Stereoscopic (3-D) Reporting in Neurosurgical Research and Education

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Introduction

It has been previously established that three-dimensional (3-D) imaging is superior to two-dimensional (2-D) imaging in improving anatomic orientation and structural differentiation. The objective of this report is to describe the setup of different 3-D recording modalities (macroscopic, endoscopic and microsurgical) used in our laboratory and operating room. The report also aims to highlight the utility of 3-D images in providing depth perception and discernment of structures in comparison to 2-D images and to discuss the potential of utilization of 3-D resources in neurosurgical research and didactics.

Methods

The technical details for equipment and laboratory set up for obtaining 3-D images were described. 3-D images were obtained by first capturing the stereo pair of images using a modified 'shoot-shift-shoot' method, and then converging them to a final 3-D form. The integrated 3-D video camera coupled to the surgical microscope was used to acquire images and videos for microsurgical procedures, both in the laboratory and operation room. Side-by-side comparison of 2-D vs. 3-D images was provided using illustrative cases.

Results

3-D imaging was found to be superior to 2-D imaging in providing depth perception and structure identification for all three modalities described, as evidenced by the side-by-side comparison of images provided. Moreover, we provided the first report of the methodology for using the 2-D endoscope to obtain 3-D endoscopic endonasal images.

Conclusions

3-D imaging, by virtue of providing immediate depth perception, allows efficient understanding of key spatial relationships, making it an invaluable tool in neurosurgical research and education. Integration of 3-D resources in neurosurgical residency programs may shorten learning curves and increase surgical efficiency, potentially leading to improved outcomes. However, it should not replace direct hands-on practice.

Learning Objectives

By the conclusion of this session, participants should be able to:

(1) Conceive the importance of the potential impact of stereoscopic (3-D) resources in neurosurgical education

(2) Understand specific technical proceedings for 3-D photography using macroscopic cameras and endoscopes as well as integrated microscopic systems

(3) Acquire the necessary knowledge to engage in the development of 3-D resources and materials to optimize neurosurgical learning

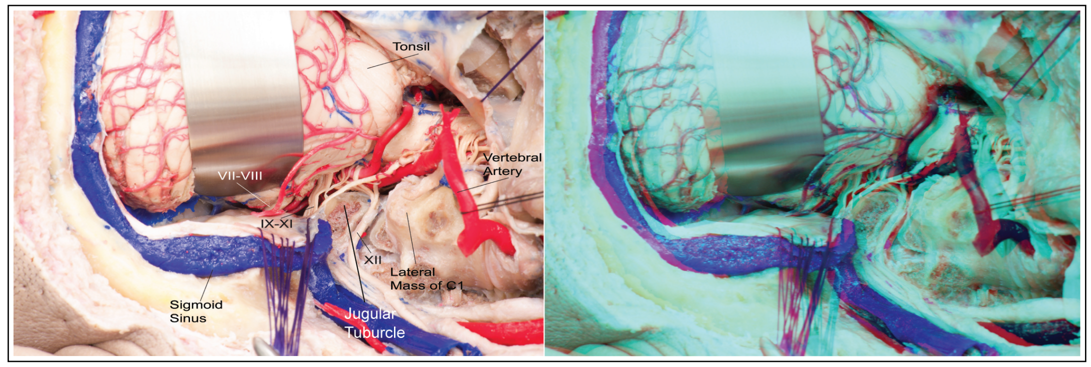

Figure 1. Macroscopic dissection using the retrosigmoid approach. The cerebellar tonsils, the sigmoid sinus, the vertebral artery (VA) and cranial nerves VII- XII were exposed using a retrosigmoid approach. The left panel depicts the 2-D image while the right panel depicts its 3-D counterpart. In the 2 -D image the vertebral artery appears to be resting on the lateral mass of the C1 vertebra. However, in the 3-D image, the relative distance between the two structures is distinctly emphasized. Moreover, the spatial orientation of the different cranial nerves (VII-XII) in relation to each other is better appreciated in 3-D image.

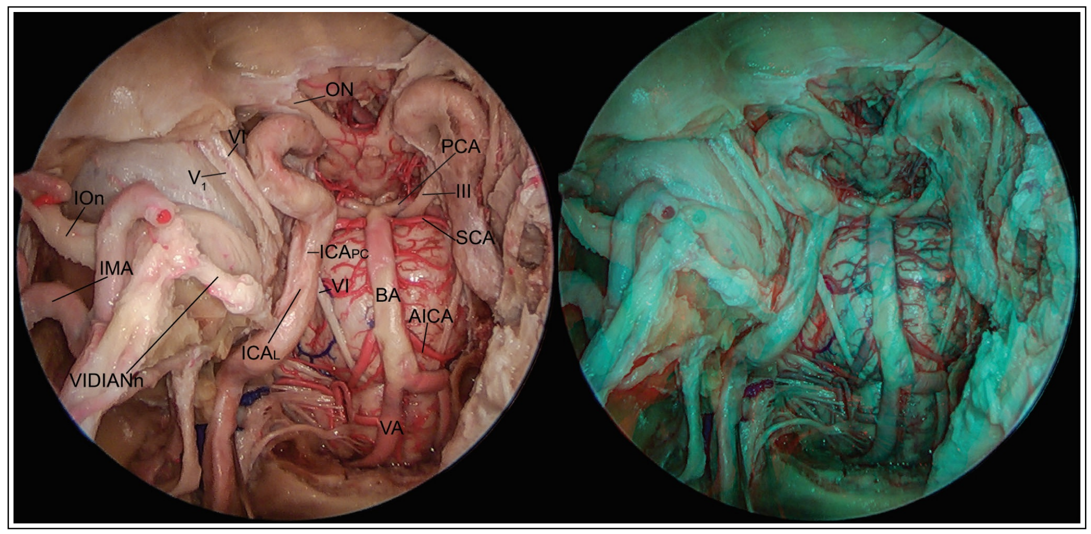

Figure 2. Endoscopic endonasal dissection using the transclival approach. The 2-D images are depicted on the left with their 3-D counterparts on the right. The different levels and depths at which the branches of basilar artery originate, e.g. the SCA, PCA and AICA are clearly appreciated in the 3D image as compared to the 2D image. The 3-D image highlights the spatial relationship between the abducens nerve (CN VI) and the AICA showing that CN VI traverses under the AICA near its origin at the pontomedullary sulcus.