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PERSPECTIVE

Incorporating musculoskeletal ultrasound into your radiology practice: patients, patience, and why your department cannot do without it

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Getting started: integrating departments and advancing synergies

Ideally, a radiology practice can offer diagnostic and interventional offerings across all modalities. Musculoskeletal US in recent years has become more available and more demanded both in academic and private radiology practices. Other medical subspecialties are also training to learn ultrasound and is a potential loss for radiology [1, 2]. In fact, the largest increases are being seen in community settings such as orthopedic institutes [1]. Musculoskeletal US is being incorporated into more clinical practices and is now included on radiology board examinations [3]. For these reasons, there is growing interest from residents and fellows in musculoskeletal US education and including it into a teaching program is no longer optional. US, intrinsically, has several advantages, which include interaction with the patient, ability to directly interact with the patient and target areas of pain, not to mention the lack of ionizing radiation and its ready availability in radiology departments.

It was critical to appoint a lead radiologist(s) to pioneer and take responsibility for this new offering. At the time we began our musculoskeletal US service in our department, there was input from both a junior attending in the musculoskeletal service and from a second junior attending primarily on the US service. This allowed us the unique ability to approach creating a curriculum from both sides, emphasizing equally musculoskeletal anatomy, pathology, and terminology, but also scanning technique, workflow optimization, and most importantly, a preexisting relation with the sonographers. The musculoskeletal section had no prior relationship with the sonographers and little interaction with the US service. The strengths of the two radiologists were complimentary in launching this program. Both attended a week-long dedicated musculoskeletal US course and spent lunch hours practicing scanning normal anatomy with sonographers, residents, and fellows. Also, targeted US scanning was offered to patients after joint MRIs in order to advance sonographers and fellow educations and MRI-US correlation. Steps to considering taking in order to start a musculoskeletal ultrasound program in a radiology department are listed in Table 1.

Synergies between the musculoskeletal and US sections included combined weekly scanning sessions for sonographers and trainees, combined didactic lectures over the noon hour, and enhanced cross disciplinary communication. This helped introduce the ever-important sonographers to the musculoskeletal faculty and orthopedic terminologies and pathologies to the US faculty. Preparatory staff recruitment, training, and developing a preliminary referral base took approximately 6 months. Several attending faculty interested in musculoskeletal US were chosen to staff this new clinical offering and initially 2 h, 1 day per week were dedicated to schedule diagnostic and interventional procedures. Over 2–3 years, this clinic grew from 2 h to a half day to two full days. Currently, 5 years later, it is offered four full days a week. Volume has tripled over this time period from 579 overall exams in the first year to 1728 in the most recent year. The most growth has been in ultrasound-guided procedures, which started at approximately 3/month and now averaging 35/month. Diagnostic evaluations have increased from 4/month to 25/month. Evolving issues then arise with an established program such as staff and resource availability to support a growing referral base.

We currently offer diagnostic ultrasound for any appropriate indication (even if we have not seen it before) and a variety of ultrasound-guided procedures including joint, bursal, tendon, and perineural injections, tendon fenestration, aspiration, barbotage. The current structure of the program involves the participation of all musculoskeletal radiology faculty who

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Table 1 The above steps are what the authors suggest in order to start a musculoskeletal ultrasound program from scratch

Proposed steps for initiating a musculoskeletal ultrasound program
1) Identify interested radiologist(s) who are willing to scan
2) Recruit 2–3 sonographers interested in learning musculoskeletal ultrasound
3) Consider having the above persons attend a dedicated musculoskeletal ultrasound course
4) Implement a weekly training curriculum aimed at teaching both radiologists and sonographers including hands-on scanning
5) Practice scanning normal anatomy
6) Start target scanning "area of pain" on DVT studies
7) Create a musculoskeletal ultrasound order and notify providers of its availability
8) Discuss with referring providers the unique capabilities of ultrasound and recommend after radiographs or MRI as appropriate
9) Offer ultrasound-guided interventions as an alternative to fluoroscopy
10) Save ultrasound cases for follow-up, correlation with other imaging, and for a quality assurance program

have subsequently been trained to staff both outpatient diagnostic and procedural ultrasound exams, as well as two dedicated ultrasound radiologists. In our experience, the collaboration of these groups has aided in closing the knowledge gap between overlapping entities (i.e., hernia and deep venous thrombosis (DVT)) and catches the unexpected musculoskeletal pathology that arises on after hours and inpatient examinations. This also allows flexibility in patient scheduling and appointment availability.

Education and departmental support

As detailed above, the core skills required to start a musculoskeletal US program likely already exist in your practice, but have to be identified and possibly combined. A key component for success is interest and meeting early and often with your team. This holds true for radiologists, sonographers, and ancillary staff.

One of the biggest challenges in starting our program was identifying and training sonographers, many of whom had no formal training in musculoskeletal US. Hiring a sonographer with previous experience is a luxury if found, however, this may be not readily available and due to initial low volume, sonographers will also likely have to perform other general US exams. Many of our sonographers were not interested in taking on a new task, were overwhelmed by the anatomy, and were generally intimidated. We were able to identify a few sonographers who were intrinsically interested and one was named chief musculoskeletal sonographer. The key, we found, is that these individuals were self-selected. Many would read about musculoskeletal US during their free time and practice scanning during a portion of their lunch hour. Musculoskeletal disease is common and it is not difficult to find amongst staff, friends, family with pathology that can be imaged for practice.

Support of the radiologists and the department is also critical. The department demonstrated support by blocking off protected time for education; approximately 30 min extra after lunch for scanning practice and a didactic series given by the radiologists. They also found financial support to send the sonographers (1–2 per year) to a musculoskeletal US training course. In our experience, the sonographers deeply value the support of their radiologists, particularly when the radiologist is willing to go in to see and scan a patient with an indeterminate finding. They do not want to feel solely responsible for making a diagnosis and working together builds their confidence and comradery.

Didactic lectures, given by the radiologists to the sonographers and the other trainees rotating on the service, are educational for the radiologists preparing the material as well as for the participants. A particularly successful approach for us is a short, simplistic 30-min didactic lecture, followed by 30 min of hands-on scanning of the relevant anatomy pertinent to that topic and has been corroborated [2]. Complex acronyms and detail initially can exceed the background necessary for sonographer comprehension. Additionally, we have found showing cases with correlation between radiographs, MRI, and/or CT are tremendously helpful for sonographers who in particular are often not trained in these modalities. At the beginning of a program, repetition and frequency are critical. These lectures and scan practice sessions initially occurred weekly lasting for approximately 1 year. This was tapered to twice per month and still occurs once per month and is ongoing. Lastly, a quality-improvement program including surgical and other imaging follow-up from cases, good calls and misses is led by one of the participating radiologists and attended by all staff on a quarterly basis. We have found to be of great educational value and it may also fulfill a departmental requirement.

Referrals: if you keep them happy, they will keep coming

MRI reports are a readily available and somewhat obvious approach to advocating for the utility of musculoskeletal US. For example, a radiologist interpreting a knee MRI may suggest US-guided aspiration of large popliteal cyst for therapeutic purposes or, similarly, US-guided barbotage can be performed for calcific tendinitis. Other advantages of US are its

dynamic capability, such as evaluating a muscle herniation or positional pathology that can be missed with cross-sectional imaging. Lastly, US-guided procedures at our institution are more feasible compared to CT-guided procedures and often patients can come in for an US-guided procedure the same day as they were seen in clinic. As a result of our radiology reports, direct conversations, and the convenience of our offerings including patient feedback, referring clinicians quickly become aware of its potential. Also, let your emergency department, urgent care center, primary care, podiatry, sports medicine, and rheumatology colleagues all know you provide this service. Meet your referring physicians face to face and continually update them on your availability and offerings. Also, making the diagnostic or therapeutic difference in a few cases will often result in long-term loyalty from a specific provider both anecdotally and in repeat referrals. For example, we were able to diagnose a hardware abnormality missed on radiographs in a patient with intractable symptoms for 6 months status post ORIF of distal radius fracture by identifying a proud screw resulting in severe tendinosis and tearing, which was immediately surgically addressed with complete resolution of the patient's symptoms. Willingness to try and accommodate a clinician, particularly with a diagnosis with which they are "stuck" is also usually greatly appreciated. Examples are agreeing to assess for slipping rib or snapping hip syndromes.

Market your service by any means necessary. Word of mouth from patients and other physicians is the oldest and in our opinion the best form of advertising to organically grow your practice. We thank each patient after a procedure and tell them to thank their doctor for the referral and to give them feedback. Formal feedback surveys for patients and/or providers could also be offered. We also encourage patients to contact us via e-mail with feedback on their progress. In particular, we have done this with patients treated with steroid injections or tendon fenestration, which can take weeks to months for the full benefit to occur and we learn from their experiences. We also list our available services and service times on our departmental Web site. Lastly, we lecture to sonographers and clinicians in the community to further awareness.

Even point-of-care use by other departments can be synergized with radiology. For example, our rheumatology department is starting point-of-care US and has asked us to proctor them for credentialing. Their scanning skills, equipment, and time are likely more limited (i.e., the highest frequency transducer they have is 9 mHz, and is poor for assessment of small joints). A positive relationship with them and providing "back-up" support can actually result in more patient referrals for musculoskeletal US. Musculoskeletal US within a department or institution is not a zero-sum game and should not be treated as one.

Experience and incidentals

The more experienced the sonographers and radiologists have become at our institution, the more we are recognizing musculoskeletal pathology on our US exams, even when this was not the primary indication. Also, there is overlap in exam coding and scheduling. An abdomen limited assessing the groin can demonstrate a hernia or a hip effusion, and assessment of a palpable mass can be anything from a lymph node, to lipoma, to an intramuscular mass.

The area where we have seen the most incidental musculoskeletal pathology is on our venous Doppler exams to assess for deep venous thrombosis, which clinicians have a low threshold for ordering for a wide spectrum of symptoms. These exams are interpreted by the radiologists in the general US section (most abdominal imaging trained) and are performed in all patient settings at all hours of the day. Our protocol includes, in addition to assessment of the vessels, targeted imaging in any area of patient symptoms. The pathology discovered by performing these extra images has been vast, including Achilles tendinosis, gastrocnemius tear, ruptured baker's cyst, abscess, joint effusion, and many more. Twice in the recent past we have diagnosed unsuspected gout with US. One was an upper extremity DVT study, which showed an elbow effusion and a "double line sign" of the hyaline cartilage; a pathognomonic US finding in gout. The fluid was aspirated and positive for negative birefringent crystals; previously unsuspected and this patient's first presentation of gout. The second was in a patient with lower extremity edema and suspected cellulitis. On his DVT study, the area of redness was over the knee and on targeted imaging there was focal mass-like echogenicity in the patellar tendon; a finding not congruent with cellulitis and in this patient with a history of gout, this changed the diagnosis and management, which would have included antibiotic use and potentially further exacerbated the gout flare. We now require all of our sonographers to have some awareness of musculoskeletal pathology. They should be able to differentiate subcutaneous tissue from muscle, recognize a tendon, and identify fluid in the tendon sheath or joint spaces.

Known advantages of US over other imaging modalities, which bear repeating, are its high spatial resolution, which allows for very detailed evaluation of targeted areas, limitless imaging planes, and dynamic capabilities. Assessment of a tiny part, such as pulleys in the finger and of soft tissue foreign bodies, is superior with US. Recently, a young female patient with supraclavicular pain had had a normal MRI of the cervical spine and of the upper extremity was sent to US for an intrascalene muscle block as the suspected abnormality. On the pre-procedural exams, a mass was immediately recognized, most suggestive of a brachial plexus nerve sheath tumor. This has been missed on both MRIs, as it was on the periphery of field of view of both exams, a limitation that US

does not share. The injection was deferred and the patient was appropriately triaged. A second example is a patient with a thigh mass, which was recommended for biopsy, however, a pre-procedure US confirmed this to be a pseudotumor unequivocally, again allowing for appropriate triage and deferral of the biopsy.

Conclusions

Musculoskeletal US is increasingly requested by both patients and referring practices alike. If you are considering starting a musculoskeletal US offering of your own, remember it is a multidisciplinary effort including referrers, patients, sonographers, and radiologists potentially from other departments as well. You do not have to have prior expertise, but be persistent and persevere in working together with all of these members of the larger team to integrate their strengths into your practice. A hard line will never exist between vascular, abdominal, and musculoskeletal pathology, and we encourage interdepartmental cross-training and communication. The result is a new clinical program, which makes you invaluable to your practice and to your referring physicians and patients alike.

Compliance with ethical standards

Conflict of interest Author 1 receives royalties from Elsevier.

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