Cardiovasc Intervent Radiol
https://doi.org/10.1007/s00270-021-02801-9

COMMENTARY

Augmented Reality: Thrilling Future for Interventional Oncology?

Luigi A. Solbiati[1,2,3]

Received: 28 January 2021 / Accepted: 8 February 2021

In the interesting study presented in this issue of CVIR, Long et al. [1] compare the accuracy and the placement time needed by five interventional radiologists and a resident with different clinical experiences (3–25 years) to place biopsy needles on millimetric targets positioned in an anthropomorphic abdominal phantom at different depths using three different imaging guidance systems: cone beam CT (CBCT)-guided fluoroscopy, smartphone- and smart glass-based augmented reality (AR) navigation platforms. Placement errors were extremely small and almost identical for all three modalities (4–5 mm), and placement time was significantly shorter for smartphone and smart glasses (38% and 55%, respectively) than for CBCT. Additionally, the results were achieved without any intraprocedural radiation for AR, compared to a significant amount of radiation that comes with CBCT-guided fluoroscopy.

AR systems used for guiding interventional procedures are simple technologies based on sensors with no repetitive pattern affixed to phantoms (or patients) and interventional devices (needles, ablation devices, etc.,) and personal computers with software which enables visualizing and segmenting virtual objects (targets in phantoms or patients). They automatically register and superimpose virtual and real images (phantoms or patients) in real-time, define the trajectory line to the target center, depict guided movements of the interventional devices without a need for additional imaging, and show the whole procedure on a display [2].

After initial studies for assisting percutaneous biopsies presented in the late 90s and numerous studies on phantoms mostly aiming at the assessment of registration accuracy, AR has been in clinical use for some years in neurosurgery, vascular, and abdominal surgery to assist localization of anatomic structures and pathologies, but only recently it has been applied as only direct guidance modality for percutaneous ablations [3, 4].

As pointed out by Long et al., in comparison with other guidance modalities, AR is significantly less expensive, it offers the ergonomic advantage that the overlay of treatment information (anatomy, target, trajectory line, etc.) is shown directly in the procedural environment and not away from the patient on a monitor, as occurs with CT- or CBCT-guided fluoroscopy. Furthermore, it shortens the learning curve (15 min in this study) and markedly reduces the variability in performance among users with different levels of experience. In our ongoing study on real patients, these data are absolutely confirmed, with young operators with limited experience performing equally or even better than senior operators with long experience.

In addition, AR technology is still improving and keep providing further advantages. Use of commercially available smart glasses with video camera mounted on them dramatically reduces, or makes completely disappear, the need for user-dependent calibrations and adjustments, as well as "cybersickness" reported in previous papers. The field of view is progressively getting wider, and the weight of smart glasses is decreasing, making them optimal for

✉ Luigi A. Solbiati
lusolbia@gmail.com

1 Department of Radiology, Humanitas Clinical and Research Center, IRCCS Humanitas Research Hospital, Rozzano, Milano, Italy

2 Department of Biomedical Sciences, Humanitas University, Pieve Emanuele, Milano, Italy

3 Present Address: Via Carlo Cattaneo, 5, Busto Arsizio, VA, Italy

Published online: 11 March 2021

long interventions, too. The images seen by the operator can be seen on monitors inside and outside the interventional room, which is a significant opportunity for education [5]. However, even though smartphones keep improving (e.g., 5G functionality), the main advantage of smart glasses is the 3D visualization, which smartphones and tablets cannot top with their 2D visualization.

In comparison with fluoroscopic guidance, the major problem of AR-guided interventional procedures is needle bending during the insertion, and control of patient's breathing when moving and deformable organs are being targeted. Given that AR sensors can monitor the spatial position of the needle's handle, but not that of the real needle (unless expensive microsensors are applied to the needle cannula), the needle bending can be (partially) avoided using introductors or fixing devices and/or through implementation of the algorithms. Regarding organ movements, respiratory motion tracking and monitoring of respiration during deep sedation or general anesthesia seem to offer the best solutions to date.

In conclusion, AR as the newborn guidance modality for interventional procedures has a potential to become the revolution of the interaction between imaging information and clinical practice, particularly suitable for young, "technologically advanced" operators who would fast learn to optimally use it to successfully perform even complicated procedures.

Declarations

Conflict of interest The author declare that he has no conflicts of interest.

Consent for Publication For this type of study, consent for publication is not required.

References

1. Long DJ, Li M, De Ruiter QMB, et al. Comparison of smartphone augmented reality, smartglasses augmented reality, and 3D CBCT-guided fluoroscopy navigation for percutaneous needle insertion: a phantom study. Cardiovasc Interv Radiol. 2020. https://doi.org/10.1007/s00270-020-02760-7.
2. Solbiati M, Passera KM, Rotilio A, et al. Augmented reality for interventional oncology: proof-of-concept study of a novel high-end guidance system platform. Eur Radiol Exp. 2018;2:18. https://doi.org/10.1186/s41747-018-0054-5.
3. Gadodia G, Yanof J, West K, et al. True three-dimensional holographic visualization for performance of percutaneous thermal ablation of solid liver tumors: an update on in-human evaluation. J Vasc Interv Radiol. 2020;31:S135-6. https://doi.org/10.1016/j.jvir2019.12.348.
4. Solbiati L, Gennaro N, Muglia R. Augmented reality: from video games to medical clinical practice. Cardiovasc Interv Radiol. 2020;43:1427–9. https://doi.org/10.1007/s00270-020-02575-6.
5. Uppot RN, Laguna B, McCarthy CJ, et al. Implementing virtual and augmented reality tools for radiology education and training, communication, and clinical care. Radiology. 2019;291(3):570–80. https://doi.org/10.1148/radiol.2019182210.