Editorial

Ultrasonography in rheumatology: developing its potential in clinical practice and research

Introduction

There have been a number of major scientific advances in our specialty in recent years and now we are beginning to see the impact of these developments on everyday clinical practice. Biologic therapies may have grabbed all the headlines but ultrasonography (US) has an even greater potential to influence the way we assess and treat our patients. In <10 yrs, it has evolved from a diagnostic tool used in a small minority of patients to a virtually indispensable clinical instrument which has been likened to the ‘rheumatologist’s stethoscope’. Research in US has focused mainly on the assessment of regional pain syndromes, the early detection of structural damage in inflammatory arthritis, and US guidance of joint and soft tissue injections [1–3].

US has a number of properties which make it particularly attractive as an imaging tool. These include the lack of radiation exposure, the ability to assess the joints in a dynamic fashion and the power to measure tissue perfusion, and therefore inflammation. There are, however, several dilemmas that face the rheumatologist who wants to become a sonographer. ‘Do I need to buy my own US equipment and which is the best machine for my purposes?’ ‘How can I master the art of scanning and maintain my skills?’ ‘How do I interpret the images correctly and standardize my technique?’

The shock of buying

Constant practice is the key to success when attempting to master the art of US, so unless you have unrestricted access to a machine, this can be very difficult. For most of us, this means that we will aspire to owning our own equipment. But which US machine should you buy? The most important point is to be patient and avoid a hasty purchase. Speak to colleagues who are experienced in the field and be clear in your mind how you intend to use the equipment. There is a wide array of different US machines on the market, so in order to acquire a high quality machine, a large financial outlay is necessary [4]. Most US machines come with a variety of options that allow the purchaser to personalize the equipment. These can have a significant impact on the overall price of the machine. They include a choice of probes of different frequencies and sizes and optional software packages for more specialized imaging.

In general, it is wise to purchase the best machine that you can afford. Currently, the price range for US equipment is between 20000 and 200000 Euro. The key elements that should act as a guide for the selection of the machine are the spatial resolution of the probe(s) (directly related to the frequency) and the presence or absence of power Doppler. In recent years, the cost-quality ratio of the US equipment has improved dramatically and an investment of ~400000 Euro will buy you a machine that produces images of an acceptably high standard.

The art of scanning

US has been defined as a technical art form and as with any art, it can be difficult for the novice to acquire the necessary skills to reach an acceptable standard. The production of a high-quality US image requires several fundamental skills, but the most important is the precise placement of the probe over the anatomical target. There is a very fine balance between acquiring an image of high quality and one that is unacceptable. This underlines the importance of training and represents one of the main obstacles to the development of these skills by a significant number of rheumatologists. There is still much debate about the appropriate amount of training necessary to acquire the basic skills of sonography [5, 6], but most experts agree that the best way to train is under the supervision of an expert [7]. The American College of Radiology recommends that US trainees should undertake 500 supervised scans in order to achieve an acceptable standard [8], but such a requirement would present major logistical difficulties for most rheumatologists, given the time constraints of a busy clinical practice and the limited number of rheumatologist sonographers. Innovative ways of addressing this challenge in US training in rheumatology are urgently needed.

The science of interpretation

Radiologists and rheumatologists have developed elaborate scoring systems to permit the accurate assessment of joint disease progression from plain radiographs, usually of the hands and feet. A similar approach can be applied to US imaging but there are some fundamental limitations to this approach. US is the most operator-dependent of all the imaging modalities and as a consequence, images are difficult to interpret outside the process of real-time acquisition. Representative printed images, saved during the US examination, are only a small part of the complex scenery viewed by the operator. A sonographer’s overall conclusions can be influenced by a variety of elements not all of which are visible to the naked eye. As a result, the efficacy of the technique depends largely upon the skill and experience of the sonographer. This limitation of conventional US has been largely overcome with the development of three-dimensional (3D) US technology. This is an exciting new modality which will allow independent readers to view imagery identical to that which is seen by the person performing the US examination. This minimizes the potential for discordance in image interpretation between the sonographer and the secondary assessor [1, 9]. 3D-US is performed by navigating through a 3D-cube of images containing an endless number of single images. Modern software packages now permit an independent reader to modulate the image parameters thus improving the quality of the information acquired during the examination.

The laws of standardization

The production of high-quality US images is intimately linked with rigorous standardization of US technique. In recent years, experts have published guidelines on the correct approach
to imaging a variety of anatomical sites in an attempt to produce an agreed standard for clinical practice, training and research [7].

As a concept, standardization is well-known in the field of plain radiography. US presents specific difficulties in relation to standardization, by virtue of its dynamic nature and the operator dependency of the acquisition process. The advent of 3D-US should address many of these difficulties but since the majority of rheumatologists will continue to practice 2D-US, these issues will remain important in the foreseeable future.

At present, two main methods of tutorship in the ‘laws of standardization’ exist for rheumatologist sonographers. These include ‘Teach the teachers’ courses and web-based consensus workshops. One of the useful spin-offs from the ‘Teach the teachers’ courses has been a formal assessment of inter-observer variability in image acquisition. The results of these studies have been impressive and have indicated that it is possible to achieve an acceptable level of standardization in 2D-US amongst a group of experienced sonographers [10, 11]. This level of concordance between experts must be interpreted in light of the high quality of the US equipment used, the cumulative experience of those involved and the basic level of the sonographic pathology being examined. An attractive alternative to the residential ‘Teach the teachers’ course is a web-based forum such as that being currently used by the EULAR Working Group for Musculoskeletal Ultrasound for assessing and scoring synovitis.

The challenge of training

To date, there is no agreed pathway for the rheumatologist to follow in order to become a competent sonographer. Guidelines for basic training were drawn up by the EULAR Working Group for Musculoskeletal Ultrasound in rheumatology in 2001 [7]. These affirmed the importance of expert supervision during the training process and this principle has been demonstrated in a self-teaching project involving a novice who was able to produce 2D-US images of sufficient quality in a short period of time [12]. In a second study, another novice was taught to scan the hip joint and demonstrated an excellent level of concordance with the tutor [13].

Over the last five yrs, the EULAR Working Group for Musculoskeletal Ultrasound in rheumatology has been organizing basic and advanced US courses which have been successful in terms of the number of participants and the level of satisfaction amongst those who have attended. These courses are only the starting point of the training process and many issues regarding training in musculoskeletal US still remain unresolved [14, 15]. These include the amount of time that should be devoted to training, the number of US examinations which need to be performed under supervision and the most effective way of assessing competency at the end of the training period.

Recently, a group of rheumatologists from Belfast described a series of steps which they took, over a 5-yr period, to gain sufficient experience to achieve a basic level of competency in US. At the end of that period, they were assessed by an experienced rheumatologist sonographer in a formal test of their ability to perform basic US examinations on normal volunteers and patients [4]. This system has the attraction of being a ‘real-time’ assessment of a dynamic technique, but it requires a considerable commitment of time on the part of all the participants.

Perhaps a more universal means of training and assessment can be devised with the help of the latest techniques of web-based learning. These are not a substitute for mentoring by an experienced sonographer but they could be a powerful adjunct to face-to-face learning. This approach has already been the subject of a pilot study in Italy where trainees have the benefit of a continuous interaction with tutors by submitting their US images to a web-based tutor for comment and feedback [16].

‘Publish or perish’

US has opened new avenues of research to rheumatology in recent years. These have principally focused on the detection of morphostructural abnormalities in target tissues in phases of the diseases where other imaging modalities may be of limited value [2, 17]. In this context, US appears particularly promising as a tool to aid the rheumatologist in Early Arthritis Clinics. The detection of very early erosions (<1 mm), the identification of cartilage damage [18], the evaluation of synovial pannus [19] and the monitoring of disease activity [20, 21] are only a few examples of many exciting research areas. Over the last 25 yrs there has been an explosion in the number of publications regarding US in rheumatology (Fig. 2A). Over 85% of these publications have originated from European countries particularly from the UK, Italy and Germany (Fig. 2B). A closer examination of the literature reveals that rheumatoid arthritis and shoulder problems are the most frequently investigated subjects (Fig. 2C and D).

In conclusion, there are many exciting challenges ahead in the field of US in rheumatology. The common denominator in all of this is the union of sensitivity and specificity in the early detection of tissue changes induced by rheumatic diseases. At present, both the methodology and the technology exist to encourage a healthy interest in US, but a dramatic increase of active researchers is required to reach the critical mass necessary to embrace this challenge.

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FIG. 2. Number of US publications related to the year of publication (A), nationality of authorship (B), anatomical area investigated (C) and rheumatic disease evaluated (D). CPPD, Calcium pyrophosphate deposition disease.

References


