Microsoft HoloLens

A review aimed to provide an update on the role of augmented reality (AR) in surgical training and investigate whether the use of AR improves performance measures compared to traditional approaches in surgical trainees.

PUBMED, EMBASE, Google Scholar, Cochrane Library, British Library and Science Direct were searched following PRIMSA guidelines. All English language original studies pertaining to AR in surgical training were eligible for inclusion. Qualitative analysis was performed and results were categorised according to simulator models, subsequently being evaluated using Messick's framework for validity and McGaghie's translational outcomes for simulation-based learning.

Of the 1132 results retrieved, 45 were included in the study. 29 platforms were identified, with the highest 'level of effectiveness' recorded as 3. In terms of validity parameters, 10 AR models received a strong 'content validity' score of 2.15 models had a 'response processes' score ≥ 1. 'Internal structure' and 'consequences' were largely not discussed. 'Relations to other variables' was the best assessed criterion, with 9 platforms achieving a high score of 2. Overall, the Microsoft HoloLens received the highest level of recommendation for both validity and level of effectiveness.

Augmented reality in surgical education is feasible and effective as an adjunct to traditional training. The Microsoft HoloLens has shown the most promising results across all parameters and produced improved performance measures in surgical trainees. In terms of the other simulator models, further research is required with stronger study designs, in order to validate the use of AR in surgical training [1)].

In minimally invasive spring-assisted craniectomy, surgeons plan the surgery by manually locating the cranial sutures. However, this approach is prone to error. Augmented reality (AR) could be used to visualize the cranial sutures and assist in the surgery planning. The purpose of our work is to develop an AR-based system to visualize cranial sutures and to assess the accuracy and usability of using AR-based navigation for surgical guidance in minimally invasive spring-assisted craniectomy.

An AR system was developed that consists of an electromagnetic tracking system linked with a Microsoft HoloLens. The system was used to conduct a study with two skull phantoms. For each phantom, five sutures were annotated and visualized on the skull surface. Twelve participants assessed the system. For each participant, model alignment using six anatomical landmarks was performed, followed by the participant delineation of the visualized sutures. In the end, the participants filled out a system usability scale (SUS) questionnaire. For evaluation, an independent optical tracking system was used and the delineated sutures were digitized and compared to the CT-annotated sutures.

For a total of 120 delineated sutures, the distance of the annotated sutures to the planning reference was [Formula: see text] mm. The average delineation time per suture was [Formula: see text] s. For the system usability questionnaire, an average SUS score of 73 was obtained.

CThe developed AR system has good accuracy (average 2.4 mm distance) and could be used in the OR. The system can assist in the pre-planning of minimally invasive craniosynostosis surgeries to locate cranial sutures accurately instead of the traditional approach of manual palpation. Although the conducted phantom study was designed to closely reflect the clinical setup in the OR, further clinical

validation of the developed system is needed and will be addressed in a future work [2)].

A total number of 12 lumbar arthrodesis have been performed while using the described AR technology, with application spanning from telementoring (3), teaching (2), surgical planning superimposition and interaction with the hologram using a custom application for Microsoft hololens (1). Surgeons wearing the AR goggles reported a positive feedback as for the ergonomy, wearability and comfort during the procedure; being able to visualize a 3D reconstruction during surgery was perceived as a straightforward benefit, allowing to speed-up procedures, thus limiting post-operational complications. The possibility of remotely interacting with a specialist on the glasses was a potent added value during COVID emergency, due to limited access of non-resident personnel in the OR. Interpretation: By allowing surgeons to overlay digital medical content on actual surroundings, augmented reality surgery can be exploited easily in multiple scenarios by adapting commercially available or custom-made apps to several use cases. The possibility to observe directly the operatory theater through the eyes of the surgeon might be a game-changer, giving the chance to unexperienced surgeons to be virtually at the site of the operation, or allowing a remote experienced operator to guide wisely the unexperienced surgeon during a procedure [3)].

The implementation of augmented reality (AR) in image-guided surgery (IGS) can improve surgical interventions by presenting the image data directly on the patient at the correct position and in the actual orientation. This approach can resolve the switching focus problem, which occurs in conventional IGS systems when the surgeon has to look away from the operation field to consult the image data on a 2-dimensional screen. The Microsoft HoloLens, a head-mounted AR display, was combined with an optical navigation system to create an AR-based IGS system. Experiments were performed on a phantom model to determine the accuracy of the complete system and to evaluate the effect of adding AR. The results demonstrated a mean Euclidean distance of 2.3 mm with a maximum error of 3.5 mm for the complete system. Adding AR visualization to a conventional system increased the mean error by 1.6 mm. The introduction of AR in IGS was promising. The presented system provided a solution for the switching focus problem and created a more intuitive guidance system. With a further reduction in the error and more research to optimize the visualization, many surgical applications could benefit from the advantages of AR guidance. [4)].

1)
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