheumatology* (Oxford) 2007; 46: 1116-21.
17. RIENTE L, DELLE SEDIE A, FILIPPUCCI E *et al*.: Ultrasound imaging for the rheumatologist: XIV. Ultrasound imaging in connective tissue diseases. *Clin Exp Rheumatol* 2008; 26: 230-33.

18. WERNICKE D, HESS H, GROMNICA-IHLE E, KRAUSE A, SCHMIDT WA: Ultrasonography of salivary glands -- a highly specific imaging procedure for diagnosis of Sjögren's syndrome. *J Rheumatol* 2008; 35: 285-93.
19. DELLE SEDIE A, RIENTE L, FILIPPUCCI E *et al*.: Ultrasound imaging for the rheumatologist: XV. Ultrasound imaging in vasculitis. *Clin Exp Rheumatol* 2008; 26: 391-4.
20. DELLE SEDIE A, RIENTE L, BOMBARDIERI S: Limits and perspectives of ultrasound in the diagnosis and management of rheumatic diseases. *Mod Rheumatol* 2008; 18: 125-31.
21. BALINT PV, KANE D, HUNTER J, MCINNES IB, FIELD M, STURROCK RD: Ultrasound guided versus conventional joint and soft tissue fluid aspiration in rheumatology practice: a pilot study. *J Rheumatol* 2002; 29: 2209-13.
22. KOSKI JM: Ultrasound guided injections in rheumatology. *J Rheumatol* 2000; 27: 2131-38.
23. CARDINAL E, CHHEM RK, BEAUREGARD CG: Ultrasound-guided interventional procedures in the musculoskeletal system. *Radiol Clin North Am* 1998; 36: 597-604.
24. JONES A, REGAN M, LEDINGHAM J, PATTRICK M, MANHIRE A, DOHERTY M: Importance of placement of intra-articular steroid injections. *BMJ* 1993; 20: 1329-30.
25. EUSTACE JA, BROPHY DP, GIBNEY RP, BRESNIHAN B, FITZGERALD O: Comparison of the accuracy of steroid placement with clinical outcome in patients with shoulder symptoms. *Ann Rheum Dis* 1997; 56: 59-63.
26. ZINGAS C, FAILLA JM, VAN HOLSBEECK M: Injection accuracy and clinical relief of de Quervain's tendonitis. *J Hand Surg* 1998; 23: 89-96.
27. HALL S, BUCHBINDER R: Do imaging methods that guide needle placement improve outcome? *Ann Rheum Dis* 2004; 63: 1007-8.
28. GRASSI W, FARINA A, FILIPPUCCI E, CERVINI C: Sonographically guided procedures in rheumatology. *Semin Arthritis Rheum* 2001; 30: 347-53.
29. FREDBERG U, VAN OVEREEM HANSEN G, BOLVIG L: Placement of intra-articular injection verified by ultrasonography and injected air as contrast medium. *Ann Rheum Dis* 2001; 60: 542.
30. QVISTGAARD E, KRISTOFFERSEN H, TERSLEV L *et al*.: Guidance by ultrasound of intra-articular injection in the knee and hip joints. *Osteoarthritis Cartilage* 2001; 9: 512-17.
31. KOSKI JM; SAARAKKALA S, HEIKKINEN J, HERMUNEN H: The use of air-steroid-saline mixture as contrast medium in greyscale ultrasound imaging: experimental study and practical applications in rheumatology. *Clin Exp Rheum* 2005; 23: 373-78.
32. JACKSON DW, EVANS NA, THOMAS BM: Accuracy of needle placement in the intra-articular space of the knee. *J Bone Surg Am* 2002; 84: 1522-27.
33. NAREDO E, CABERO F, BENEYTO P *et al*.: A randomised comparative study of short term response to blind injection versus sonographic-guided injection of local corticosteroids in patients with painful shoulder. *J Rheumatol* 2004; 31: 308-14.
34. GRASSI W, FARINA A, FILIPPUCCI E, CERVINI C: Intralesional therapy in carpal tunnel sindrome: a sonographic-guided approach. *Clin Exp Rheumatol* 2002; 20: 73-6.
35. D'AGOSTINO MA, AYRAL X, BARON G, RAVAUD P, BREBAN M, DOUGADOS M: Impact of ultrasound imaging on local corticosteroid injection of symptomatic ankle, hind-, and mid-foot in chronic inflammatory diseases. *Arthritis Rheum* 2005; 53: 284-92.
36. RAZA K, LEE CY, PILLINO D *et al*.: Ultrasound guidance allows accurate needle placement and aspiration from small joints in patients with early inflammatory arthritis. *Rheumatology* 2003; 42: 976-79.
37. POURBAGHER MA, OZALAY M, POURBAGHER A: Accuracy and outcome of sonographically guided intra-articular sodium hyaluronate injections in patients with osteoarthritis of the hip. *J Ultrasound Med* 2005; 24: 1391-95.
38. MIGLIORE A, TORMENTA S, MARTIN MARTIN LS *et al*.: [Safety profile of 185 ultrasound-guided intra-articular injections for treatment of rheumatic diseases of the hip]. *Reumatismo* 2004; 56: 104-9.
39. MIGLIORE A, TORMENTA S, MARTIN MARTIN LS *et al*.: Open pilot study of ultrasound-guided intra-articular injectionof hylan G-F 20 (Synvisc) in the treatment of symptomatic hip osteoarthritis. *Clin Rheumatol* 2005; 24: 285-89.
40. RAVAUD P, MOULINIER L, GIRADEAU B *et al*.: Effects of joint lavage and steroid injection in patients with osteoarthritis of the knee: results of a multicenter, randomised, controlled trial. *Arthritis Rheum* 1999; 42: 475-82.
41. IKE RW: Tidal irrigation in septic arthritis of the knee: a potential alternative to surgical drainage. *J Rheumatol* 1993; 20: 2104-11.
42. CAPORALI R, ROSSI S, MONTECUCCO C: Tidal irrigation in Milwaukee shoulder syndrome. *J Rheumatol* 1994; 21: 1781-2
43. EPIS O, VIOLA E, BRUSCHI E, BENAZZO F, MONTECUCCO C: Milwaukee shoulder syndrome (apatite associated destructive arthritis): therapeutic aspects]. *Reumatismo* 2005; 57: 69-77.
44. EPIS O, CAPORALI R, SCIRÈ CA, BRUSCHI E, BONACCI E, MONTECUCCO C: Efficacy of tidal irrigation in Milwaukee shoulder sindrome. *J Rheumatol* 2007; 34: 1545-50.
45. SMITH MD, BAETEN D, ULFGREN AK *et al*.: OMERACT synovial special interests group. Standardisation of synovial tissue infiltrate analysis: how far have we come? How much further do we need to go? *Ann Rheum Dis* 2006; 65: 93-100.
46. KOSKI JM, HELLE M: Ultrasound guided synovial biopsy using portal and forceps. *Ann Rheum Dis* 2005; 64: 926-29.
47. SCIRÈ CA, EPIS O, CODULLO V *et al*.: Immunohistological assessment of the synovial tissue in small joints in rheumatoid arthritis: validation of a minimally invasive ultrasound-guided synovial biopsy procedure. *Arthritis Res Ther* 2007; 9: R101.