THE ISSUE IS . . .

Role of Sonographic Imaging in Occupational Therapy Practice

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MeSH TERMS
- occupational therapy
- outcome assessment (health care)
- patient care planning
- professional role
- rehabilitation
- ultrasonography

Occupational therapy practice is grounded in the delivery of occupation-centered, patient-driven treatments that engage clients in the process of doing to improve health. As emerging technologies, such as medical imaging, find their way into rehabilitation practice, it is imperative that occupational therapy practitioners assess whether and how these tools can be incorporated into treatment regimens that are dually responsive to the medical model of health care and to the profession's foundation in occupation. Most medical imaging modalities have a discrete place in occupation-based intervention as outcome measures or for patient education; however, sonographic imaging has the potential to blend multiple occupational therapy practice forms to document treatment outcomes, inform clinical reasoning, and facilitate improved functional performance when used as an accessory tool in direct intervention. Use of medical imaging is discussed as it relates to occupational foundations and the professional role within the context of providing efficient, effective patient-centered rehabilitative care.

Roll, S. C. (2015). The Issue Is—Role of sonographic imaging in occupational therapy practice. *American Journal of Occupational Therapy, 69,* 6903360010. http://dx.doi.org/10.5014/ajot.2015.015941

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Occupational therapy practice is grounded in the provision of occupation-centered, patient-driven treatments that engage clients in the process of doing to maximize health. Concern about the profession straying from these roots has been raised for more than 3 decades (Gillen, 2013; Kielhofner, 1983; Wood, 1998). At the center of the debate are preparatory activities and other easily reimbursable interventions that are not perceived as occupation centered and that appear to mimic other professions (e.g., physical therapy).

Unfortunately, in rehabilitative care, a bottom-up focus on individual body structures and performance components is often the path of least resistance to meet efficient, cost-conscious reimbursement expectations (Fisher & Friesema, 2013). In addition, there is no easy solution to the disconnect between the field's occupation-centered foundation and the delivery of increasingly medically focused services. Consequently, as technologies such as medical imaging find their way into rehabilitation practice, it is imperative that occupational therapy practitioners assess whether and how these tools can be incorporated into treatment regimens that are dually responsive to the medical model of health care and to the foundation in occupation.

Although medical imaging as a whole may be viewed as preparatory and reductionistic, for occupational therapy practitioners to stay relevant in an environment in which other medical and rehabilitation providers increasingly use medical imaging, the question is, Is medical imaging an appropriate occupation-centered tool to be used in occupational therapy interventions? Moreover, is medical imaging a viable means for enhancing the delivery of efficient and effective care? To this end, this article discusses the use of medical imaging by rehabilitation providers and occupational therapy practitioners in the context of efficient, effective patient- and occupation-centered care. Specifically, this article highlights the utility of musculoskeletal sonographic imaging to facilitate patient engagement in occupation-centered treatments and discusses challenges and implications of integrating sonographic imaging into occupational therapy practice.

Medical Imaging in Rehabilitation

For people with neurologic, musculoskeletal, and orthopedic conditions, medical imaging for diagnosis is compulsory. MRI is used to diagnose central neurologic disorders of the brain and spinal cord, and both MRI and X ray are regularly used for diagnosing injuries of muscles, tendons, bones, and joints. In certain rehabilitation populations, follow-up MRI or X ray assessment after intervention is common to evaluate changes or improvement in tissues and structures. In addition, although during functional MRI (fMRI) and diffusion tensor imaging (DTI) the body segment being imaged must remain static, these modalities can be used to evaluate dynamic changes during and after participation in functional tasks and therapeutic activities (Cagnie et al., 2011; Lin et al., 2010; Voelbel, Genova, Chiaravalotti, & Hoptman, 2012).

These imaging modalities will continue to be important for diagnosing and building research evidence for rehabilitation interventions; however, these techniques have limited applied clinical utility for occupational therapy practitioners. MRI is expensive to obtain and operate, requires substantial training, and has numerous contraindications. X ray provides low-dose radiation to patients and is limited to evaluating bones, metal, and radioactive materials. With the exception of dynamic X ray fluoroscopy in the evaluation and treatment of swallowing disorders (Cha, Oh, & Shim, 2010), MRI, fMRI, DTI, and X ray, along with computed tomography and positron emission tomography, are primarily static medical imaging modalities. These static images have a discrete place in occupation-centered intervention for patient education and as a measurement tool.

In contrast, sonography is a dynamic medical imaging modality with broader clinical application for occupational therapy practitioners. Using a piezoelectric transducer and coupling gel, sonography sends high-frequency sound waves (i.e., vibrations) into the body. In contrast to thermal ultrasound transducers that focus the sound waves into one high-energy beam, sonography transducers send individual sound waves into the body, which do not have enough energy on their own to cause tissue heating. Once through the skin, the varied density and physiologic properties of the subcutaneous tissues alter the frequency and amplitude of the sound waves and refract and reflect portions of the sound waves back to the transducer (i.e., echoes). The altered sound waves return to the transducer and are converted into electrical impulses, and an image is created. Different tissue types (e.g., bone, muscle) are represented with various shades of gray based on the frequency, amplitude, and amount of returning echoes, and the timing and returning angle of the sound waves are used to spatially orient each structure in the image.

Sonography has numerous benefits over other medical imaging technologies. It can show real-time movement of musculoskeletal tissues in a quick, efficient, pain-free manner, with no radiation or side effects and minimal contraindications. When compared with other medical imaging equipment, sonography is affordable and portable and can produce high-definition images of exceedingly small musculoskeletal structures. Performing sonographic imaging for diagnostic purposes requires certification and, in some states, licensure (i.e., Oregon, New Jersey, New Mexico, and West Virginia). However, the use of sonography as a supplementary tool to augment routine service delivery by other, noncertified or nonlicensed professionals is not regulated. Moreover, because sonographic imaging has no direct patient bioeffects, it is not a physical agent modality (PAM; McPhee, Bracciano, & Rose, 2008); therefore, its use is not regulated by therapy licensure requirements for PAMs.

These limited regulations, combined with the ability to rapidly acquire dynamic, point-of-care images, have led to expanded use of musculoskeletal sonography beyond diagnostics. Clinical use is being reported with increasing frequency by rheumatologists (Brown et al., 2004; Cunnington, Platt, Raftery, & Kane, 2007), sports medicine practitioners (Tok, Özçakar, De Muynck, Kara, & Vanderstraeten, 2012; Yim & Corrado, 2012), physical medicine physicians (Özçakar, Tok, De Muynck, & Vanderstraeten, 2012), and orthopedic surgeons (Seagger, Bunker, & Hamer, 2011; Thomason & Cooke, 2012; Ziegler, 2010). Musculoskeletal sonography is also being incorporated into research and clinical practice by athletic trainers and physical therapy practitioners (Teyhen, 2007). Physical therapists use sonography to visualize morphological changes over time as a clinical outcome measure (Brown, 2009), to monitor tissue response to therapy as a means for clinical decision making (Callaghan, 2012), and to provide biofeedback for enhancing patient engagement and improve the precision of clinical interventions (Ariail, Sears, & Hampton, 2008; Herbert, Heiss, & Basso, 2008; Worth, Henry, & Bunn, 2007). Despite increasing use by other medical and rehabilitation providers, no evidence describes clinical use of sonographic imaging by occupational therapy practitioners.

Sonography in Occupational Therapy Practice

Sonographic imaging has the potential to blend multiple forms of intervention to document treatment outcomes and inform clinical reasoning. Additionally, as a supplementary tool in rehabilitative, preventive, and wellness interventions, sonography may be useful for facilitating patient engagement and adherence, resulting in improved occupational performance.

Outcome Measures

Clinical studies using sonography to document structural and tissue morphology changes after medication regimens, surgery, and rehabilitative interventions are rapidly expanding. In follow-up after carpal tunnel release, sonography shows a large reduction in swelling of the median nerve in the carpal tunnel (Kim, Yoon, Kim, Won, & Jeong, 2012). Similarly, sonographic imaging has been extensively used to document reduction in joint swelling and improvement in cartilage health in response to injections and medication regimens for people with arthritis (Henrotin, Hauzeur, Bruel, & Appelboom, 2012; Montecucco, Todoerti, Sakellariou, Sciré, & Caporali, 2012; Seymour et al., 2012). Although not as prolific, examples of sonographic imaging in rehabilitation exist. Sonography was used to document increased thickness of triceps and extensor carpi radialis muscles by nearly 12% and 25%, respectively, after comprehensive functional strength training for children with cerebral palsy (Lee et al., 2013). Similarly, muscle hypertrophy has been observed with sonography after therapeutic intervention for people with spinal cord injuries (Dudley-Javoroski, McMullen, Borgwardt, Peranich, & Shields, 2010).

Although measuring objective physiological changes follows the medical model, relating these changes to patient-centered functional and occupational performance outcomes as a result of occupation-centered interventions is crucial for occupational therapy practitioners (Hocking, 2001). Point-of-care musculoskeletal sonographic imaging is positioned at the intersection of objective outcome measures and patient-reported functional performance. The association of these constructs has been explored in people with symptoms of carpal tunnel syndrome, whereby an increase in the size of the median nerve in the carpal tunnel as measured with sonographic imaging has been linked to decreased functional tolerances, even in people without a formal diagnosis (Roll, Evans, Li, Sommerich, & Case-Smith, 2013). Moreover, after intervention for people with carpal tunnel syndrome, changes in sonographic measures (e.g., reduced nerve swelling, increased muscle size) have been associated with improved occupational performance (Kim et al., 2012; Lee et al., 2013). An association between sonographic measures of morphology and functional performance has also been reported in the development of abnormal gait patterns in older women that coincided with a loss in muscle mass of adductor and quadriceps muscles (Abe et al., 2012). Given the link to functional outcomes, objective measurement of changes in tissue morphology using sonographic imaging has the potential to enrich clinical and research evidence for occupation-centered interventions.

Clinical Reasoning

In addition to capturing outcomes after an intervention, sonographic imaging could be integrated throughout the episode of care to inform clinical reasoning. Trombly (1993) suggested that a narrowly focused evaluation may assist in tailoring rehabilitation interventions, especially when the cause of an occupational limitation is not fully apparent. In this way, sonographic evaluation could assist occupational therapy practitioners in identifying the source, location, and severity of pathology that is limiting functional performance.

In a recent qualitative study, multiple instances were identified in which the use of sonographic imaging assisted in ongoing evaluation by the occupational therapists, leading to patient-specific tailored interventions (Roll, Gray, Frank, & Wolkoff, in press). One therapist indicated that imaging was beneficial for "gathering more information at the beginning of the treatment process [for patients] where the evaluation alone and the operative report don't really give a full picture of exactly what's happening" (Roll et al., in press). In one case, sonography permitted the therapist to detect nonpalpable tendon scarring in a location proximal to a surgical incision that was limiting tendon movement, a problem she likely would not have identified or addressed in her intervention had she not used imaging in her evaluation (Roll et al., in press).

This use of imaging for successful differential clinical diagnosis could drastically affect intervention effectiveness. For example, although occupational therapy practitioners often equate trigger finger with swelling of the involved flexor tendon, sonographic data have indicated that fewer than half of people with trigger finger have tendonopathy (Guerini et al., 2008). Instead, regardless of the presence of tendonopathy, nearly all people with trigger finger have a thickened pulley, limiting tendon gliding (Guerini et al., 2008; Sato, Ishii, Noguchi, & Takeda, 2012). Therefore, in patients whose functional deficits occur as a result of pulley hypertrophy, with no associated tendonopathy, conservative therapeutic interventions may not be effective. In these cases, delivery of occupational therapy intervention may be fiscally irresponsible until surgical intervention reduces impingement caused by the pulley. The utility of imaging for differentiation of tissues involved in clinical diagnoses extends to practice settings beyond orthopedics, for example, to examine hemiplegic shoulder pain (Huang, Liang, Pong, Leong, & Tseng, 2010) and secondary tendonopathies after a stroke or brain injury (Falsetti, Acciai, Carpinteri, Palilla, & Lenzi, 2010; Pong et al., 2012).

Direct Intervention

Beyond evaluation, point-of-care sonographic imaging can augment numerous biopsychosocial occupation-centered interventions. Central to imaging use in direct intervention is the opportunity for a patient to observe his or her own anatomy and pathology, a vital step in establishing a mind–body connection. As such, patient education is not limited to the use of static textbook images or models but can use real-time, dynamic images of a patient's own structures. Both pathologic and normal tissue appearance and movement can be quickly displayed by scanning a patient's affected and unaffected side. Establishing a mind–body connection through education with sonographic imaging could enhance the patient learning experience and assist in building self-determination, leading to increased engagement and overall patient adherence (Radomski, 2011).

Moreover, educating a patient using his or her own anatomy could lead to enriched patient-specific evidence discussions between the patient and practitioner, which in turn will improve self-awareness and self-calibration, pillars of successful biopsychosocial interventions (Borrell-Carrió, Suchman, & Epstein, 2004). This use of imaging is highly responsive to the call in the Patient Protection and Affordable Care Act of 2010 (Pub. L. 111–148) for patients to be actively engaged in decisions about their care and the treatment process, leading to empowerment for continued health and recovery after discharge from care.

This ability of sonographic imaging to engage and empower a patient by establishing a mind–body connection perfectly situates it as a visual biofeedback tool. Dynamic sonographic imaging can be used to enhance mental imagery and improve proper performance of therapeutic exercises and functional, occupation-centered tasks. Sonographic visual biofeedback has been primarily applied as a tool for rehabilitation of back pain (Herbert et al., 2008; Van, Hides, & Richardson, 2006; Worth et al., 2007) and pelvic floor disorders (Ariail et al., 2008; Dietz, Wilson, & Clarke, 2001). In both cases, the biofeedback is valuable to help patients learn which muscles to use and enhances the quality of exercises. This biofeedback process could also be used to improve performance of occupational tasks (e.g., tendon travel during pinching of a key) and may supplement other mind–body and mental imagery techniques currently being used in upper-extremity rehabilitation (Nilsen, Gillen, DiRusso, & Gordon, 2012). A variety of client populations could benefit from increased understanding of their own tissue pathology and how these tissues may or may not be appropriately moving during functional tasks to enhance their occupational performance.

Prevention and Wellness

With the ability to quickly visualize and measure musculoskeletal structures, use of sonographic imaging for regular health screening is increasing. Evidence for preventive sonographic screening by physicians to monitor the development and progression of rheumatic and arthritic conditions is prolific, and literature discussing preventive screening that is relevant to occupational therapy practitioners is increasing. For people with decreased mobility, visually undetectable pressure ulcers can be identified in early stages of development using sonography to monitor internal soft tissue breakdown (Deprez, Brusseau, Fromageau, Cloutier, & Basset, 2011) or thinning of the skin over bony prominences (Yalcin, Akyuz, Onder, Unalan, & Degirmenci, 2013). Similarly, sonography has also been used to monitor joint integrity in people with paretic extremities (Tunç et al., 2012).

In contrast to inactivity, evidence supporting the use of sonography in the identification of negative tissue responses to occupational performance has also begun to grow. One group of researchers is using sonography to evaluate overuse syndromes and changes in musculoskeletal structures of the shoulder and wrist as a result of their use in wheelchair propulsion (Collinger, Impink, Ozawa, & Boninger, 2010; Impink, Collinger, & Boninger, 2011). A second research group is exploring methods for the use of sonography screening in early identification of carpal tunnel syndrome and upper-extremity work-related musculoskeletal disorders (Evans, Roll, Li, & Sammet, 2010; Evans & Sommerich, 2009; Roll, Evans, Li, Freimer, & Sommerich, 2011; Roll, Evans, Volz, & Sommerich, 2013). The growing evidence for health screening in both inactive and active people expands the relevance of sonographic imaging beyond clinic-based services to occupational therapy practitioners providing industrial and community-based services.

Challenges and Potential Pitfalls

Although sonography has the potential to enhance occupational therapy practice, its use comes with multiple challenges and potential pitfalls. It is imperative that occupational therapy practitioners consider their professional foundation and ensure beneficence when providing any client intervention. Therefore, to adequately discuss integration of medical imaging into clinical practice, one must identify the relation of imaging to occupation-centered activities and the occupational therapy scope of practice and determine implications related to the delivery of skilled, efficient, and effective services.

Occupational Foundations

Occupation-centered practice has been discussed as *occupation as ends* versus *occupation as means* (Gray, 1998). On the surface, medical imaging inherently supports occupation as ends; however, multiple opportunities are available to use imaging to augment occupational-centered treatment, that is, occupation as means (e.g., biofeedback). Sonography can be used to provide a deeper understanding of and leverage the link between body structures and occupational performance to enhance intervention. Additionally, although occupational therapy practitioners consider occupation to be essential in improving body structures and functional restoration, sonographic images can contradict this positive preconceived notion. Sonography can show the negative effects on body structures caused by the performance of repetitive, high-risk occupational tasks.

Occupational therapy practitioners use a diverse clinical toolbox and varied forms of intervention (e.g., preparatory, purposeful, and occupational) to address physical, psychological, and contextual factors and maximize occupational performance for each unique patient (American Occupational Therapy Association, 2014; Clark et al., 1991). They should avoid the use of sonography as the sole preparatory, evaluation, or outcome measurement tool because using this type of narrowly focused assessment risks neglecting important occupational performance issues (Hocking, 2001). In addition, measured improvement in tissue pathophysiology may not necessarily always relate to improved functional outcomes (Trombly, 1993). However, as a multidimensional assessment and biopsychosocial intervention tool, sonography may be a useful addition to occupational therapy's clinical toolbox. Clinical use to establish mind–body connections, to engage patients through education and dynamic biofeedback during functional activity, and to monitor for negative effects of activity performance should be priority considerations for integrating sonographic imaging into occupational therapy practice.

Professional Scope and Interprofessional Jurisdiction

Although a solid occupational theoretical foundation underlies the profession of occupational therapy, the integration of medical imaging into practice extends a historical trend of being influenced by and adopting the approaches of other professions (Gillen, 2013). However, this incorporation of other approaches is not unique to occupational therapy. Professions exist in an intermingled ecologic system in which the systemic environment constantly promotes creation, destruction, reshaping, and swapping of roles and tasks among the professions (Abbott, 1988). Technology and culture are frequent drivers of this jurisdictional creation, destruction, and redefinition (Abbott, 1988).

Together, advances in imaging technology and a rapidly changing health care environment requiring efficient, point-of-care services have prompted numerous professions to adopt imaging (i.e., sonography) into their clinical practice. Although medical imaging has long been exclusive to radiologic professions, the credentialing process for musculoskeletal sonography was recently opened to nontraditional providers (i.e., health professionals without extensive sonographic training or certification). This change demonstrates a willingness of radiologic professionals to relinquish a portion of their jurisdiction over this technology. Moreover, the use of sonographic imaging by occupational therapy practitioners for differential clinical diagnosis would not likely be viewed as an encroachment on the primary diagnostic role of the physician. Instead, complementary use of sonographic imaging by all rehabilitation team members will inform treatment planning and enhance outcomes and lead to profession-specific interventions (e.g., occupation-centered biofeedback), all of which enrich the system of professions as a whole.

Despite generating interventions unique to occupational therapy, the rapid advancement and adoption of emerging point-of-care musculoskeletal sonography by numerous providers create various blurred jurisdictional lines. Vigilance is necessary to ensure that public, legal, and workplace jurisdiction claims do not limit the ability of occupational therapy practitioners to advance patient care through integration of imaging into clinical practice (Abbott, 1988). These claims are typically manifested in scope-of-practice and licensure legislation and continuously shifting reimbursement practices.

This article does not suggest that using medical imaging to diagnose patients should be included in occupational therapy's scope of practice. However, given the potential for imaging to enhance occupation-centered treatments, it is important that access to this technology not be limited by jurisdictional claims of other professions, legal or otherwise. Similarly, as a supplementary tool for augmenting patient-centered care, it may not be appropriate for practitioners to expect individual reimbursement for the use of sonographic imaging. Instead, reimbursement requests should be based on the primary occupation-centered service being provided. When combined with increased clinical documentation reflecting the role of sonographic imaging within the occupational treatment context, research demonstrating the benefit of sonographic imaging for biofeedback and other occupation-centered interventions will strengthen any future claims for direct reimbursement or inclusion of imaging within the scope of occupational therapy practice.

Skilled Service Delivery

With any new intervention tool or technique, adequate training and competency are crucial to ensure that the delivery of efficient, effective patient care is enhanced and not hindered. Increased point-of-care clinical use has prompted an expansion of sonography training in numerous health care professional curricula. Expanded training has been most prolific in physician education, including the recent establishment of the Society of Ultrasound in Medical Education, which now hosts an annual world congress to advance sonography training in general medical education. Similarly, the Commission on Accreditation in Physical Therapy Education (2014) noted an increase in medical imaging content in physical therapy curricula after the shift to doctoral training for entry-level education.

Despite increased training within these professional curricula, establishing comprehensive proficiency in sonographic imaging could require up to 100 hr of training (Brown et al., 2004). With current extensive curriculum requirements, this quantity of applied training in medical imaging is not appropriate within master's-level occupational therapy education. However, as a requirement for doctoral-level training is considered, providing foundational knowledge of imaging techniques and establishing basic skill in reading medical images will allow practitioners to remain relevant in the technologically progressing health care system. Additionally, this basic knowledge would benefit those students who wish to develop applied competency once they are in clinical practice.

Postprofessional training in sonographic imaging is increasingly available through hands-on training workshops developed specifically for nontraditional users. Although training workshops can establish technical proficiency, substantial practice beyond didactic training is essential in establishing the clinical competency necessary to ensure efficient, effective use of sonographic imaging. Clinical competency involves comprehensive understanding of mechanical operation of the equipment; continuous evaluation of image quality; and detailed analysis of images, along with the skill to differentiate normal from pathologic characteristics.

Occupational therapy practitioners who complete training and develop clinical competency can obtain a certification in musculoskeletal sonography; however, with an intended use to supplement routine clinical practices, the credentialing process may be excessive for most practitioners. Moreover, because components of clinical competency for occupational therapy practitioners have not been established, additional research is needed to more clearly determine clinical applications and competencies that may or may not be adequately addressed by this credentialing process.

Conclusion

As the profession and individual occupational therapy practitioners contemplate clinical implementation of medical imaging, we must move forward cautiously with a focus on the delivery of efficient, effective patient-centered care. Although use of most medical imaging modalities by occupational therapy practitioners is limited, sonographic imaging has numerous potential applications for enhancing rehabilitative care as part of an occupation-centered intervention plan. First, evidence places point-of-care sonographic imaging of musculoskeletal structures at the intersection of subjective reports, objective findings, and functional performance. This convergence has important implications for improving intervention efficacy through enhanced clinical reasoning and for advancing evidence that substantiates clinical interventions.

Second, sonography has exceptional potential to augment the biospsychosocial principles central to occupational therapy interventions. A growing body of evidence supports the use of integrative, mind–body interventions to reduce clients' length of stay in a clinical setting and speed recovery. Therefore, occupational therapy practitioners can use sonographic imaging for patient education and dynamic visual biofeedback during functional activity performance to actively engage patients and establish a mind–body connection.

Further examination of implementation strategies and development of occupation-centered imaging interventions, training models, and definitions of clinical competency are necessary to ensure that occupational therapy practitioners are adequately informed and prepared to use this technology in a manner consistent with the profession's occupational foundation while providing the efficient, effective care required by the medical system. Given careful consideration to the process, medical imaging has great potential for enhancing occupation-centered occupational therapy care. ▲

Acknowledgments

National Institutes of Health (NIH) Rehabilitation Research Career Development Program Grant K12 HD055929 funded Shawn Roll at the time this article was prepared. Its contents are solely the responsibility of the author and do not necessarily represent the official views of the NIH.

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