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CORR Insights®: Can Augmented Reality Be Helpful in Pelvic Bone Cancer Surgery? An In Vitro Study

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Where Are We Now?

Augmented reality (AR) systems, which add sensory information to the user's real-world environment, are good examples of novel technologies that can potentially transform surgical practice. These systems typically involve overlaying images onto the real world as seen through a screen or glasses, but can also include sound, haptic (touch) feedback, smell and taste, and combined with enhanced imaging techniques, could potentially indicate the location of tumor cells or infection [5].

Unlike virtual reality systems, AR systems are not completely immersive and allow continued interaction with the real world in an experience sometimes known as "mixed reality". As well as guiding surgeons in theatre, AR systems have the potential to enhance preoperative planning and training. The new worlds of "telepresence" and "telementoring", both supported by AR technologies, may become invaluable tools for teaching and training across wide geographical boundaries and may increase access to expert clinical opinion for patients worldwide [6].

It is possible that AR might be able to support surgeons in theatre with real-time information, access to clinical records, operative instructions, and advice from colleagues, but perhaps most notably, with three-dimensional (3-D) models of the patient's anatomy derived from preoperative scans projected into the visual field. These images can appear to be anchored in the real world, colocated with the patient's anatomy. They could therefore include information about the size and location of a tumor, navigation guidance or, in a recent example, the location of perforating vessels critical for fasciocutaneous flap development [7].

The current study by Cho and colleagues [1] describes a step towards the adoption of AR technology in one particularly challenging area of orthopaedic oncology surgery: The resection of pelvic tumors. Their study supplements some of those authors' previous research, which used their AR technology for tumors in the femur [2], where the surgeon's reality was augmented by a virtual ruler showing the position of the tumor in the diaphysis and in a previous in vitro study of a pelvic tumor model [3]. Pelvic anatomy is complex and variable and this is one area of clinical practice in which technological navigation assistance has a proven ability to help surgeons obtain negative surgical margins [4]. The authors argue [1] that traditional navigation systems are cumbersome and that their AR system is easier to use, although their systems are a long way from clinical adoption.

Where Do We Need To Go?

As medical technology continues to evolve, surgeons will likely be increasingly supported by tools such as AR, navigation technologies, robotics,

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and artificial intelligence that decrease variability and increase accuracy.

Although interesting, the current study represents an early in vitro proof-of-concept study and their group is far from developing a system ready for use in clinical practice. We still need more evidence on the accuracy, reliability, and safety of their system in the harsh environment of an operating theatre, where lighting, contamination with blood and tissue, and physical obstructions can interfere with optical tracking devices.

Indeed, before an AR system can be fully implemented, it must be thoroughly studied, and the evidence must demonstrate clear advantages over existing approaches to solving genuine clinical problems, some of which (for example, the humble ruler) are reassuringly simple. AR systems must also fit into existing workflows with minimal disruption, be easy to use, robust, and reliable in clinical practice. Further, we need an ongoing dialogue with busy clinicians about what they need or how they would incorporate AR systems into their practice.

Cost is also critical, and the authors of the current study are to be congratulated for adopting a readily available PC platform and open source software for this purpose. Still, we need to determine the cost-effectiveness of this technology; AR systems will have to survive in a competitive commercial environment, and will likely need substantial investment, industrial partnership, and a successful business model.

Additionally, Cho and colleagues' AR system is based on a 2-D screen, which needs to be in the surgeon's line of sight without contaminating the surgical field. Perhaps future studies can compare AR systems to head-mounted systems in a theatre environment [7].

How Do We Get There?

Successful implementation of new technologies requires expertise in the problems and limitations of surgical practice, a deep understanding of which new tools may help surgeons, close interaction between clinicians, scientists, and industry, an ethical framework that ensures the safe application of new technologies and protects the rights of individuals and their personal data, and a stepwise evidence-based approach to implementation. Therefore, if patients are to benefit from AR technologies, new studies are required that prove their benefit over existing techniques, for example, by demonstrating better resection margins and benefits for patients in terms of morbidity and physical functioning. However, they must also carefully evaluate the usability of these systems in clinical practice .

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