Archives of Rehabilitation Research and Clinical Translation (2021) 3, 100098

ACRM
AMERICAN CONGRESS OF REHABILITATION MEDICINE

Archives of Rehabilitation Research and Clinical Translation

Archives of Rehabilitation Research and Clinical Translation 2021;3:100098

Available online at www.sciencedirect.com

Special Commnication

Education in the Time of COVID: At-a-Distance Training in Neuromusculoskeletal Ultrasonography

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KEYWORDS
Diagnostic imaging;
Internship and residency;
Physical and rehabilitation medicine;
Rehabilitation

Abstract
Point of care ultrasound is important to the specialty of physical medicine and rehabilitation (PM&R) to aid in the diagnosis and treatment of a variety of neuromusculoskeletal conditions commonly seen in practice. However, across Canada, resident education of sonoanatomy skills is variable. There remain no standards in terms of how ultrasound is taught as part of the residency curriculum as set by the Royal College of Physicians and Surgeons of Canada. As such, residents are often required to find their own educational opportunities. This report describes an alternative approach to learning these skills that was inspired by disruption due to coronavirus disease 2019 in first year residency. This report explores how a PM&R resident was able to develop valuable ultrasound skills from home using not only textbooks and videos, but also new and novel teleguidance technology, namely an ultrasound probe that connects to a clinician's own smart devices to display images.

Point of care ultrasound is important to the specialty of physical medicine and rehabilitation (PM&R) to aid in the diagnosis and treatment of a variety of neuromusculoskeletal conditions commonly seen in practice.[1] Although it has not yet been specifically listed as a core competency by the Royal College of Physicians and Surgeons of Canada,[2] it is recognized as a fundamental component of PM&R practice by the American Academy of Physical Medicine and Rehabilitation and the

List of abbreviations: COVID-19, coronavirus disease 2019; PM&R, physical medicine and rehabilitation.
Disclosures: none.
Cite this article as: Arch Rehabil Res Clin Transl. 2021;3:100098.

https://doi.org/10.1016/j.arrct.2020.100098

Accreditation Council for Graduate Medical Education in the United States.[1] The use of ultrasound ranges from diagnosis of an array of neuromusculoskeletal conditions to assisting in management with procedures.[3] Ultrasound can also assist in the education of PM&R trainees by using it to learn anatomy, improve palpation skills,[4-6] guide electromyography needle placement,[7] and more.

Physiatrists have often relied on expensive, inconvenient imaging techniques such as magnetic resonance imaging to diagnose and confirm a neuromusculoskeletal condition.[8] The use of ultrasound offers a promising alternative that reduces cost, saves time, and avoids unnecessary radiation exposure.[9-12] Furthermore, it offers the ability to compare abnormal pathology to normal pathology on the patient's contralateral side.[13]

Despite it becoming increasingly important for physiatrists to use ultrasound in practice, there are barriers to achieving this, including access to devices and education.[14-16] It is suggested that mastery of point of care ultrasound depends on proficiency in image acquisition, interpretation, and integration of these into medical decision making.[13] However, how to develop this proficiency among PM&R residents remains unclear, as this has traditionally been left to radiologists.[11] A brief review of the literature reveals several different education methods that have been explored in PM&R residency programs, including peer-teaching,[13,17] self-guided learning,[18] team-based learning,[19] a 1-day course,[14] didactic lectures,[13] interdisciplinary collaboration (eg, with rheumatology),[15] web-based programs,[11,13] use of cadavers and simulation centers,[11,13] clinical rotations,[11,13] objective examination,[11,13] and more.

As mentioned, ultrasound education has been recognized as important to PM&R practice but has not yet been incorporated formally into Canadian PM&R residency programs. As there are no curriculum standards for ultrasound education in Canada, PM&R residents are often required to find their own opportunities. This report describes an alternative approach to learning these skills that was inspired by disruption in first year residency due to coronavirus disease 2019 (COVID-19). The cancellation of all nonurgent medical care across Canada during the pandemic resulted in several residency rotations being cancelled. Residents from a variety of specialties sought alternative rotations. This report explores how a PM&R resident was able to develop valuable ultrasound skills from home using new and novel teleguidance technology with the Butterfly iQ,[a] an ultrasound probe that connects to a clinician's own smart devices to display images.

Distance learning of ultrasonography is new, with limited presence in the literature. One technique described involves a USB video capture device to connect ultrasound images to a computer, a webcam to capture scanning, and videoconference technology to display the images side by side.[20] Sports medicine educators have also suggested that the ability to connect a transducer to a computer and stream live on a virtual meeting platform (Skype, Zoom, FaceTime, Microsoft Teams, etc) is all that is required.[21] They acknowledge that connecting an ultrasound image to a computer can be costly, and a more affordable strategy would be to use 2 personal electronic devices to obtain separate images and stream both simultaneously.[21] This report describes an easier setup using the Butterfly iQ, which displays ultrasound images on a smart device (eg, iPad) through an app, captures scanning directly to the app via the smart device's camera, and subsequently enables videoconferencing through the app.

Methods

PM&R residency programs involve rotations of 4-week blocks on different services. The blocks are structured around achieving core competencies set by the Royal College of Physicians and Surgeons of Canada, and meeting CanMEDS roles. There exists flexibility with "electives" by which residents can choose rotations to supplement their core knowledge in specific areas. To create a block like the one described in this report, it is the role of the program director to ensure that learning objectives are valid and address a specific area of PM&R practice, and that the supervising attending is qualified to evaluate the trainee based on these objectives. For this 4-week block, learning objectives were tailored toward the CanMEDS Framework[22] with the principle objectives as follows: To understand neuromusculoskeletal anatomy of upper and lower extremities, including muscles and tendons, ligaments, bones, joints and nerve supply, and to identify relevant sonoanatomy features of these structures using the Butterfly iQ. A schedule was then created. In week 1, the resident reviewed anatomy using textbooks and online resources, and weeks 2 to 4 involved working through sonoanatomy.

The Butterfly iQ involves a single probe that emulates any type of transducer. It connects to a clinician's own smart device, enhancing portability. It offers 19 clinical presets and color Doppler imaging, and is set up to offer easy access to whole body scanning. All data acquired is secured through encryption. Furthermore, a clinician can scan for more than 2 hours before the built-in battery needs to be charged via wireless charging. Regarding education, the Butterfly Network offers several education videos related to ultrasound basics, image acquisition and interpretation, and specific common diagnoses.[a]

Butterfly teleguidance is a collaboration tool that allows for live connection to any other Butterfly user directly from the app. The scanner's image and camera are live streamed to a Butterfly user who is able to adjust the preset, mode, gain, and depth, and capture images. The user can give verbal and graphical instructions to guide the scanner to achieve the correct view.[a]

As this rotation was constructed to avoid unnecessary contact between individuals in the context of COVID-19, and given that the Butterfly iQ enables distance education, the attending supervisor, an expert in neuromusculoskeletal ultrasound, was located at a distance. Working through sonoanatomy involved several steps, with the first being a textbook review of basic ultrasound principles. After this, for each anatomic area of interest, the resident would first review an ultrasound approach using videos, textbook, and online resources. After reviewing this information, the resident would proceed to practice scanning on individuals within the same household, as COVID-19 restrictions at the

time prohibited contact between anyone else. While scanning, "Musculoskeletal," "MSK-soft tissue," and "Nerve" presets were used, and images and videos were captured and saved for later discussion with the attending supervisor.

Finally, teleguidance was used for each anatomic region. Here, the attending staff observed the resident live scan another individual, offering real-time feedback and corrections, as well as clinical suggestions and guidance. The attending staff also shared previously captured images and videos that demonstrated various pathologies. In a 40-hour work week, approximately 30 hours were spent in self-study (half using textbook/online resources, half practicing scanning), and 10 hours were spent on teleguidance training and instruction. In the span of 4 weeks, all joints were covered in the upper and lower extremity, as well as important structures in between. No objective outcome measures were tracked but rather the resident was evaluated on the achievement of learning objectives, as this is how most rotations work.

Discussion

This elective rotation enabled a PM&R resident to establish an understanding of neuromusculoskeletal anatomy and, more importantly, to develop a foundation of neuromusculoskeletal ultrasound skills that will be useful, and clinically applicable, throughout residency and future practice. In the short-term, the resident gained confidence to use ultrasound on off-service rotations (eg, scanning tendons in the hand on plastic surgery and scanning joints on rheumatology). Off-service rotations are the bulk of first- and second-year Canadian PM&R residency programs. In the long-term, these skills will be further developed and used to enhance diagnosis and management of neuromusculoskeletal conditions in a PM&R practice.

As previously discussed, major barriers to using ultrasound in a PM&R practice include access to devices and lack of education. This rotation addressed both of these barriers. The Butterfly iQ is relatively affordable when compared with other imaging modalities and is extremely portable, making learning more accessible and possible in any environment. Although it may not be possible for every resident to acquire a Butterfly iQ as the cost is still significant at an individual level, it may be an option for residency programs looking to acquire an ultrasound device for residents to share. Furthermore, the Butterfly iQ encourages distance learning, which is valuable for residency programs in which access to experts in ultrasound is limited. For clinicians already in practice who hope to enhance their ultrasound skills, this rotation highlighted the ability to connect readily with a colleague located anywhere.

Study limitations

Despite many benefits, there were also challenges encountered during this rotation. Guiding a learner through scanning via verbal and visual cues is not as easy as hands-on teaching or physically assisting the learner to reposition the probe. It was also noted that occasionally when the attending supervisor would mark up an image to highlight an important feature, the mark-up would not be accurately placed on the receiving end over teleguidance and was often 0.5 to 1 cm off. This was brought to the attention of the Butterfly Network and the issue was ultimately resolved. Furthermore, home setups are variable, and the proper positioning essential to use teleguidance is occasionally difficult to achieve. Ensuring that the smart device camera was always in view of the probe proved to be difficult.

Timing was a minor issue. The time difference was always in consideration and required both the learner and attending supervisor to be flexible. Normally, time away from the clinic would have posed as a bigger challenge for the attending. However, due to COVID-19, the attending also had fewer clinic appointments. Another challenge is that teleguidance is currently only possible between Butterfly users, which limits the ability to connect with clinicians who use more traditional ultrasound technology.

Conclusions

Overall, this report highlights a way to develop valuable ultrasound skills from home with guidance from a supervising attending located at a distance. This experience demonstrates the potential to enhance ultrasound education among other PM&R residents. Moving forward, objective evaluation of residents' ultrasound skills would be beneficial to support future rotations of this nature. Furthermore, with more use in residency programs, a comparison could be made between different ultrasound curriculums to help establish ultrasound education standards for the Royal College of Physicians and Surgeons of Canada.

Supplier

a. Butterfly iQ; Butterfly Network, Inc.

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