



Incorporating Real Time Ultrasound Imaging Education Within a Doctor of Physical Therapy Program: A Needs Assessment

Alycia Markowski^{1*}, Maureen K. Watkins², Peter Dzaugis³, Victoria Etzel³, Alyssa Lindau³

¹Department of of Physical Therapy, Movement and Rehabilitation Sciences, Northeastern University, Boston, USA

²Department of of Physical Therapy, Northeastern University, Boston, USA

³Doctor of Physical Therapy Candidate, Northeastern University, Boston, USA

***Corresponding author:** Alycia Markowski, Department of of Physical Therapy, Movement and Rehabilitation Sciences, Northeastern University, Boston, USA. Tel: +15087894736; Email: a.markowski@neu.edu

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Abstract

Objective: To assess the need for implementation of ultrasound imaging (USI) education into physical therapy (PT) curricula through: a review of educational standards, literature search and students' perspective survey.

Background: As USI technology becomes more accessible and applicable, it is important to consider the educational opportunities for students and PT programs.

Methods: A needs assessment including; A literature search on USI as a teaching tool in PT education. A review of current PT educational standards to determine guidelines on the instruction of USI. A survey to assess PT students' perspective, interest and knowledge of USI.

Results: The literature search resulted in limited publications but provide initial evidence that USI is an effective teaching tool. Educational guidelines require up-to-date education on imaging technology, requirements specific to USI in PT curricula is limited. Students' surveyed identified interest in using USI to learn anatomy and applications in the clinic.

Conclusions: Physical Therapy programs must have education consistent with current technology. This needs assessment suggests USI should be introduced early and longitudinally in the curriculum as an adjunct learning tool for students to gain fundamental knowledge of equipment, anatomy and clinical applications.

Background

There is growing evidence that Ultrasound Imaging (USI), also known as sonography, or Real Time Ultrasound Imaging (RUSI) should be considered as an adjunct tool for treatment and assessment technique for patients with neuromusculoskeletal disorders and motor control deficits [1]. RUSI is used by physical therapists to simultaneous view dynamic motion and *in vivo* images of morphology, pathology or joint changes. Muscle length, thickness, width, cross-sectional area and pennation angles can be observed and measured [2-4]. RUSI can also be utilized to provide biofeedback. Visualizing the muscle improves patients' ability to recruit and isolate specific muscles [5]. RUSI technology offers many applications in PT clinical practice, including treatment,

evaluation technique, and outcome measures [1]. As RUSI becomes a contemporary tool for PTs in the clinic it is important to consider the educational needs to students and educational programs.

The cost of RUSI equipment has decreased in recent years, while the quality of images continues to improve. In addition, ultrasound imaging is a safe non-invasive imaging modality that does not have any known side effects. The recent advancements-increased availability, decreased expense and safety of this imaging modality-have made it more practical to develop RUSI pedagogy in PT curricula.

Formal instruction and training for RUSI can be time intensive and potentially resource intensive [6]. Programs can understandably be reluctant to add to an already full curriculum.

There is currently limited evidence for the benefits of RUSI education in a PT curriculum. However, evidence found pertaining to RUSI as a teaching tool in anatomy education for medical students revealed many beneficial results for these students [6-7]. Medical students who were taught anatomy using RUSI demonstrated increased knowledge of anatomy when compared to other methods of teaching medical student's anatomy [8-9]. Other methods included cadavers, arthroscopic surgery and two-dimensional images. RUSI provides students with concurrent knowledge of results and knowledge of performance, enhancing student confidence. Medical and non-medical students who studied anatomy with an ultrasound curricular component demonstrated increased knowledge, reported increased self-perceived confidence and valued the contribution of USI to learning anatomy [10-11]. Medical students further reported that the addition of USI training while learning gross anatomy positively impacted their clinical decision making during their first medical rotations. The impact on student learning, confidence and student perspective is important to understand in developing future learning tools to be sure to meet the need of the consumer.

As technology is incorporated into teaching and learning, it is necessary to develop strategies that meet the current requisites. This needs assessment was performed to assess the benefit of including RUSI teaching pedagogy into PT curricula through three components: a review and evaluation of current educational standards and professional guidelines in the United States, a literature search on the use of RUSI as a teaching tool in PT and a survey of students' perspectives. This study aimed to support the need for implementation of RUSI education into PT curricula through the triangulation of results.

Methods

A needs assessments was completed that included; A review of PT educational standards and professional guidelines in the United States, literature search to identify RUSI use in PT education and a survey was developed to assess current PT students' perspectives on RUSI. Themes were identified related to USI and education and the survey was analyzed using descriptive statistics.

Review of PT Program Educational Standards

A review of PT educational standards and professional guidelines in the United States was performed to determine current recommendations on the instruction of imaging techniques in accredited PT programs. The Doctorate of Physical Therapy curriculum is guided by the Normative Model of Physical Therapy Professional Education and the Commission on Accreditation in Physical Therapy Education (CAPTE), as well as the governing body, the American Physical Therapy Association (APTA) guidelines. These sources were reviewed for terminology

regarding "Real time ultrasound imaging," "ultrasonography," and current imaging techniques used by practicing PTs, as well as standards outlined by state practice acts. Related terms and their corresponding sections and implications were recorded and evaluated to determine themes relevant to RUSI.

RUSI Literature Search

A literature search was conducted to identify RUSI use in PT education. The search was performed using Scholar One Search, which searches multiple article databases, with the search terms "physical therapy" and "education" and "RUSI" and "real time ultrasound" and "classroom." Articles pertaining exclusively to the use of ultrasound for its doppler feature were excluded due to lack of specificity of application. Articles referring to RUSI for diagnostics or use in health care professions outside of physical therapy were excluded due to the lack of focus on principles that are included in PT practice.

Development of Survey

A survey was developed to assess current PT students' perspectives on RUSI. The goals of the survey were:

1. To identify PT students' current general knowledge of RUSI and its uses in clinical practice.
2. To understand how to best incorporate RUSI into the PT curriculum by gathering data on students' interest level.

The initial survey was developed based on four categories in order to gain an understanding of DPT students' demographics, level of interest, comfort and experience with USI. The survey categories were selected based on a study performed by Potter et al [12]. In this study, practicing physical therapists responded to a survey regarding demographics (areas of practice), competencies (ability to accurately interpret US images), and US perceptions (how RUSI is best used in clinical practice) [12]. Questions were modified to address students' knowledge and experience in the professional phase of the curriculum opposed to practicing clinicians. The survey consisted of 22 questions divided into the four categories. Demographics were broken down into: age, gender and graduation year. Experience and comfort with RUSI questions focused on knowledge of safety, cross sectional anatomy and morphology. Interest questions included applications and perceived value of RUSI in clinical practice. These questions were delivered using a Likert scale.

The survey was developed using Type Form, a website for creating and distributing surveys securely and anonymously. Type Form provided some analysis of the survey results, but most of the analysis was performed after the results were transferred to an Excel spreadsheet. SPSS was utilized for statistical analysis of the survey data.

Results

Review of Curricular Guidelines

With the APTA Vision 2020, all physical therapy programs in the United States have strengthened their curriculum depth and breadth to offer the DPT as the entry-level degree. Diagnostic imaging content was one of the content areas that many programs expanded in order to keep students up to date on current technology. A review of current license requirements and US education standards was performed.

The PT licensure abides by individual state practice acts. Currently these documents do not specifically identify or refute the use of RUSI in PT practice. In relation to the use of imaging, only the use of “roentgen rays” and the use of “radiology for any purpose” are explicitly excluded in a couple states [13].

CAPTE, the accrediting body for PT programs in the US, and The Normative Model of Physical Therapist Professional Education identified the requirement for PT curricula. These documents state that up to date information on imaging technology is required for physical therapy programs, but do not specifically mention RTUI [14-15]. While the curricular guidelines that govern PT educational programs do not specifically call for teaching RUSI, the professional associations do. The American Academy of Orthopedic Manual Physical Therapists (AAOMPT), a specialty group recognized by the national governing body of physical therapists, the APTA, issued a support statement in 2009. “It is the position of the AAOMPT that ultrasound imaging is within the scope of physical therapist practice.” The statement further supported the development of an imaging curriculum [16].

The Imaging Special Interest Group of the Orthopedic Section of the APTA published the 2015 Imaging Education Manual for Doctor of Physical Therapy Professional Degree Programs (IEM) [17]. The IEM supports PT use of USI, stating that PT is “well-suited to guide the utilization of imaging and the assimilation of imaging results into [clinical] decision making” [17]. Therefore, the IEM supports the inclusion of “comprehensive imaging content to optimally prepare future practitioners.” This manual emphasizes the need for additional training for physical therapists to learn appropriate machine settings, differentiate structures and comprehend images obtained with RUSI for use in musculoskeletal imaging. The IEM calls for the integration of education in imaging techniques to prepare PTs for a variety of patient presentations. Specific recommended instructional content for USI includes muscle integrity, contraction ability, volume and degenerative changes and soft tissue and joint swelling evaluation. These methods are not for the purpose of diagnosing, but are intended to “identify abnormal tissue,” which will assist PTs to make well-informed clinical decisions and provide the best treatment for patients. The IEM differentiates between USI for the examination

of specific pathology, which is outside of the PT scope of practice, and viewing tissue as “normal” versus “abnormal,” which is not diagnostic and therefore within the PT scope. PTs need to have a comprehensive understanding of imaging techniques, including reading imaging studies and recognizing normal anatomy in order to know “when to refer a patient” [17].

The review of current license requirements and US education standards implicitly supports the inclusion of RUSI in PT education. The EIM is the only document identified that specifically calls for the training of students in RUSI to interpret and apply information to assist in clinical decision making and patient care.

Review of Articles About RUSI Education

Overall six articles were identified, three articles regarding physical therapists’ perspectives on RUSI in the clinical setting and three articles pertaining to RUSI education in physical therapy.

Three articles suggested the perceived benefit of incorporating RUSI in the PT profession. Potter in 2012 evaluated the use of RTUI and the potential interest among practicing physical therapists in the United Kingdom. Forty-six PTs responded on their training and knowledge regarding ultrasound imaging as well as the competency among a variety of skill sets relating to ultrasound imaging. Over half of the respondents indicated that they felt “not at all competent” in “interpreting muscle morphology” and “gaining information about types of muscle activity.” A lack of RUSI competency but a willingness to learn and need for specific education on RUSI pertaining to PT practice in the UK was identified.¹² An article by Teyhen in 2011 suggests that RTUI is an effective method to “improve the understanding of the relationship between motor control and function” in clinical practice, particularly in the context of neuro-musculoskeletal disorders [1]. Physical therapists are experts in motor control, function and movement, and RUSI allows a clinician to understand and accurately monitor the efficacy of an intervention via augmented feedback [1]. MJ Callahan also supports for the utility of RUSI in clinical practice. RUSI can be used to identify thickness of the Achilles tendon in cases of Achilles tendinopathies, which Callahan notes is important in clinical practice “because the three stages of Achilles tendinopathy have differing physiotherapy rehabilitation protocols.” [18] Overall, ultrasound imaging has become an increasingly useful technology, in part due to the increasing costs of other forms of imaging but also due to the safety, convenience and comparatively low cost [18].

Three articles begin to investigate the use of RUSI as an educational tool to enhance students’ learning. Maher and Hale demonstrated that RUSI is of interest to physical therapy students [19]. After a course on ultrasonography, 100 percent of the students in this study responded they were stimulated by the lesson. Morales et al investigated student self-directed e-learning

versus conventional learning as it relates to ultrasound imaging in a classroom of physical therapist students [20]. The practical use of RUSI in their setting was related to the palpation of knee and internal structures. The teaching style incorporated theoretical knowledge of ultrasound in a four-hour in-class session followed by a practical hands-on experience with the equipment and positioning of patients. The results of the study showed e-learning with ultrasound imaging as “an effective educational strategy for physiotherapy students to acquire skills in palpation and USI of the knee as a supplement to on-campus education” [20]. Canatero-Villanueva et al. discussed that e-learning incorporating RUSI instructional methods may be an effective “adjunct educational strategy to acquire musculoskeletal manual skills and ultrasound imaging of the lumbopelvic area” [21].

Survey Data

The survey was sent electronically to 110 DPT Professional Year Two (PGY 2) students and 110 DPT Professional Year Three (PGY 3) students via email and to their class Facebook page. The survey was open for two weeks and the response rate for PGY 2 was 56% and the response rate for PGY 3 was 37% for a total response rate of about 46%. Overall 20% of survey respondents were male and 80% were female. The average age was 23 years old.

To evaluate perceived value of RUSI use in clinical practice students were asked four questions. (Figure 1) displays the combined class response. Fifty-nine percent of the students that responded had previous experience/exposure with

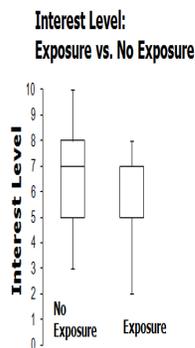


Figure 1: Students response to; If given the opportunity, what is your interest level in learning to use real time ultrasound imaging? The box and whisker plots show the interquartile ranges - the top of the box is

the 3rd quartile and bottom is 1st quartile mark. The line inside is the 2nd quartile (median) range. In the case of the “exposure” interest level, the median and the 1st quartile range are equal. Example with a number set – 1,2,4,4,4,4,4,5,6,7 4 is the median and 4 is the 1st quartile range.

RUSI (n= 61/103), while 41% had no experience/exposure throughout their DPT experience (n=42/103). (Figure 2) breaks down the exposure/experience type giving information as to the specific way students may have already learned about this technology. These categories included the classroom/lab, literature, Cooperative Education (co-op), clinical education, work/volunteer, and personal. Fifty-four percent (n 66/103) of the total respondents had classroom/lab experience.

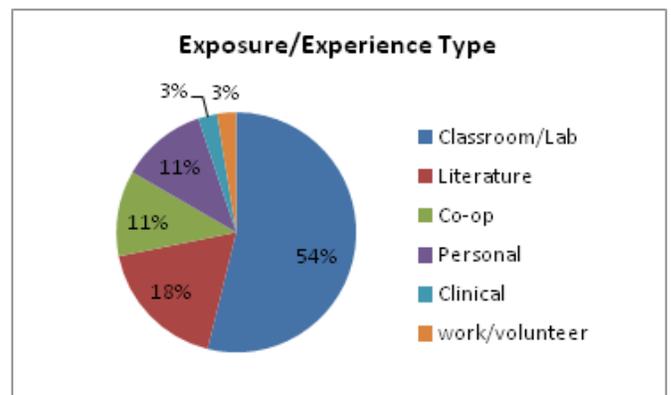


Figure 2: Represents an N = 103.

Students reported confidence in determining general anatomy/muscle morphology using multiple imaging modalities to include, USI, radiographs and MRI. Students felt least confident with USI with a median confidence level of five out of 10, but felt more confident with radiographs 7/10 and MRIs 8/10. The anatomical structures that students felt the least confidence in their knowledge of composition and function were the multifidus, deep neck flexors and the plantar fascia (Figure 3). The survey questioned whether students would be interested in using RUSI in clinical practice. Seventy-eight percent (n=81/103) responded that they were interested in using RUSI in their clinical practice. Students reported that they were most interested in learning RUSI within the PT curriculum or as part of their clinical education experiences (Figure 4). No correlation was found between interest level in using RUSI and previous work exposure or experiences, PT oriented volunteer experiences, clinical education, or classes at other universities.

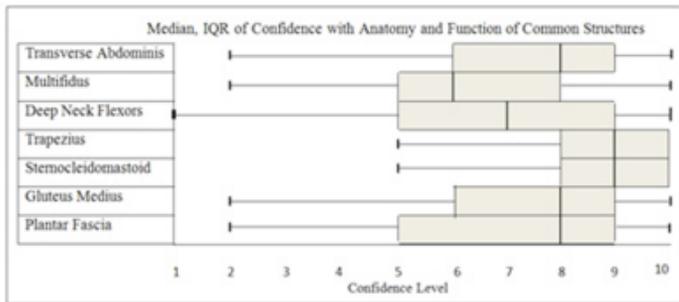


Figure 3: Students response to; What is your comfort level with the anatomy and function of the following anatomical structures.

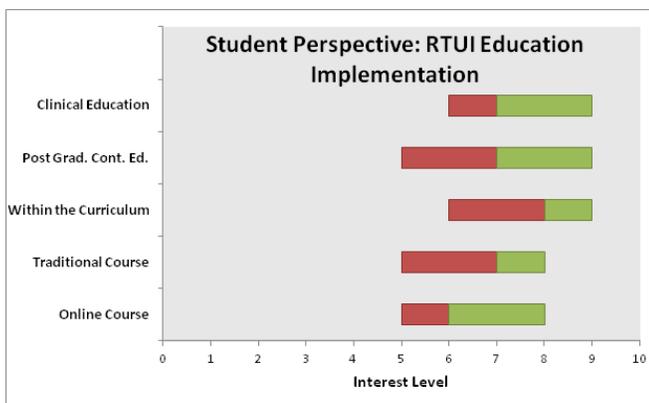


Figure 4: Students response to; If you are interested in learning how to use real time ultrasound imaging, please indicate your interest level as it relates to the following settings? Data is based on 103 survey responses.

Discussion

RUSI has been gaining popularity due to the additional clinical value it can offer in physical therapy practice. Current uses include biofeedback, a standardized outcome measure, an objective way to observe muscle pathology and assessment of muscle morphology [12]. Recent literature supports RUSI as a beneficial clinical tool as well as an educational tool to improve anatomical knowledge and student confidence. This supports the need for PT programs to provide students with fundamental current knowledge in RUSI uses and applications. Including RUSI education longitudinally within PT education will prepare students for contemporary practice and provide more opportunities for students to solidify their knowledge of anatomy in classroom and lab experiences.

Curricular Guidelines

Educational guidelines emphasize that the most up-to-date imaging should be covered in curricula but do not specifically state where, when or how to include them. The IEM manual is a springboard for incorporating RUSI into PT education for

musculoskeletal imaging. It was identified that more specific resources are needed to prepare students for the “broader use of imaging by PTs which challenges educational programs to ensure their content will meet societal demands on future practitioners.” [17]

Article Search

Many studies have been published regarding the use of ultrasound and its reliability as a clinical tool. This includes measuring muscle size and performance., McGaugh in 2011 researched the reliability of using RUSI for measuring muscle length changes in the deep neck flexors [22]. Welk et al examined the plantar fascia changes in runners and walkers and offered another clinical use of RUSI [23]. RUSI is currently being researched as a biofeedback treatment option. In a study by Tehyan RUSI was used to target the transverse abdominis muscle length in patients with lower back pain [1]. As additional studies are conducted on the use of ultrasound imaging technology in PT clinics, it is necessary to inform and adapt educational curricula. Using RUSI in examination and management is commonly referred to as point-of-care application. The growth of point-of-care and research activity strengthens the case for PT student education in RUI.

Including RUSI in PT education will allow for students to reinforce their knowledge of anatomy by allowing them to apply what they learn to live subjects. The combination of using cadavers and imaging together enhances students’ retention and ability to identify anatomical structures [24]. Students need to be equipped with knowledge of USI safety, how to use the machine and how to read the images. Subsequently, clinical principles can be introduced, and students can be taught how to use RUSI for biofeedback, evaluation of muscle cross sectional area and as a measure of motor control. This supports the longitudinal manner in which RUSI can be incorporated into the curriculum and can be seamlessly transitioned to clinical practice principles.

Student Survey

Through the student survey, it is clear that students have a desire to learn how to use and apply this emerging imaging technology. Seventy-eight percent of students who took the survey are interested in using RUSI in future clinical practice. PT students need to have access to imaging techniques that interest them and also have a variety of uses in clinical practice. Students reported that they were most interested in learning RUSI within the PT curriculum or as part of their clinical education experiences. Students felt less confident in identifying anatomy on USI compared to other imaging modalities. Areas where students feel they were the least comfortable with their knowledge of anatomy and function were neck, back and feet. Incorporating RUSI as a teaching strategy could be beneficial to improve learning and the understanding of muscle morphology and understanding and

applying USI studies in practice.

Continuing education courses for RUSI that exist are expensive; therefore, it would be more practical to institute RUSI into PT curricula in a longitudinal fashion by including it in classroom and lab experiences, particularly as an adjunct to gross anatomy courses. Close student-professor relationships will be necessary to explore the ways in which RUSI can be administered, and academic experiences are needed to keep up with the newest imaging techniques. The General Medical Council (GMC) recommends that anatomy education should integrate clinical sciences, and this includes studying anatomy through the use of medical imaging methods such as radiographs and ultrasound [2]. A lab setting would provide the hands-on experience that would allow students to learn the most efficient and successful techniques for using RUSI. In a study by Patten, USI was introduced to undergraduate medical students to enhance “clinical anatomy teaching and to aid skill development in interpretation of cross-sectional anatomy (CSA)” [25]. The majority of the medical students “valued opportunities to see and/or use an imaging modality, which they anticipated using in the future” [25]. The study found that USI “reinforced existing anatomical knowledge” while allowing students to be exposed to anatomical variations. This gives students the opportunity to integrate clinical application into learning through use of their knowledge of anatomy to interpret dynamic images through RUSI technology.

Strengths Limitations and Future Work

Survey

The strengths of the study include a thorough survey consisting of less than 25 questions that assessed both educational needs and confidence with RUSI compared to other imaging techniques. The survey was developed after performing a literature search and it was based on what students should theoretically know given the current state of PT curricula. The questions went in-depth without requiring a significant time constraint on participants. The survey also yielded an excellent response rate. Triangulation of data from the survey, educational guidelines and the literature search allowed for a strong body of evidence for the need for RUSI in PT education. The study faced a few limitations, including the lack of current research that exists on RUSI and PT education. Another limitation was possible respondent confusion surrounding the understanding of what RUSI is and how it differs from therapeutic ultrasound.

A possible misconception that therapeutic ultrasound is synonymous with RUSI may have altered participants’ answers to survey questions. Additionally, some participants chose to leave some questions blank as opposed to answering all of the survey questions. This should be addressed in future studies.

Sampling

The survey yielded a strong total response rate of 46%, which allowed us to confidently analyze the results. However, the population included only students from one DPT program, so further research is required in order to increase the generalization of the results and assess the need for incorporation of RUSI into DPT programs at other universities. A convenience sample was used for ease of dissemination of the survey, but future studies should utilize a larger sample size with randomized selection. It was assumed that all of the participants had internet access to complete the survey, but the response rate may have been affected by choosing to distribute the survey via email and Facebook. This should also be addressed in future research.

Future Work

There is a need for RUSI education in order to prepare future clinicians for the changing technological landscape. As faculty become skilled at RUSI and incorporating RUSI, other less effective teaching tools and methods can be discontinued, allowing for minimal overall impact on teaching time and resources. Further research should address whether RUSI augments understanding and learning of anatomy and morphology for PT students specifically.

Conclusion

As RUSI becomes a more essential tool for physical therapists in the clinic, students must have an education consistent with current technology. This needs assessment addresses the implementation of RUSI into a PT program. Based on US PT standardized curricular and practice documents, current evidence and student perspective, our findings suggest ultrasound imaging should be introduced early and longitudinally in the curriculum as an adjunct learning tool for students to gain fundamental knowledge of the use of RUSI, equipment, anatomy and clinical applications. There are few formal USI education programs designed specifically for physical therapy students and based on our findings it is clear that guidelines for an educational foundation for RUSI would be beneficial to DPT programs. By incorporating RUSI in a longitudinal fashion, academic programs may see that the benefits outweigh the challenges when it comes to adding RUSI. It is well-suited to facilitate learning of anatomy and movement as well as reinforcing existing knowledge due to its safe, non-invasive real-time imaging of live subjects.

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