



OPEN ACCESS

Feasibility and workflow analysis of IV-DSA-based augmented reality-guided brain arteriovenous malformation resection in a hybrid operating room: i-Flow tailored method

Chih-Wei Huang,¹ Chung-Hsin Lee,¹ Kai-Chen Chung,¹ Yuang-Seng Tsuei ^{1,2}

► Additional supplemental material is published online only. To view, please visit the journal online (<http://dx.doi.org/10.1136/jnis-2023-020797>).

¹Neurosurgery, Taichung Veterans General Hospital, Taichung, Taiwan

²Department of Post-Baccalaureate Medicine, College of Medicine, National Chung Hsing University, Taichung, Taiwan

Correspondence to

Dr Yuang-Seng Tsuei, Neurosurgery, Taichung Veterans General Hospital, Taichung, Taiwan; astrocytoma2001@yahoo.com.tw

Received 25 July 2023

Accepted 18 August 2023



© Author(s) (or their employer(s)) 2023. Re-use permitted under CC BY-NC. No commercial re-use. See rights and permissions. Published by BMJ.

To cite: Huang C-W, Lee C-H, Chung K-C, *et al.* *J NeuroIntervent Surg* Epub ahead of print: [please include Day Month Year]. doi:10.1136/jnis-2023-020797

ABSTRACT

Augmented reality (AR) has emerged as a promising technology in various medical fields.^{1 2} In the context of brain arteriovenous malformation (bAVM) surgery, AR offers the potential to enhance surgical visualization and improve procedural accuracy.^{3 4 5 6} This report aims to explore the application of digital subtraction angiography (DSA) from an IV contrast injection (IV-DSA) in AR-guided resection of bAVMs in a neurosurgical hybrid operating room.

The workflow of IV-DSA-based AR-guided surgery for the resection of bAVMs consists of four main components: (1) acquiring source images through i-Flow tailored or multiphase scans (Siemens, Germany); (2) labelling targets in the workstation using Smartbrush software (Brainlab, Westchester, Illinois, USA); (3) using the Brainlab Curve navigation system; and (4) merging microscopic AR fusion using Zeiss Kinevo (AG, Germany). In [video 1](#) we show the entire workflow and introduce i-Flow tailored IV-DSA data acquisition in the hybrid operating room. In summary, IV-DSA-based augmented reality is an innovative technique for bAVM surgery.



Video 1 -i-flow tailored iv-DSA

Contributors Data acquisition: CH-L, KC-C. Drafting: CW-H. Design and final approval: YS-T.

Funding The authors have not declared a specific grant for this research from any funding agency in the public, commercial or not-for-profit sectors.

Competing interests None declared.

Patient consent for publication Not applicable.

Ethics approval This study involves human participants and was approved by the Institutional Review Board (IRB) of Taichung Veterans General Hospital (TCVGH) ID: CE17084A. Participants gave informed consent to participate in the study before taking part.

Provenance and peer review Not commissioned; externally peer reviewed.

Open access This is an open access article distributed in accordance with the Creative Commons Attribution Non Commercial (CC BY-NC 4.0) license, which permits others to distribute, remix, adapt, build upon this work non-commercially, and license their derivative works on different terms, provided the original work is properly cited, appropriate credit is given, any changes made indicated, and the use is non-commercial. See: <http://creativecommons.org/licenses/by-nc/4.0/>.

ORCID iD

Yuang-Seng Tsuei <http://orcid.org/0000-0002-8495-5458>

REFERENCES

- 1 Contreras López WO, Navarro PA, Crispin S. Intraoperative clinical application of augmented reality in neurosurgery: a systematic review. *Clin Neurol Neurosurg* 2019;177:6–11.
- 2 Mofatteh M, Mashayekhi MS, Arfaie S, *et al.* Augmented and virtual reality usage in awake craniotomy: a systematic review. *Neurosurg Rev* 2022;46:19.
- 3 Ozaydin B, Dawkins DW, Armstrong SA, *et al.* Intraoperative application of a new-generation 3D IV-DSA technology in resection of a hemorrhagic cerebellar AVM. *Neurosurg Focus Video* 2021;4.
- 4 Thorsteinsdottir J, Sandner T, Biczok A, *et al.* Detection of impending perfusion deficits by intraoperative computed tomography (iCT) in aneurysm surgery of the anterior circulation. *Acta Neurochir (Wien)* 2021;163:3501–14.
- 5 Hashimoto H, Iida J, Hironaka Y, *et al.* Surgical management of cerebral arteriovenous malformations with intraoperative digital subtraction angiography. *J Clin Neurosci* 2000;7 (Suppl 1):33–5.
- 6 Grüter BE, Mendelowitsch I, Diepers M, *et al.* Combined endovascular and microsurgical treatment of arteriovenous malformations in the hybrid operating room. *World Neurosurg* 2018;117:e204–14.