Seeing What We Might Miss: AI-Assisted Inline Detection of Intracranial Aneurysms on TOF-MRA

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Introduction

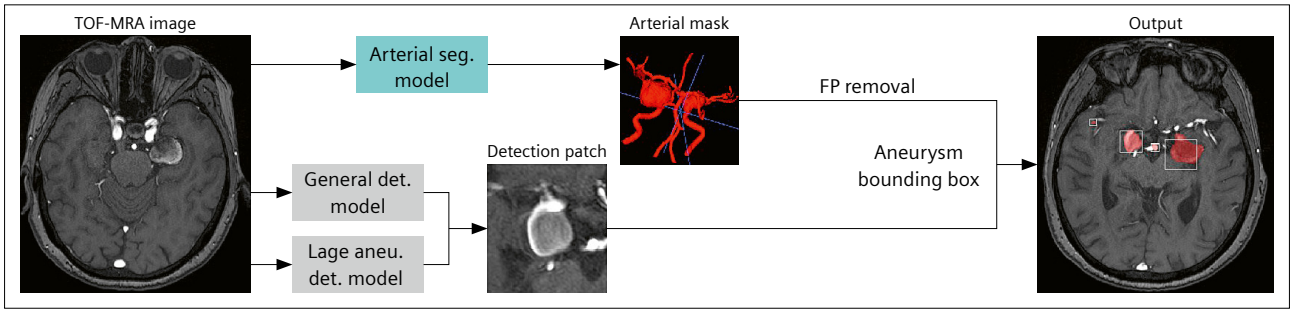
In our daily practice, time-of-flight magnetic resonance angiography (TOF-MRA) has become one of the most commonly used non-contrast techniques for cerebrovascular screening. It is fast, widely available, and well accepted by patients, especially in routine health examinations and follow-up of suspected vascular disease. Yet every radiologist knows the challenge: Small intracranial aneurysms may be subtle, may arise at complex arterial bifurcations, and may be overlooked when the reading workload is high or image quality varies. Because a missed aneurysm can have serious clinical consequences, we continuously look for tools that can help us read more consistently and with greater confidence.

From clinical need to AI support

To address this clinical need, Siemens Healthineers developed a deep learning solution for automated intracranial aneurysm detection and segmentation on 3D TOF-MRA.[1] The prototype of the aneurysm detection tool[1] is implemented as an add-in attached to the TOF sequence. Once the TOF scan is completed, the add-in automatically launches image analysis to identify potential aneurysms, eliminating the need for a separate post-processing step and making the workflow highly convenient.

From a physician's point of view, the goal is not to replace expert interpretation, but to provide a second set of eyes directly within the imaging workflow. For screening examinations, where sensitivity is particularly important, this kind of inline support could be valuable if it performs reliably across scanners, sites, and patient populations.

[1] *Work in progress. The application is currently under development and is not for sale in the U.S. and in other countries. Its future availability cannot be ensured.*

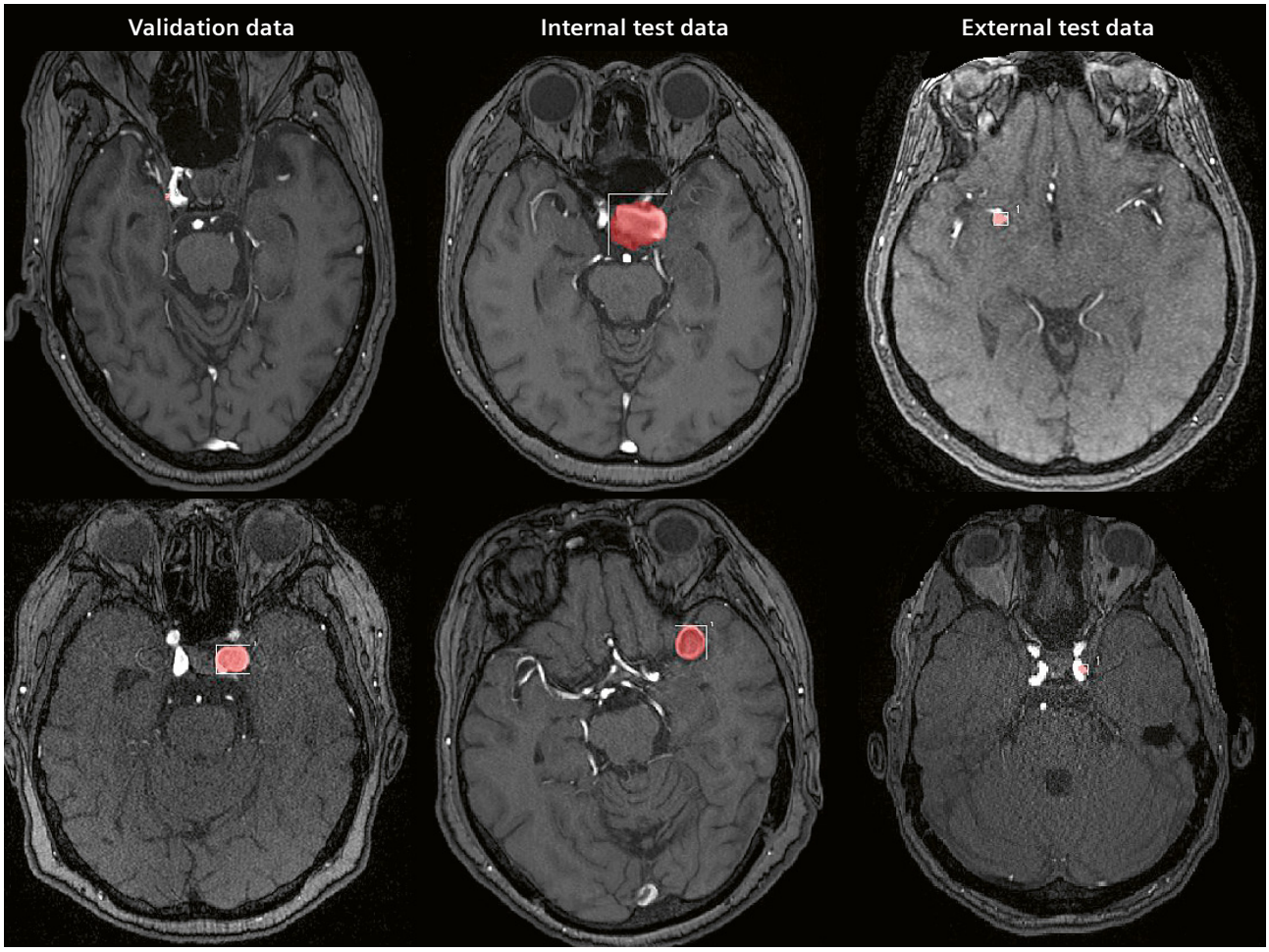


1 A novel 3D deep learning framework with brain vessel constraints [1]. The pipeline consists of three major stages: (1) brain vessel segmentation, (2) aneurysm detection, and (3) false-positive (FP) suppression using vessel priors.

How the model was developed and evaluated

The aneurysm detection model (Fig. 1) was trained using 1,916 3D TOF-MRA scans from patients with at least one unruptured intracranial aneurysm confirmed by experienced radiologists. The development dataset combined images from three clinical sites and public datasets, including ADAM, INSTED2024, and Lausanne, and was divided into training and internal validation sets. All annotations were performed by radiologists with more than five years of TOF-MRA interpretation experience and blinded to patient information. In addition, an internal test cohort from Changhai Hospital included 39 examinations with intracranial aneurysms and 232 examinations without aneurysms, and an external test cohort from RSNA included 555 examinations with intracranial aneurysms and 697 examinations without aneurysms, allowing evaluation in a clinically relevant population with both positive and negative cases.

For us as clinicians, the key question is whether the algorithm can maintain high sensitivity while keeping false positives at a manageable level. In the validation dataset, the model achieved a sensitivity of 96% at two false positives per scan. In the internal test set from Changhai Hospital, it maintained a sensitivity of 95% at two false positives per scan. On the external dataset, the positive predictive value reached 90%, an encouraging result given the screening-oriented setting and the expected challenge of false-positive findings in populations with relatively low disease prevalence. Representative results of aneurysm detection from the validation, internal test, and external test sets are shown in Figure 2. More detailed results can be found in the published ISMRM abstract [1].



2 Example results of aneurysm detection from the algorithm on validation dataset, internal test dataset, and external test dataset [1]. All six cases are confirmed intracranial aneurysm patients, and the algorithm successfully identified the aneurysmal lesions (marked in red) in each case.

Clinical relevance in routine reading

In a busy reading room, an AI-based aneurysm detection tool may be most helpful when it is integrated seamlessly into the routine TOF-MRA workflow. By highlighting suspicious aneurysm candidates and providing segmentation information, it can draw attention to small or difficult-to-see lesions before the final report is signed. This may be particularly useful for screening examinations, follow-up studies, and cases with complex vascular anatomy. The current results suggest that the prototype has the potential to support radiologists by improving vigilance, reducing oversights, and helping to standardize detection performance across different clinical settings.

Outlook

The next step will be prospective evaluation in real-world clinical workflows. Beyond algorithm performance metrics, future studies should assess reading efficiency, radiologist confidence, case-level decision making, and the practical handling of false-positive findings. For AI to become truly useful in neuroradiology, it must fit naturally into the clinical pathway and provide clear value at the point of care. From this perspective, automated aneurysm detection on TOF-MRA is a promising example of how deep learning can move from technical innovation toward meaningful clinical assistance.

Reference

1 Hou Y, Fu C, Pan H, Lan N, Li H, Zhang T, et al., Deep Learning for Detection of Intracranial Aneurysms on TOF-MRA: A Multi-Center Study with External Validation. Poster session presented at: ISMRM & ISMRT Annual Meeting; 2026 May 9–14; Cape Town, South Africa. Abstract 352-02-016.

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