Exploring Occupational Therapists' Perceptions of the Usefulness of Musculoskeletal Sonography in Upper-Extremity Rehabilitation

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MeSH TERMS

- hand
- occupational therapy
- patient care management
- qualitative research
- ultrasonography

OBJECTIVE. To identify the potential utility of musculoskeletal sonographic imaging in upper-extremity rehabilitation.

METHOD. Two occupational therapists in an outpatient hand rehabilitation clinic were recruited by convenience, were trained in the use of sonography, and implemented sonographic imaging in their clinical practice. Qualitative data were obtained during and after the implementation period by means of questionnaires and interviews. Data collection, analysis, and interpretation were completed in an iterative process that culminated in a thematic analysis of the therapists' perceptions.

RESULTS. The data indicate four potential areas of utility for musculoskeletal sonography in upper-extremity rehabilitation: (1) mastering anatomy and pathology, (2) augmenting clinical reasoning, (3) supplementing intervention, and (4) building evidence.

CONCLUSION. Numerous potential uses were identified that would benefit both therapist and client. Further exploration of complexities and efficacy for increasing patient outcomes is recommended to determine best practices for the use of musculoskeletal sonography in upper-extremity rehabilitation.

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Sonography is an imaging modality that provides real-time, dynamic views of anatomical structures in a pain-free manner without exposure to radiation. Sonographic technologies have been rapidly advancing, leading to smaller, more portable equipment that requires minimal user-machine interface while providing good resolution of small, superficial structures. Increased ease of use, along with enhanced imaging, has prompted an increase in point-of-care use of sonographic imaging for musculoskeletal conditions by nonradiology providers. Specifically, evidence of the use of sonographic imaging in physical rehabilitation settings is growing. For example, therapists are using sonography to improve clinical evaluations of painful shoulders in patients with hemiplegia resulting from stroke (Huang, Liang, Pong, Leong, & Tseng, 2010), to document outcomes of therapeutic interventions for patients with spinal cord in-

juries and cerebral palsy (Dudley-Javoroski, McMullen, Borgwardt, Peranich, & Shields, 2010; Lee et al., 2013), and as a biofeedback intervention tool for pelvic floor disorders in women and patients with low back pain (Ariail, Sears, & Hampton, 2008; Herbert, Heiss, & Basso, 2008).

Although increasing evidence has suggested that musculoskeletal sonography has numerous rehabilitation applications, no studies have evaluated the use of sonographic imaging by occupational therapists for the rehabilitation of acute orthopedic hand conditions. In addition, no qualitative studies have explored the use of sonographic imaging in the rehabilitation context. Therefore, we designed this study to explore how occupational therapists use sonography in clinical practice, to identify additional potential uses for sonographic imaging by occupational therapists, and to inform future research

regarding the integration of imaging into practice.

Method

Study participants were 2 occupational therapists providing services in an outpatient hand rehabilitation clinic. Recruitment was based on the therapists’ availability, willingness to participate in training, and access to clients. Therapist 1 (T1) was a certified hand therapist with >25 yr experience, and Therapist 2 (T2; author Wolkoff) was an entry-level occupational therapist completing her doctoral residency. In addition to participating in the research, T2 assisted in the initial steps of data analysis; however, to minimize bias, her researcher role was eliminated in subsequent phases, in which data were analyzed and interpreted by the other authors. The institutional review board of the academic center approved this study, and the therapists and their clients who received sonographic imaging provided informed consent. Rigorous qualitative methods were used to ensure trustworthiness (Lincoln & Guba, 1985; Patton, 2002), and the authors’ involvement in research activities is summarized in Table 1.

Each therapist was trained in sonographic imaging by the study’s lead author and primary investigator (Roll), who is both a registered and licensed occupational therapist and a sonographer registered in musculoskeletal sonography. Twenty-eight hours of training was provided across twelve 2- to 3-hr sessions over 4 mo. Training included basic principles of sonography, equipment operation, image acquisition, and identification of anatomic structures of the distal upper extremity. The therapists

practiced with the sonographic equipment on an intermittent basis for 1 mo before implementing the imaging with clients. Over a 3-mo period, clients were recruited by convenience as long as they did not have open sores or wounds, were older than age 18 yr, and spoke English. Sonographic imaging was completed with a Venue-40 point-of-care sonography machine (GE Healthcare, Milwaukee, WI) after completion of the initial and discharge evaluations for each recruited client.

During the implementation period, data were obtained from the 2 therapists using a questionnaire and brief semistructured interviews. The questionnaire was developed by the lead author (Roll) specifically for this study and was used as a means of cuing the therapists to think about various aspects of their experience with the sonographic imaging process. The questionnaire included a wide range of open-ended questions regarding confidence with the sonography, factors that promoted or challenged the use of the sonography, and the usefulness of imaging for the individual client. Each therapist completed the questionnaire at the conclusion of every sonographic scan. The lead author conducted semistructured interviews lasting approximately 15 min every 2–3 wk, resulting in a total of five brief interviews. In these interviews, the therapists were asked to expand on the benefits of and barriers to using sonography that they had reported on the questionnaires.

As is customary in qualitative research, the interpretive process of data analysis was recursive with data collection (Creswell, 2007). After initial data collection, we individually reviewed and then collectively discussed the data from the questionnaires

(*N* = 10) and transcripts of the brief interviews (*N* = 5) to identify patterns in the data. Rather than fitting the data to themes developed a priori, we used an open approach to coding, and the fourth author (T2, Wolkoff) drafted a summary of these preliminary findings. On the basis of this framework, the two qualitative researchers who were not involved in previous data collection developed a semistructured interview guide and conducted an individual follow-up interview with each therapist. Follow-up interviews lasted approximately 1 hr and engaged the therapists in open-ended discussion in two broad domains: (1) their experiences using sonography with their clients and (2) their perceptions more generally about uses for sonography in upper-extremity rehabilitation.

After reviewing transcripts of the follow-up interviews, the two qualitative researchers met to further collapse and refine the themes relating to the use of sonographic imaging in upper-extremity rehabilitation. The refined themes were discussed with the lead author, and the research team conducted a comprehensive review of all data sources to ensure the emerging themes were well supported throughout. The second author (Gray), a qualitative researcher, reread and recoded all data in relation to the emerging themes agreed on by the research team. The recoded data were synthesized into manuscript form, and all authors met numerous times to review and discuss the written findings. Using an iterative process, the synthesis of findings was edited by each author until consensus was reached on the meaning and overall implications of the data.

Results

The therapists viewed sonography as a positive addition to their clinical practice. Four areas of perceived usefulness were identified: (1) mastering anatomy and pathology, (2) augmenting clinical reasoning, (3) supplementing intervention, and (4) building evidence.

Mastering Anatomy and Pathology

Both therapists spoke of the usefulness of sonography as a means of advancing understanding and mastering knowledge of musculoskeletal anatomy, both general and

Table 1. Participant (Author) Involvement in Study Activities

Activity	T1	T2 (MW)	Trainer (SCR)	Qualitative Researcher 1 (JMG)	Qualitative Researcher 2 (GF)
Training	X	X	X		
Data collection and instrument design		X	X		
Brief interviews with T1 and T2			X		
Preliminary data analysis		X	X	X	X
Design of follow-up interview guide				X	X
Follow-up interviews				X	X
Final thematic analysis			X	X	X

Note. GF = Gelya Frank; JMG = Julie McLaughlin Gray; MW = Monique Wolkoff; SCR = Shawn C. Roll; T = therapist.

client specific. Most important, they indicated that sonography provided a means to study anatomy, specifically their own anatomy, in lieu of in a cadaver lab:

This is another way to just scan yourself or your friend and see that a muscle is deeper down than another muscle, or see what happens when you flex. So I think it's just a great way for people to learn, even beyond 3-D models or videos, as opposed to flash cards or anatomy coloring books and things like that. (T1)

T1 also perceived that a novice therapist's anatomical learning could be accelerated by using sonography as a learning tool:

Just observing [T2], who's a beginner, I think she picked it up really fast, and it was a great way for her to learn anatomy because you can definitely see superficial and deeper muscles, and you're seeing them as they're working. I would look at her and say, "Do you know how lucky you are instead of just looking at a still from a book?"

T2 agreed that sonography helped to enhance her mastery of basic anatomy:

I did one scan of a client with a diagnosis of thumb extensor tenosynovitis. Initially I was looking for edema around the extensor pollicis longus. I was expecting to just see a black area around the tendon indicating some liquid. I found this circular black area in the joint space between the radius and the carpal bones. I thought I had found inflammation that was impacting her movement. We reviewed it with [the trainer] later. He scanned his own hand and showed that there is actually that amount of fluid in this joint space in normal anatomy.

In addition, the therapists found sonography useful in gaining a greater understanding of their clients' pathology and factors affecting recovery. T1 commented, "We have more information than we previously could have . . . about our clients by scanning them with sonography." T2 ech-

oed, "As a new practitioner, I was nervous about feeling like I didn't know enough. The musculoskeletal sonography offers a deeper insight into the pathology, what's exactly happening." As T2 also noted,

For cases where the diagnosis is not very specific, it's nice to be able to get some information about where the inflammation is occurring, or what type of inflammation it might be, because it could be inflammation within the tendon itself or just tenosynovitis around the tendon.

Both therapists noted their improved ability to determine how a repaired or injured tendon was functioning—specifically, whether it was intact and gliding properly. They also noted an improved ability to determine the location and causes of edema, the location and impact of scar tissue on surrounding structures, and the characteristics of a client's blood flow to the injured area. T2 noted enhancements in assessing the client's capacity for full recovery. She recalled scanning a client who had experienced a blast injury 20 yr earlier and had recently undergone multiple grafts and revisions to his flexor digitorum profundus:

We were curious whether there is any glide of the tendon, and we were able to scan and see that the tendon really ends and turns into scar tissue at the proximal phalanx. So there's no gliding of the tendon; the movement that we're seeing is purely the tendon pulling on the scar tissue. (T2)

Augmenting Clinical Reasoning

The therapists' enhanced understanding of typical anatomy and their clients' specific pathology directly informed, and often overlapped with, discussion of the usefulness of sonography for enhancing clinical reasoning and intervention planning. On the most basic level, sonography was perceived as helpful for differential diagnosis in cases in which the diagnosis was not very specific, especially when receiving referrals for nonspecific diagnoses, such as hand pain. The therapists also noted that sonography could help to determine the cause of limited movement or pain and to focus and guide

intervention plans. For the client with the blast injury discussed earlier, the therapist described how her clinical reasoning and intervention planning were affected by the information gained from the sonogram:

[Seeing the scarring] definitely changed how I'm going to approach treatment because treatment now is going to probably mostly focus on increasing his MP flexion and strengthening lumbricals. I don't think he has interossei. It's definitely going to have an impact on how I spend my time throughout therapy. (T2)

The therapists imagined how sonography could be useful throughout the episode of care. T2 put it this way: "When something new happens clinically, it would be nice to see what's happening physiologically, too." Finally, the dynamic capabilities of sonography could reduce frustration by allowing the clinician to link clinical observations and reports with dynamic tissue movements. T1 noted, "Usually a client will say, 'When I do [this] motion, it really annoys me.' [What] if we could scan that motion and see what's going on?!"

Supplementing Intervention

Regarding use in direct intervention, the therapists described sonography as a tool for client education and biofeedback. T1 envisioned using sonography to instruct clients about their condition "the way we pull out a textbook." Sonography, she reasoned, was potentially more helpful than textbook illustrations because it could show clients their own anatomy and pathology. Both therapists noted that sonography provided a dynamic, interactive method for educating clients about the structure and function of the hand that was not available with textbooks. The therapists frequently mentioned dynamic movement in relation to scar tissue and noted that it would be useful after internal fixations to show clients the exact placement of plates and screws to help them better understand restrictions on their movement.

The therapists further suggested that viewing internal structures of the hand with sonography could be a source of emotional support to the client. T1 envisioned

how using sonography to assist clients in witnessing their own healing process could help them understand what might be causing plateaus or setbacks in their progress:

Right now when I work with clients, I'll pull out a picture from a book. But, how cool is it when it's your own hand, and it's your own hand moving, versus a picture in a book? So, I think motivation; visualizing your own healing and where you're stuck, I think, is very powerful.

T1 suggested that, through the use of sonography, clients may gain an increased understanding of what could be improved, and they might "have hope [that they] can improve." T2 noted that even the smallest details elucidated by sonography could be "encouraging for clients, because seeing that their tendon is moving, even if they don't see their finger moving, makes a big difference." In addition, viewing physiological evidence may have a potentially positive effect by validating a client's symptoms. T1 described a client who was distressed by not having a clear understanding of the reason for her persistent discomfort, which disrupted her daily occupations. Because the client did not have evidence to explain her experience, she imagined that people suspected her of malingering. Instead, sonography validated the client's otherwise inexplicable dysfunction and reassured her:

It was just a little incision, and [she said] "It's really bothering me. I can't type. I can't go back to work. I can't hold the mouse. It's driving me insane." I think that was validating to say, "Yes, it is stuck underneath, and what you're describing is right." It calmed her anxiety to see pictures of her own hand and that I was spending time with her about it. (T1)

T1 summarized, "There's a big mind-body connection in educating the client this way." She envisioned leveraging this mind-body connection by providing sonographically guided biofeedback: "You could show the client, 'This is what has to move. Okay, it moved some. Do you see where it is stuck?'" In another instance, she noted,

There's a lot more in health care that we're finding out that we have this big [mind-body] connection, so I try to bring that in with the people that I treat, and I think that [sonography] is just such a visual motivator. (T1)

Building Evidence

Because sonography allows the therapist access to details of the client's physiology related to injury and healing, it can also be useful for measuring outcomes, a crucial step in the process of evidence-based practice. One of the therapists discussed the potential for sonography to assist in understanding the effects of her intervention on a physiological level, which enhanced her observations and the client's report. The sonogram could inform her practice, she suggested, by confirming her clinical speculations about a client's condition and providing a means for monitoring client progress throughout care in relation to her interventions: "Seeing over time how exactly things are healing. Is the bone actually healing? What's happening to the structures right above that bone? With edema? Are the tendons freely gliding over [the bone]?" (T1).

According to this therapist, sonography offers a way to observe and measure tissue changes that otherwise cannot be seen: "I'm still really interested in how the collagen gets realigned. It'll be interesting to see how that looks in the end, because [the client] is doing better" (T1). She also envisioned using sonography in clinical studies to provide practice-based evidence for her interventions: "I would do it as a clinical study. Do our scar mobilization techniques make a difference? Does myofascial release work? That would help therapists know that this is a technique that works" (T1).

Discussion

The purpose of this exploratory study was to identify actual and potential clinical uses of musculoskeletal sonography in upper-extremity rehabilitation as perceived by occupational therapists and to identify areas for future research. On the basis of their experience in this study, the therapists envisioned that sonography could enhance therapists' clinical practice and enrich the rehabilitation experience for clients.

First, with regard to enhancing clinical practice, sonographic imaging advanced the therapists' own knowledge and understanding of anatomy and pathology. Sonography is increasingly being used as an educational method in gross anatomy courses to increase student understanding of anatomy (Dreher, DePhilip, & Bahner, 2014). As with its use in didactic student learning, anatomical mastery of both normal anatomy and pathology was advanced not only for the novice therapist but also for the experienced therapist.

Second, the therapists viewed sonography as a means to augment clinical reasoning, obtain data necessary for monitoring progress, and provide evidence as an outcome measure. For upper-extremity conditions, sonography has been used by rehabilitation providers to identify causes of shoulder pain in clients with hemiplegia (Pong et al., 2012), as well as to begin differentiating pathological presentation and severity for patients with lateral epicondylitis (Chourasia et al., 2013) and carpal tunnel syndrome (Roll, Evans, Li, Sommerich, & Case-Smith, 2013; Roll, Volz, Fahy, & Evans, in press). The therapists in this study mentioned that intervention planning could be enhanced by identifying the specific location and progression of pathological changes. The most common perceived uses included identifying blood flow and edema, observing the impact of scar tissue on tendon movements, and monitoring the dynamic interaction of tendons with plates and screws that were surgically placed.

In terms of the client's experience in therapy, the therapists discussed using sonography as an educational aid. Education is a vital component of rehabilitation (Seu & Pasqualetto, 2012); it serves to actively engage a client and allows the client to take more responsibility for his or her improvement through changes in habits of use and adherence to exercises. When using sonography in undergraduate education, anatomical learning benefits have been documented with as little as 10 min of basic instruction (Ivanusic, Cowie, & Barrington, 2010). Furthermore, like the therapists in our study, students indicated that the use of sonography to show living anatomy reinforced their learning and had advantages over the use of cadavers (Ivanusic et al., 2010). Although these studies were completed with

undergraduate students, the therapists in the current study noted that clients had similar experiences and reported increased understanding of their anatomy with only minimal orientation to the images. As such, sonography may be an effective and dynamic way to educate a majority of clients about their own anatomy as an alternative or as a supplement or complement to textbooks and models.

In addition to education, the therapists suggested that sonographic imaging might be useful as a biofeedback tool to improve muscle activation and movement patterns. Biofeedback using sonographic imaging has been successfully used to assist clients with low back pain to activate the correct muscles during exercises (Hides et al., 2010; Worth, Henry, & Bunn, 2007) and to encourage effective performance of exercises for female clients with pelvic floor disorders (Ariail et al., 2008; Dietz, Wilson, & Clarke, 2001). In addition to directly enhancing performance, these types of sonographic interventions increase understanding, attention, and awareness of normal and abnormal structures. Furthermore, understanding normal and abnormal movement of tissues during functional tasks, facilitated by sonographic imaging, may lead to improved individual mental practice and occupational performance outside the clinic.

The use of sonographic imaging as an education and biofeedback tool may leverage the mind–body connection to enhance healing and client outcomes. Evidence has suggested that mind–body techniques are useful for modifying pain appraisals, reducing anxiety, strengthening awareness of biokinetic processes, and increasing self-efficacy (Jensen, Day, & Miró, 2014; Vøllestad, Nielsen, & Nielsen, 2012; Wong, Chan, & Chair, 2010). Each of these factors can be tied to improved client engagement, motivation, and adherence to intervention plans, especially for clients who are already interested in learning about the therapy process (Moorhead, Cooper, & Moorhead, 2011). The therapists consistently reported positive client feedback and noted that clients were engaged in asking questions to further understand how their pathological condition was tied to functional movements and limitations. Given the literature and our results, sonography could contribute to improved efficiency,

cost-effectiveness, and holistic mind–body care in rehabilitation (Dale et al., 2002).

The findings of this study are based on the experiences of 2 therapists who were recruited by convenience, were interested in learning to use sonographic imaging, and planned to implement imaging in clinical practice. Thus, the results are meant to be exploratory and not necessarily widely generalizable. Because this was an initial exploratory study of clinical utility, emphasis on evaluating the initial training process itself was minimal. Similarly, although we obtained data concerning constraints and challenges to integrating musculoskeletal sonography into clinical care, we have not emphasized these findings in this report. Deeper exploration of training methods (e.g., who provides training, duration and intensity of training), professional boundaries, and other challenges is necessary to ensure successful implementation. Finally, we did not explore or measure effects of the use of sonographic imaging on client outcomes. Rather, this article provides a foundation on which additional analyses and feasibility studies can be conducted to evaluate best practices for implementation and efficacy of musculoskeletal sonography in the rehabilitation of upper-extremity conditions.

Implications for Occupational Therapy Practice

The results of this study have the following implications for occupational therapy practice:

- Sonographic imaging may assist therapists in mastering anatomy and pathology, inform clinical reasoning, and improve the planning and delivery of interventions.
- Sonography may enhance client motivation and engagement in the treatment process through education and biofeedback.
- The inclusion of sonography in clinical practice may prove a viable tool for outcomes research and increase the evidence base for upper-extremity rehabilitation.
- Further studies are necessary to develop effective training models, identify best practices for implementation, and evaluate the relationship between the clinical

use of sonographic imaging and client motivation, engagement, adherence, and outcomes. ▲

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