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Editorial

Enhancing Orthopedic Education: Integrating Brain-Dead Cadavers Post Organ Donation into Arthroscopy Training

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Editorial

The demand for medical services in the field of musculoskeletal disorders is predicted to grow significantly, with an estimated increase of 50% by the end of the next decade (1). This increasing trend necessitates a reassessment and adjustment of the educational processes involved in training orthopedic specialists. Developing surgical expertise is a multifaceted process that requires substantial time, continuous effort, and rigorous training. This career pathway begins with residency programs and continues with fellowship. After entering the medical field, surgeons must continually refine their clinical skills by participating in educational workshops, gaining hands-on experience in anatomical laboratories, and studying the latest scientific advancements and technical innovations, all of which are essential for achieving professional competence.

Knee and shoulder arthroscopy are among the most frequently performed procedures in orthopedic surgery. Importantly, they require a significant amount of skill and experience. The technical complexity, demand for precision, and the potential risks associated with these procedures make effective and efficient training methods essential (2).

Over the past decades, training modalities in arthroscopic surgery have evolved significantly. Traditional training, once centered on patient observation and hands-on practice, has increasingly given way to modern educational technologies due to limitations such as patient availability, safety concerns, cost, and ethical constraints (3). In response, virtual reality (VR) and augmented reality (AR) tools have emerged as valuable alternatives for surgical training. VR systems create interactive and highly realistic simulated settings that allow surgeons to practice and refine their skills in a completely controlled, risk-free environment. These settings closely mimic the visual and procedural aspects of actual surgeries (4, 5). In contrast, AR technologies present a novel approach to surgical training by combining digital content with the actual environment (6). However, the high cost of these technologies may limit their accessibility for certain educational purposes (5).

Despite the growing reliance on digital tools, the use of fresh cadaveric specimens remains a well-established and irreplaceable component of arthroscopic training. These specimens, obtained from organ donation centers, provide a highly realistic educational space, allowing surgeons to accurately simulate surgical settings and receive sensory feedback that closely replicates the in vivo experience (7). This level of realism is especially critical for arthroscopy, where high-level precision and tissue responsiveness are essential for safe and effective performance (8). Freshly frozen human specimens are regarded as the most accurate representation of surgical anatomy, providing a teaching environment that closely resembles real surgical conditions (7).

Compared to artificial models and VR simulators, which are limited by inadequate tactile feedback and simulated variability, cadaveric training offers irreplaceable experiential learning (9). No artificial substitute currently matches the educational fidelity of cadaver-based training (10), and we believe that neglecting this opportunity may lead to the loss of valuable educational experiences. Evidence of skill transfer from cadaveric practice to the operating room, including reduced complications and faster recovery times, further supports its integration into standard orthopedic curricula (11).

However, including this opportunity in the educational curriculum faces some challenges, both logistical and structural, that must be directly addressed to realize its full potential. One of the central obstacles is maintaining tissue quality, which is essential for realism in training. Although various preservation techniques exist, such as formalin fixation, Thiel embalming, saturated salt solution, cryo-dehydration, and plastination, each method carries trade-offs in terms of cost, complexity, tissue fidelity, and usability duration (12-15). These limitations impact not only the realism of the specimens but also the feasibility of integrating cadaveric training into routine educational programs. Beyond preservation concerns, additional barriers include high operational costs, limited access to suitable facilities, potential biohazard risks, and a lack of standardized protocols across institutions (16).

Even with these limitations, we maintain that the educational value of fresh cadaveric specimens far exceeds these obstacles. To address challenges related to access and ethical sourcing, we propose the use of brain-dead donors, after organ and tissue harvesting, as a practical and ethical source for fresh cadaveric training. These individuals, already prepared and transferred to surgical suites for transplantation procedures, offer a unique opportunity for immediate and respectful educational use following organ retrieval. This model minimizes ethical ambiguity, as consent for anatomical use can be transparently obtained from the legal next of kin during the transplant consent process. Furthermore, it reduces the need for long-term storage, extensive preservation techniques, and specimen transport, thereby simplifying logistics and improving specimen quality.

Pioneering this approach, we have successfully implemented the use of fresh cadaveric specimens from brain-dead donors, following organ retrieval, for diagnostic arthroscopy training at Sina Hospital, Tehran University of Medical Sciences, Tehran, Iran. To the best of our knowledge, this represents the first reported instance of integrating such specimens directly into a structured surgical education program. This approach has demonstrated both operational feasibility and ethical integrity, offering residents a highly realistic environment for skill acquisition while maintaining full respect for donor dignity. Moreover, this specific opportunity, which is available through transplant centers, shows promise for broader implementation in minimally invasive procedures not only within orthopedics but also across other surgical fields such as neurosurgery and general surgery, thereby amplifying its educational impact.

We believe that adopting this model would not only expand access to realistic training experiences but also promote a more integrated and respectful approach to donor body utilization. By maximizing the educational value of a single donor event, institutions can simultaneously uphold ethical standards and enhance orthopedic education. We urge medical schools and surgical training programs to collaborate with transplant centers to formalize protocols for this practice, ensuring that this underutilized resource contributes meaningfully to surgical education.

Considering the growing demands on orthopedic training and the limitations of current simulation technologies, integrating fresh cadaveric specimens, particularly from brain-dead donors post organ retrieval, offers a realistic and ethical path forward. This approach not only enhances technical skill acquisition but also honors the gift of anatomical donation through meaningful educational use. We call on academic institutions, policymakers, and surgical boards to recognize and support cadaveric training as an indispensable component of arthroscopic education. Embracing this model is not only an educational improvement but also a commitment to better-prepared surgeons and safer patient outcomes.

Conflict of Interest

The authors declare no conflict of interest in this study.

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