Heads-Up-Display (HUD) Accuracy in the Retrosigmoid Neurosurgical Approach: A Single Center Experience

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Abstract

Objective: Our study aims to analyze the usage and accuracy of HUD in the retrosigmoid craniotomy, a standard workhorse neurosurgical approach with a wide range of applications

Introduction

Heads-up-display (HUD) projects a visual overlay of navigation information into the microscope view in real time, without the operator needing to avert their attention to a separate screen and disrupt the surgical workflow. It can be valuable during multiple stages of the procedure, from guiding head positioning to highlighting critical structures during tumor resection. Its accuracy has yet to be demonstrated in the literature.

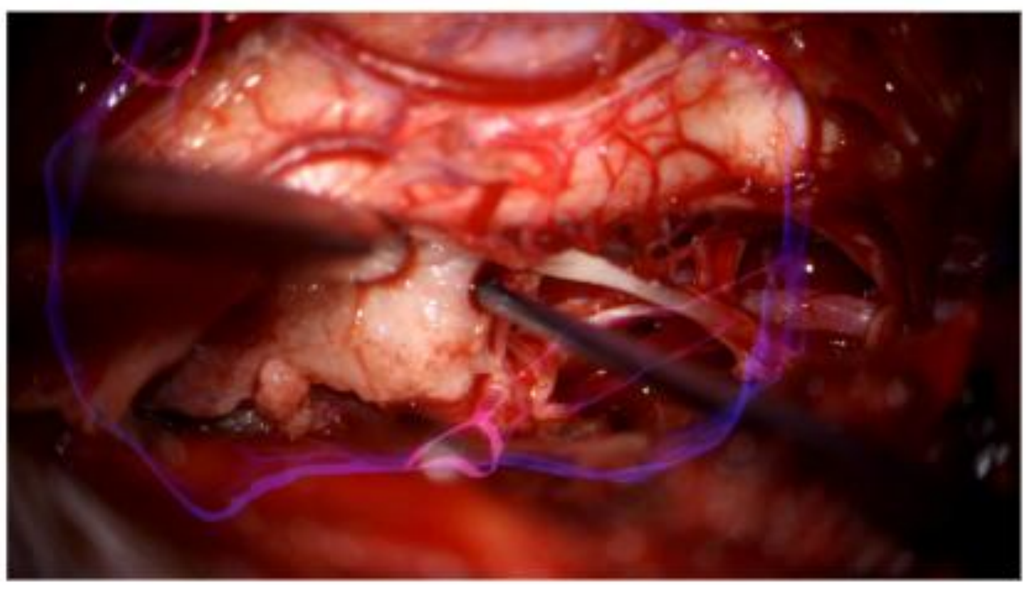

Image 1 Intraoperative snapshot of right side far lateral approach to a large foramen magnum. The purple outline indicates the tumor at the microscope focal depth, and the bright pink indicates the vertebral artery. There is a high degree of accuracy correlating well with the intraoperative anatomy. The HUD was helpful in early identification of the course of the vertebral artery and protecting its integrity throughout the resection.

Methods and Materials

This retrospective review included all consecutive cases of retrosigmoid craniotomy with HUD usage under a single attending from January 2023 to June 2024. Demographic characteristics, preoperative diagnosis, imaging characteristics, and surgical approaches were collected from the electronic medical records. Intraoperative images and videos, and preoperative MRIs were analyzed to determine the degree of mismatch between the HUD and anatomic structures. The anatomical structures were divided into superficial (transverse and sigmoid sinuses) and deep (lesion, nerves, and vessels) for sub analyses. Whether or not navigation was updated intraoperatively, and if done prior or post tumor exposure were noted.

Results

From January 2023 to June 2024, twenty surgeries were performed via the retrosigmoid approach and utilized intraoperative HUD. Nine were for vestibular schwannoma resection, seven for meningioma, two for microvascular decompression, one for hemangioblastoma, and one for a pontine cavernous malformation. On average, 2.55 structures were segmented for the HUD, and included transverse and/or sigmoid sinuses (19), lesions (18), arteries (9), and cranial nerves (5). The superficial structures had a mean mismatch of 6.69 mm +/- 5.01 in the superior-inferior axis, and 6.745 mm +/- 6.73 in the medial-lateral axis. Only seven cases did not undergo navigation update prior to exposure of the deep structures, and for those cases the deep structures had a mean deviation of 5.63 mm +/- 4.63 in the superior-inferior axis, and 3 mm +/- 1.53 in the medial-lateral axis. Ten patients were noted to have had navigation updated intraop, and eight were updated prior to tumor exposure.

Pathology types	# of Cases
Vestibular Schwannoma	9
Meningioma	7
Microvascular Decompression	2
Hemangioblastoma	1
Brainstem cavernous malformation	1

Image 2 The HUD was used in guiding skin incision for a right side retrosigmoid approach. The blue outline identified the transverse and sigmoid sinuses. The craniectomy was made directly below the transverse sinus and posterior to the sigmoid sinus. Similar view was used to guide the dural opening as well.

Conclusion

HUD's accuracy is integral to its precision and efficiency as an augmented reality form of intraoperative navigation in complex skull base surgeries. Further analyses on larger case series with more diversity in object segmented, surgical approach, lesions location, and depth of view are needed to explore the various factors that can impact its accuracy.

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References

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