CONCISE REPORT

Sonographic training in rheumatology: a self teaching approach

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Objective: To evaluate a self teaching approach to be followed by a novice without previous practical experience in musculoskeletal ultrasonography.
Methods: The novice was given short general training (two hours) by an experienced sonographer focusing on the approach to the ultrasound equipment, and asked to obtain the best sonographic images of different anatomical areas as similar as possible to the "gold standard" pictures in the online version of the guidelines for musculoskeletal ultrasonography in rheumatology (free access at http://www.sameint.it/eular/ultrasound). At the end of each scanning session, both novice and tutor scored "blindly" all the images from 0 (the lowest quality) to 10 (the highest quality), with a minimum quality score of 6 considered acceptable for standard clinical use. The tutor then explained how to improve the quality of the pictures. Fourteen consecutive inpatients (seven with rheumatoid arthritis, three with psoriatic arthritis, two with reactive arthritis, and two with osteoarthritis) and five healthy subjects were examined. Ultrasound examinations were performed with a Diasus (Dynamic Imaging Ltd, Livingston, Scotland, UK) using two broadband linear probes of 5–10 and 8–16 MHz frequency.
Results: Sonographic training lasted one month and included 30 scanning sessions (24 hours of active scanning). 243 images were taken of the selected anatomical areas. The mean time required to produce each image was 6 minutes (SD 4.2; range 1–30). At the end of the training, the novice scored ⩾6 for each standard scan.
Conclusion: A novice can obtain acceptable sonographic images in 24 non-consecutive hours of active scanning after an intensive self teaching programme.

Over the past few years, rheumatologists have become increasingly interested in ultrasonography (US).[1–9] However, US is the most operator dependent imaging modality and requires experience and expertise.[2 3] Only a few comments on the learning curve in musculoskeletal US have been made, and most of them state the importance, the difficulty, and the relatively long duration of the training.[3 5 7 9] Moreover, there is no standardised educational model for training in musculoskeletal US.

In a recent paper Balint *et al* showed that a novice in musculoskeletal US can be trained by an experienced investigator to produce acceptable images of the hip within three hours.[10]

Our study aimed at evaluating a self teaching approach to be followed by a novice without previous practical experience in musculoskeletal US.

METHODS

The novice (ZU) had not previously performed an ultrasound examination and her anatomical knowledge was basic. After a short general training (two hours) focusing on the approach to the ultrasound equipment by an experienced sonographer (EF), the novice was asked to obtain the best sonographic images of different anatomical areas as similar as possible to the "gold standard" pictures included in the online version of the guidelines for musculoskeletal ultrasound in rheumatology[5] (freely available on the website of the EULAR Working Group for Musculoskeletal Ultrasound in Rheumatology: http://www.sameint.it/eular/ultrasound).

This version has the basic structure of a web based teaching file and provides sonographic images corresponding to each specific standard scan in a very short time, allowing immediate support for the sonographer while performing an ultrasound examination. The novice had free access to a CD-ROM version of the online guidelines, using a computer placed beside the ultrasound machine. Additional resources used by the novice during the teaching programme that may have hastened her learning curve included textbooks and atlas of anatomy and musculoskeletal US, and some recent papers on musculoskeletal US.

The teaching programme focused on eight main anatomical areas (shoulder, elbow, wrist, hand, hip, knee, ankle, and foot) and 66 standard scans.

Scanning sessions were numbered chronologically and each session included all the standard scans of a specific anatomical area. An axillary scan of the shoulder was not included in the teaching programme, because this scan cannot be performed in all patients with shoulder pain.

The novice was free to choose the chronological succession of the anatomical areas to explore. The only instructions were to try to obtain acceptable sonographic images in a specific anatomical area, according to the tutor's evaluation, before starting to explore another one.

At the end of each scanning session, both novice and tutor scored "blindly" all the images from 0 (the lowest quality) to 10 (the highest quality). The minimum quality score considered acceptable for standard clinical use of US was 6. After discussing the scores with the novice the tutor explained how to improve the quality of the pictures. Time spent by the tutor was recorded. The novice recorded the time spent in producing each image and scored the perceived difficulty in performing each standard scan from 0 (the lowest difficulty) to 10 (the highest difficulty).

Fourteen consecutive inpatients with different rheumatic diseases (seven with rheumatoid arthritis, three with psoriatic arthritis, two with reactive arthritis, and two with osteoarthritis) and five healthy subjects were included in this educational programme. Ultrasound examinations were performed with a Diasus (Dynamic Imaging Ltd, Livingston, Scotland, UK) using two broadband linear probes of 5–10 and 8–16 MHz frequency.

RESULTS

Sonographic training lasted for one month and included 30 scanning sessions (24 hours of active scanning). Table 1 lists the details of the teaching programme. The novice decided to

Table 1 Details of the teaching programme

Sessions	Anatomical area	Time spent in active scanning (min)	Number of sonographic images	Mean time spent on each sonographic image in minutes (range)	Tutor - Median quality score (range)	Novice - Median quality score (range)	Novice - Median difficulty score (range)	Time spent by tutor (min)
1	Hand	50	14	3.6 (1–5)	4 (2–7)	5 (3–9)	1.5 (1–3)	60
2	Wrist	47	10	4.7 (1–15)	4 (3–5)	3.5 (3–8)	6 (4–9)	30
3	Hand	96	14	6.9 (2–10)	6 (3–6)	5.5 (3–8)	6 (2–8)	30
4	Wrist	79	10	7.9 (2–15)	4 (3–6)	5.5 (4–7)	7 (6–8)	30
5	Hand	158	14	11.3 (3–18)	6 (4–7)	7 (6–8)	5 (4–7)	30
6	Wrist	98	10	9.8 (2–15)	6 (4–7)	7 (2–8)	4 (2–7)	30
7	Elbow	37	6	6.2 (5–8)	4.5(1–7)	6 (4–7)	2.5 (2–6)	15
8	Elbow	17	6	2.8 (2–3)	6 (5–8)	7 (4–8)	2 (2–3)	15
9	Elbow	39	6	6.5 (4–10)	7 (6–8)	8 (6–8)	2.5 (2–8)	15
10	Shoulder	45	8	5.6 (2–10)	5 (2–6)	7 (3–8)	6 (3–7)	20
11	Shoulder	89	8	11.1 (7–15)	6 (3–7)	7 (5–8)	6.5 (6–8)	5
12	Wrist	70	10	7 (4–15)	4 (3–6)	7 (5–7)	3.5 (3–7)	10
13	Shoulder	97	8	12.1 (7–30)	6 (5–7)	6.5 (5–7)	7.5 (5–10)	20
14	Ankle	69	8	8.6 (3–20)	5 (4–6)	6 (5–8)	5 (2–10)	30
15	Shoulder	56	8	7 (3–10)	6 (5–7)	7 (5–7)	8 (5–8)	5
16	Ankle	22	8	2.8 (2–4)	6 (5–7)	6 (4–8)	3 (3–5)	15
17	Foot	22	7	3.1 (2–4)	6 (5–7)	6 (5–7)	2 (2–3)	15
18	Shoulder	30	8	3.8 (3–5)	7 (6–7)	7 (6–7)	3 (2–8)	5
19	Ankle	36	8	4.5 (2–8)	6 (4–6)	6.5 (5–7)	3 (2–6)	20
20	Foot	19	7	2.7 (2–3)	6 (4–7)	6 (5–7)	2 (1–3)	5
21	Ankle	23	8	2.9 (2–5)	4.5(4–6)	4.5 (4–7)	3 (2–5)	5
22	Knee	48	10	4.8 (2–7)	6 (5–7)	6 (5–7)	2 (2–3)	30
23	Knee	57	10	5.7 (2–11)	6 (5–7)	6 (5–7)	4 (2–7)	15
24	Knee	24	10	2.4 (2–3)	6.5(6–7)	7 (6–7)	2 (2–4)	5
25	Ankle	22	8	2.8 (2–4)	6 (5–7)	6.5 (5–7)	2 (1–3)	5
26	Foot	14	7	2 (1–5)	7 (6–7)	7 (4–7)	1 (1–3)	5
27	Hip	24	3	8 (7–10)	6 (5–6)	5 (5–6)	3 (1–5)	10
28	Hip	28	3	9.3 (8–10)	5 (5–7)	5 (5–7)	5 (2–5)	5
29	Hip	12	3	4 (4–4)	7 (6–7)	6 (6–7)	3 (3–3)	10
30	Hip	22	3	7.3 (7–8)	6 (6–6)	6 (6–6)	5 (2–5)	5
Total		1450	243	6				500

start with the upper limb and then to examine the lower one. A total of 243 images were taken of the selected anatomical areas. The mean time required to produce each image was 6 minutes (SD 4.2; range 1–30).

Table 1 shows the results of both the self assessment and tutor evaluation of the quality of the pictures taken by the novice. The median values of the tutor scores were ≥6 in 8 of the first 15 sessions and in 13 of the last 15 sessions. As the study continued, the scores given by the tutor and the novice for the quality assessment of the pictures, gradually became more similar. Lack of concordance occurred in all the first 15 sessions and in only 5 of the last 15. Table 1 also reports the novice's perception of the difficulty level of the scanning sessions. Wrist and shoulder were the most demanding areas.

The total time spent by the tutor in discussing the quality of the sonographic images with the novice was 8 hours and 20 minutes. Over the teaching programme the time spent by the tutor for each session has gradually decreased.

At the end of the training, the novice was able to reach a quality score of ≥6 for each standard scan. Table 2 reports the time spent to reach a score of ≥6 for the different anatomical areas. The hand required the longest time (3 hours and 32 minutes) to reach a score of ≥6 in all the standard scans, whereas the foot required the shortest time (28 minutes). Time spent by the novice in obtaining at least one acceptable sonographic image for each standard scan was extremely variable, ranging from 45 minutes for the anterior longitudinal scan in maximal internal rotation for the supraspinatus tendon to two minutes for the longitudinal dorsal scan of the metatarsophalangeal joint of the big toe.

Figure 1 shows some representative sonographic images scored ≥6 by the tutor evaluation.

Table 2 Time spent on active scanning to reach a score of ≥6 for all the standard scans of each anatomical area

Anatomical area	Number of sessions	Total time spent on scanning for each anatomical area	Mean time spent on scanning for each standard scan in minutes (range)
Hand	3	3 h 32 min	15.1 (4–29)
Wrist	4	3 h 26 min	20.6 (7–36)
Elbow	3	1 h 8 min	11.3 (5–20)
Shoulder	3	2 h 22 min	17.8 (7–45)
Foot	2	28 min	4 (2–7)
Ankle	3	1 h 35 min	11.9 (5–30)
Knee	2	58 min	5.8 (4–8)
Hip	3	36 min	12 (7–22)

DISCUSSION

Musculoskeletal US is considered to be one of the most operator dependent imaging modalities in rheumatology, and adequate training is, therefore, of fundamental importance.[3 5] At present, there is still no standardised model for training in musculoskeletal US. It has been reported that proper training must provide the guidance of an experienced investigator,[5] but no operative programmes have been proposed so far.

According to the scarce published data the minimal time required to train a rheumatologist to become an expert sonographer is six months, if sonography is performed frequently,[7] or 300 supervised scanning hours in an accredited training department.[3]

Our experience has indicated that a novice can obtain acceptable sonographic images in 24 non-consecutive hours of

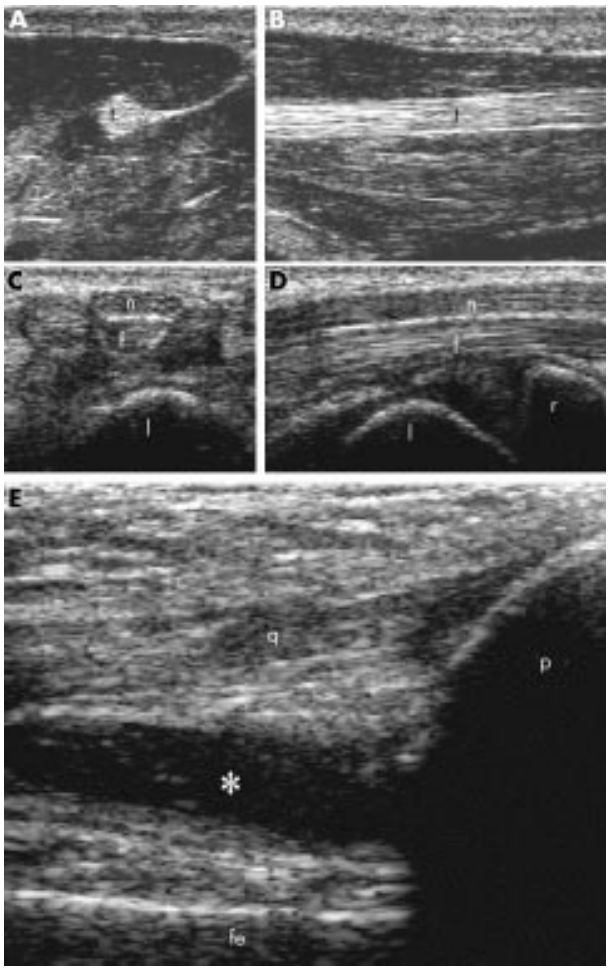

Figure 1 (A, B) Healthy subject. Thenar eminence. Deep flexor tendon of the first finger (t). Transverse (A) and longitudinal (B) volar scans. (C, D) Healthy subject. Carpal tunnel. Median nerve (n) and finger flexor tendons (f). Transverse (C) and longitudinal (D) volar scans. l = lunate bone; r = radius. (E) Rheumatoid arthritis. Knee joint. Longitudinal suprapatellar scan. Suprapatellar pouch enlargement due to knee synovitis. * = synovial fluid; q = quadriceps tendon; p = patella; fe = femur.

active scanning after an intensive self teaching programme. Hand, wrist, and shoulder were the anatomical areas with the longest learning curve.

At the end of the educational programme the novice could obtain acceptable images. We believe that basic skills in exploring the main acoustic windows is the first step in the complex and endless training in musculoskeletal US. Adequate experience in interpretation of the wide spectrum of sonographic findings requires further training and closer supervision by an expert tutor.

Although further studies are needed to define the most adequate training in musculoskeletal US, and the self teaching programme should be tested against other learning methods, our experience indicates that this kind of approach may reduce the time needed to gain familiarity with the sonographic landmarks of standard scans, allowing a quick and direct comparison between the "gold standard" images and those taken by the novice.

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