



Mixed Reality Improves 3D Visualization And Spatial Awareness Of Bone Tumors In Orthopaedic Oncology

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Abstract

1 Introduction

In orthopaedic oncology, computer navigation and 3D-printed guides facilitate precise osteotomies only after surgical exposure[1,2]. Mixed Reality is an immersive technology that merges real and virtual worlds, and users can interact with digital objects[3]. Through Head-Mounted Displays, surgeons directly visualize holographic models that overlay tumor patients in their physical environment before surgeries start. Clinical reports of MR applications are limited, and there is no data in orthopaedic oncology.

2 Methods

Between July 2021 and January 2024, we retrospectively reviewed 24 bone tumor patients undergoing surgeries. A holographic application was created using patients' 2D medical images. In the conventional 2D method (Figure 1A), the surgeon studied 2D images and mentally overlaid the virtual 3D models onto the patients' bodies. In the MR method (Figure 1B), the surgeons directly visualized 3D holograms on the patients' bodies via HMD. Both methods were used to clinically assess the same patient. The surgeon completed 1) a Likert-Scale (LS) questionnaire to assess his opinions on the spatial awareness of the bone structures and the effectiveness of surgical planning and 2) The National Aeronautics and Space Administration-Task Load Index (NASA-TLX) score to evaluate the surgeons'

cognitive workload. The results of the two methods were compared using the Wilcoxon Signed Rank Test.

3 Results

The Likert-scale questionnaire revealed that the 3D holograms in the MR technology group were more effective than the Conventional 2D group. For the cognitive workload for preoperative clinical assessment, the MR technology group received significantly lower “mental”, “performance” and “frustration” scores; however, they received significantly higher “physical demand” and “effort” ratings than the Conventional group. There were two local tumor recurrences after surgeries.

4 Discussion and Conclusion

MR technology improved 3D visualization and spatial awareness of bone tumors in patients’ anatomies and may facilitate surgical planning before skin incisions in orthopaedic oncology surgery. The results concurred with the first case series of MR applications during orthopaedic surgery [4]. With less cognitive load and better ergonomics, surgeons can stay focused on the patients and surgical tasks while keeping their hands free and sterile to manipulate virtual objects [5]. Further studies can investigate whether MR technology guides and replicates surgical plans.

5 References

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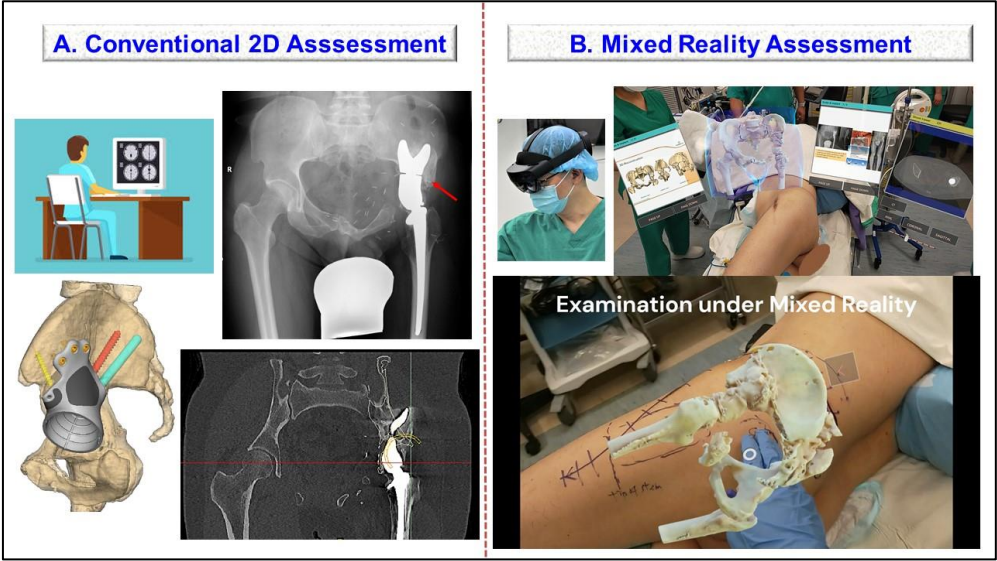


Figure 1 shows the Conventional 2D method (A) and the Mixed Reality method (B) in surgical planning before skin incision in orthopaedic oncology surgery