

Prvá AI asistovaná operácia nádoru mozgu v strednej Európe

Andrej Šteňo

Neurochirurgická klinika LF UK a UNB, Nemocnica Ak. L. Dérera, Bratislava - Kramáre



ITAPA Health & Care 2026

18. - 19. marec 2026

Hotel Družba Jasná

Vyhlásenie o konflikte záujmov autora

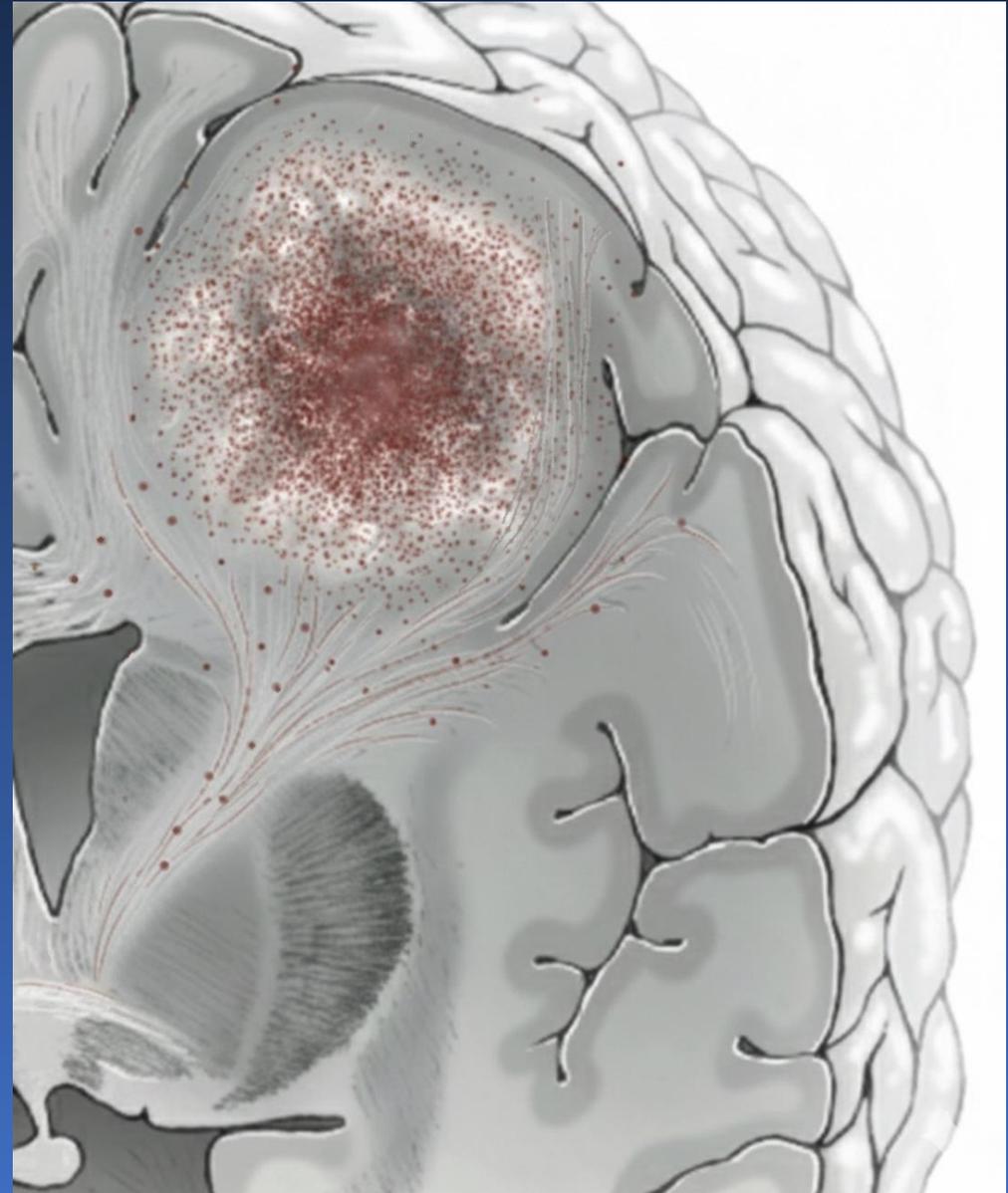
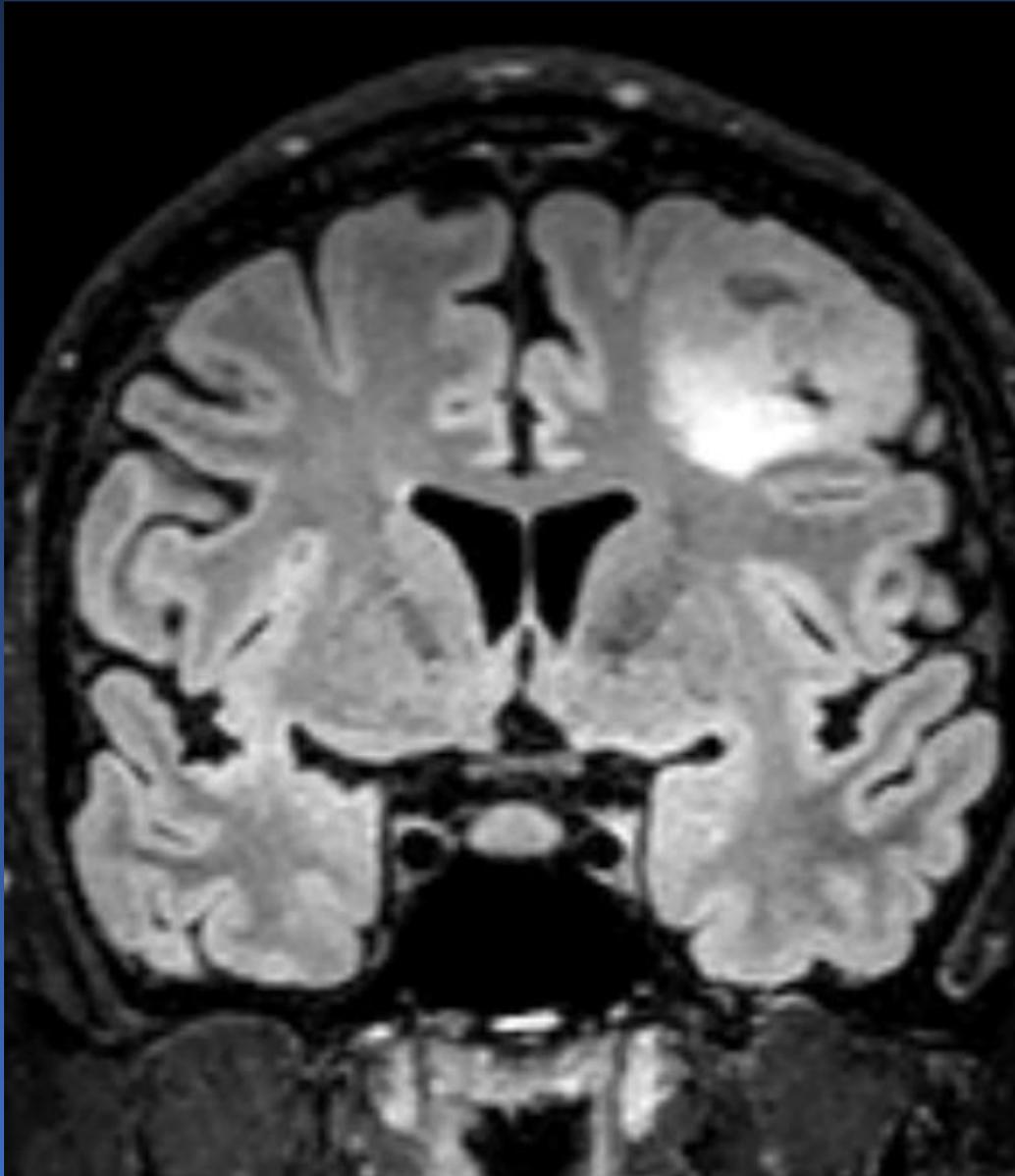
Forma finančného prepojenia	Spoločnosť
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Nepeňažné plnenie (v zmysle zákona)	
Prednášajúci	
Akcionár	
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Ostatné príjmy (špecifikovať)	

Podľa UEMS (upravené v zmysle slovenskej legislatívy)

Difúzne gliómy mozgu

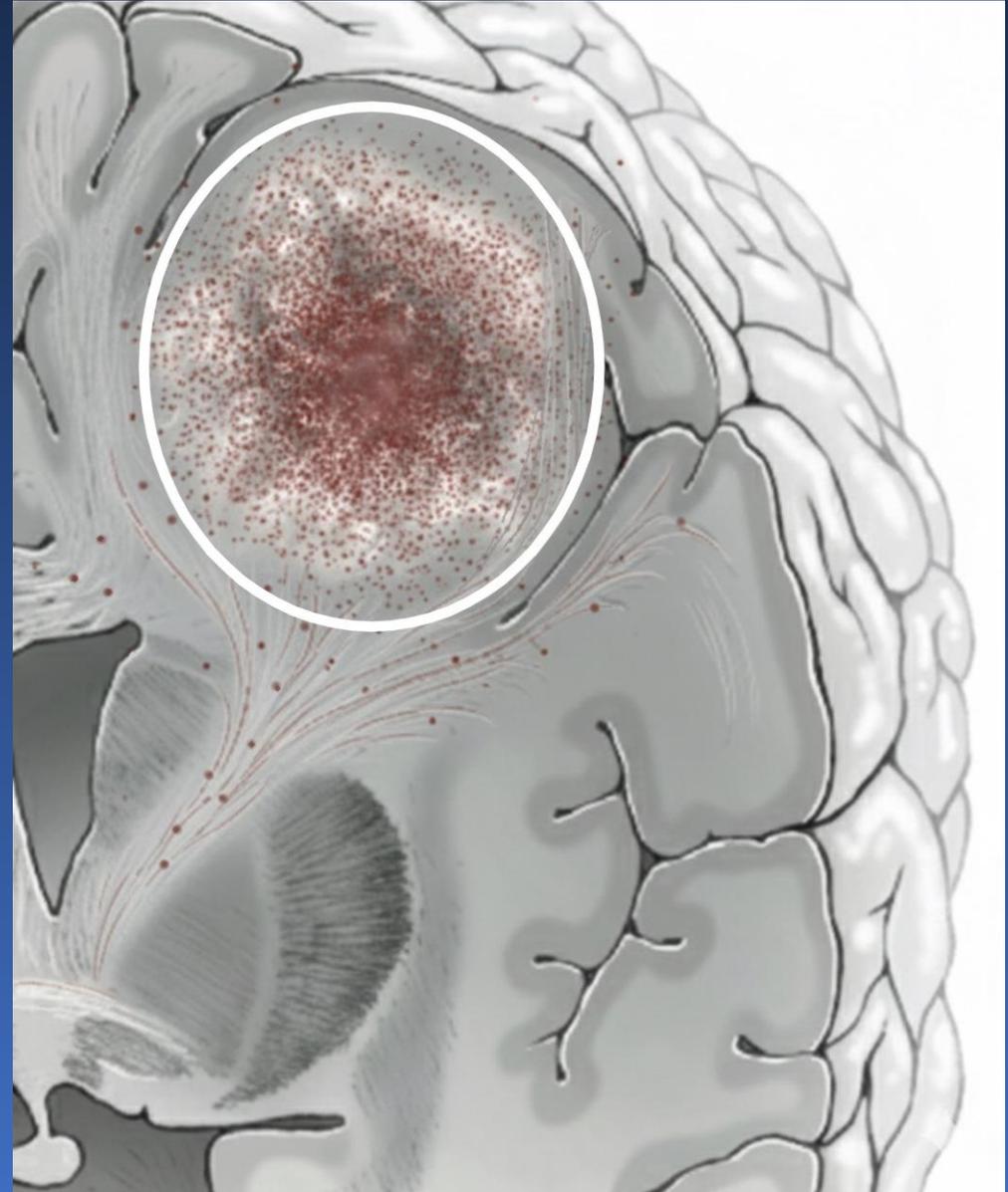
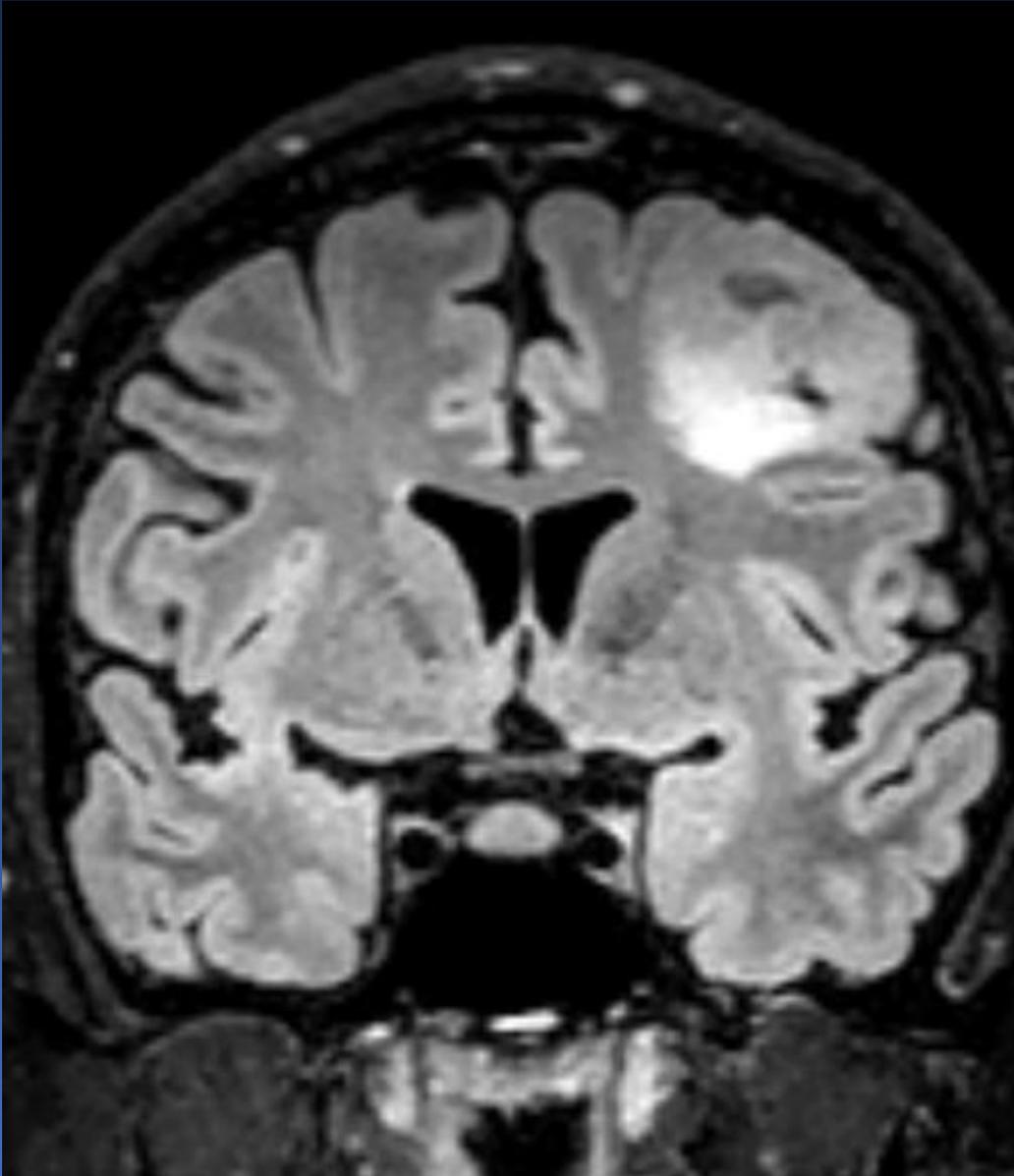
- Najčastejšie primárne nádory mozgu dospelých
- Najnižší stupeň zhubnosti je WHO st. 2 (malígne od začiatku)
- Vždy smrteľné
- Závažný socio-ekonomický problém

Problém 1 – infiltratívny rast už v stupni zhubnosti 2., tzv „low-grade“



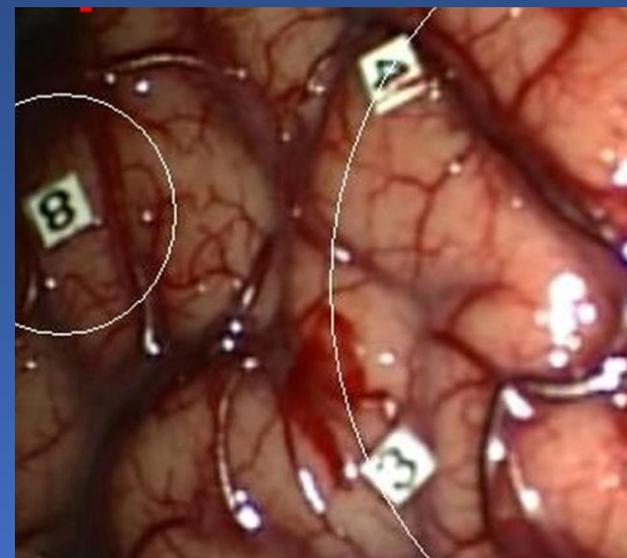
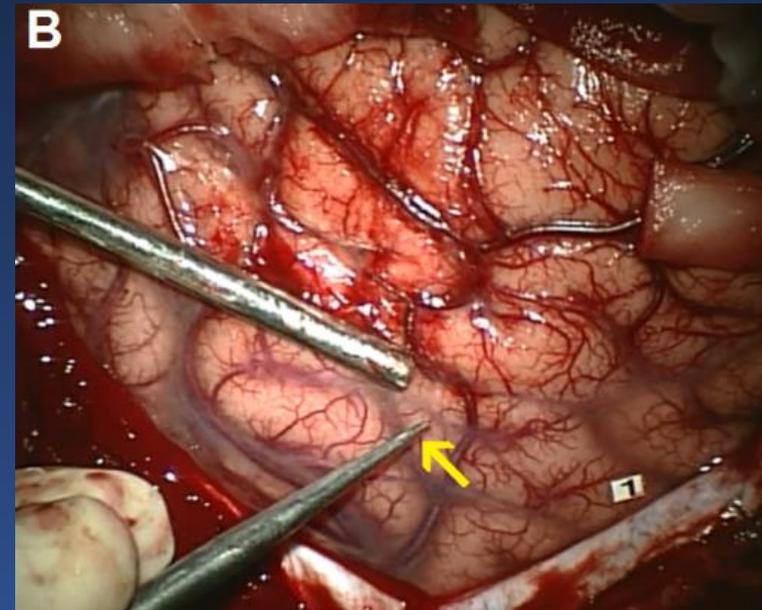
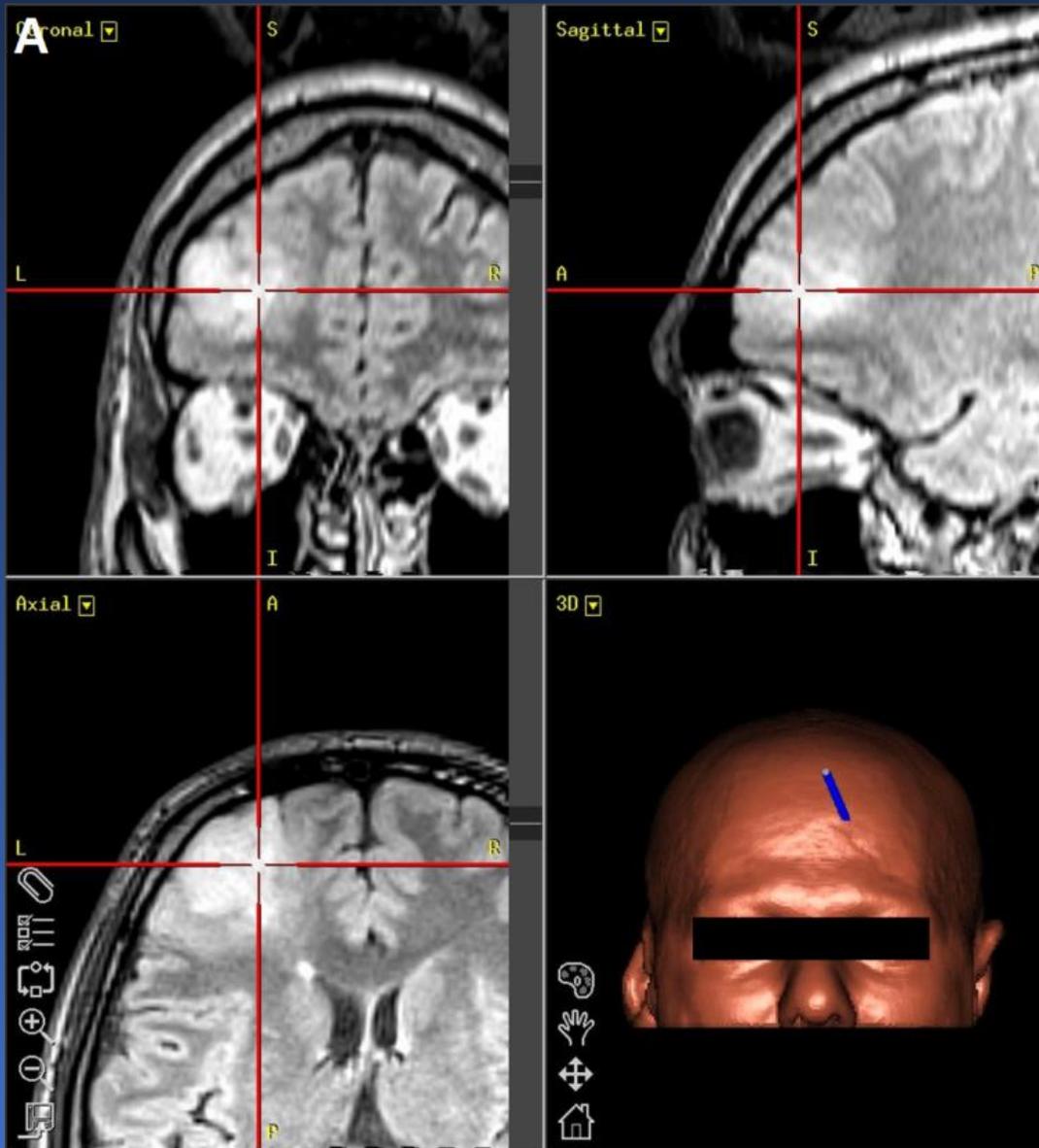
Zdroj: Young et al., Neurooncology, 2023, AI modif.

Problém 1 – infiltratívny rast už v stupni zhubnosti 2., tzv „low-grade“

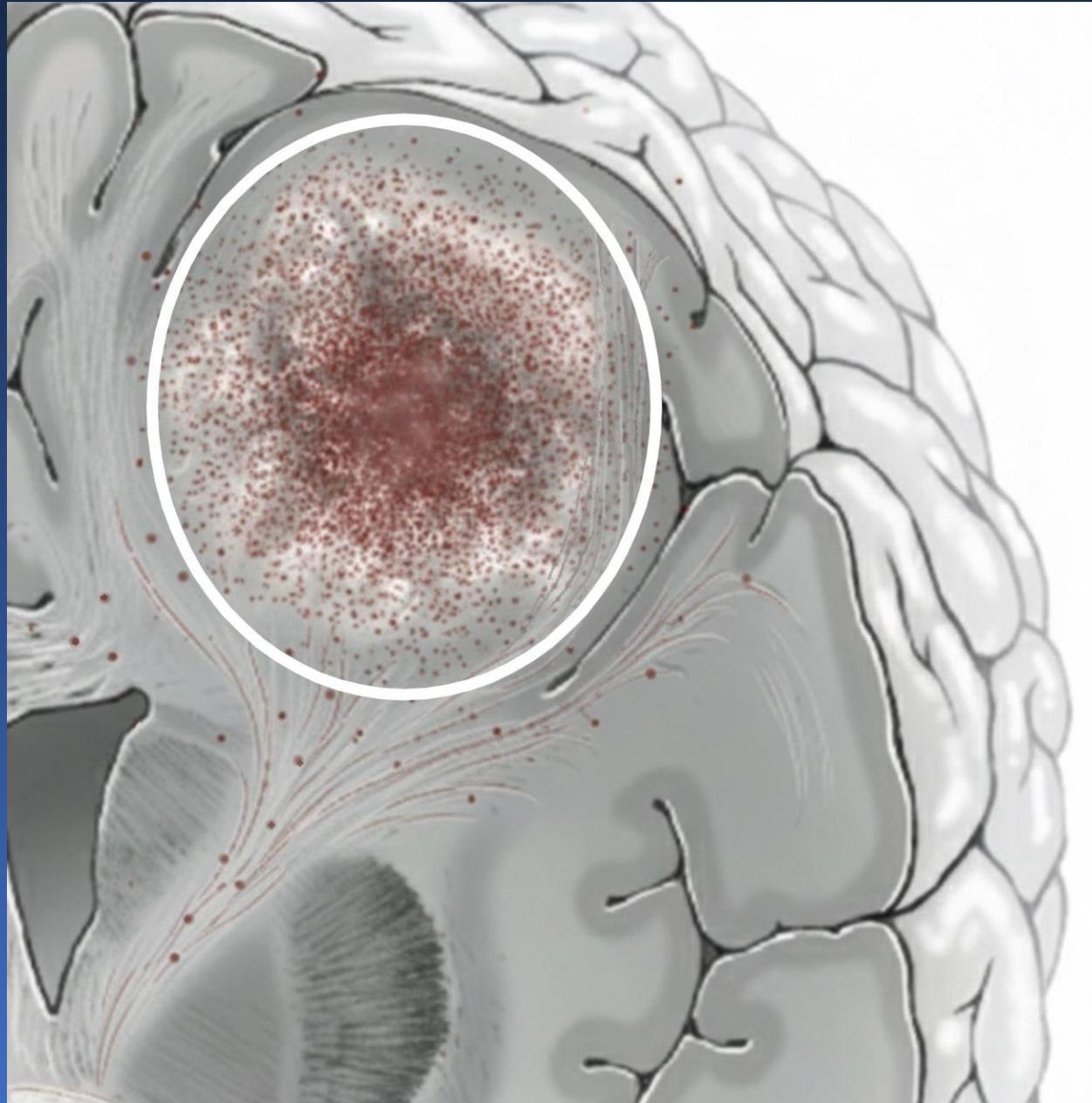


Zdroj: Young et al., Neurooncology, 2023, AI modif.

Problém 2 – čiatočná/úplná „neviditeľnosť“

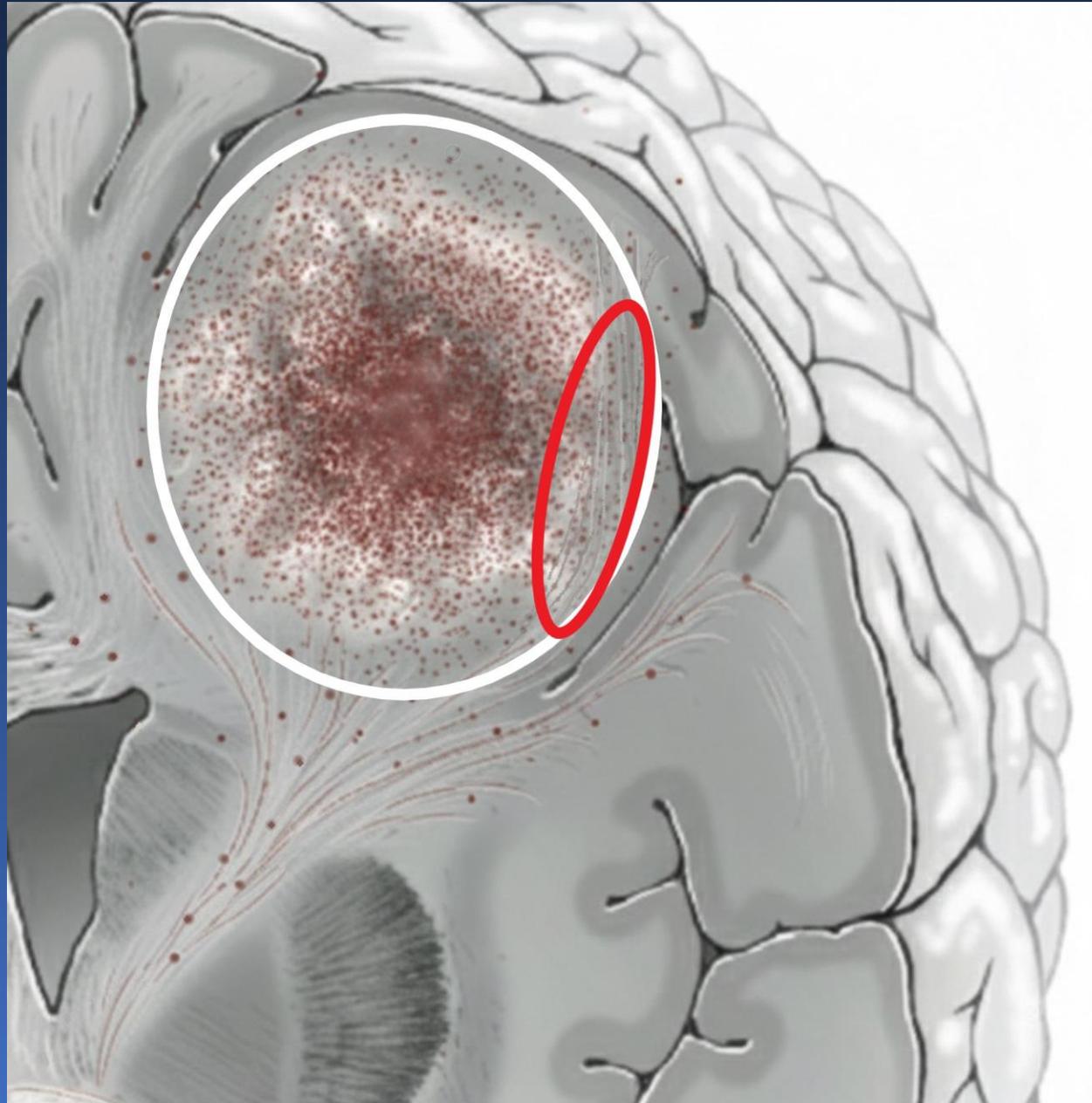


Problém 3 – prerastanie stále fungujúcich štruktúr mozgu

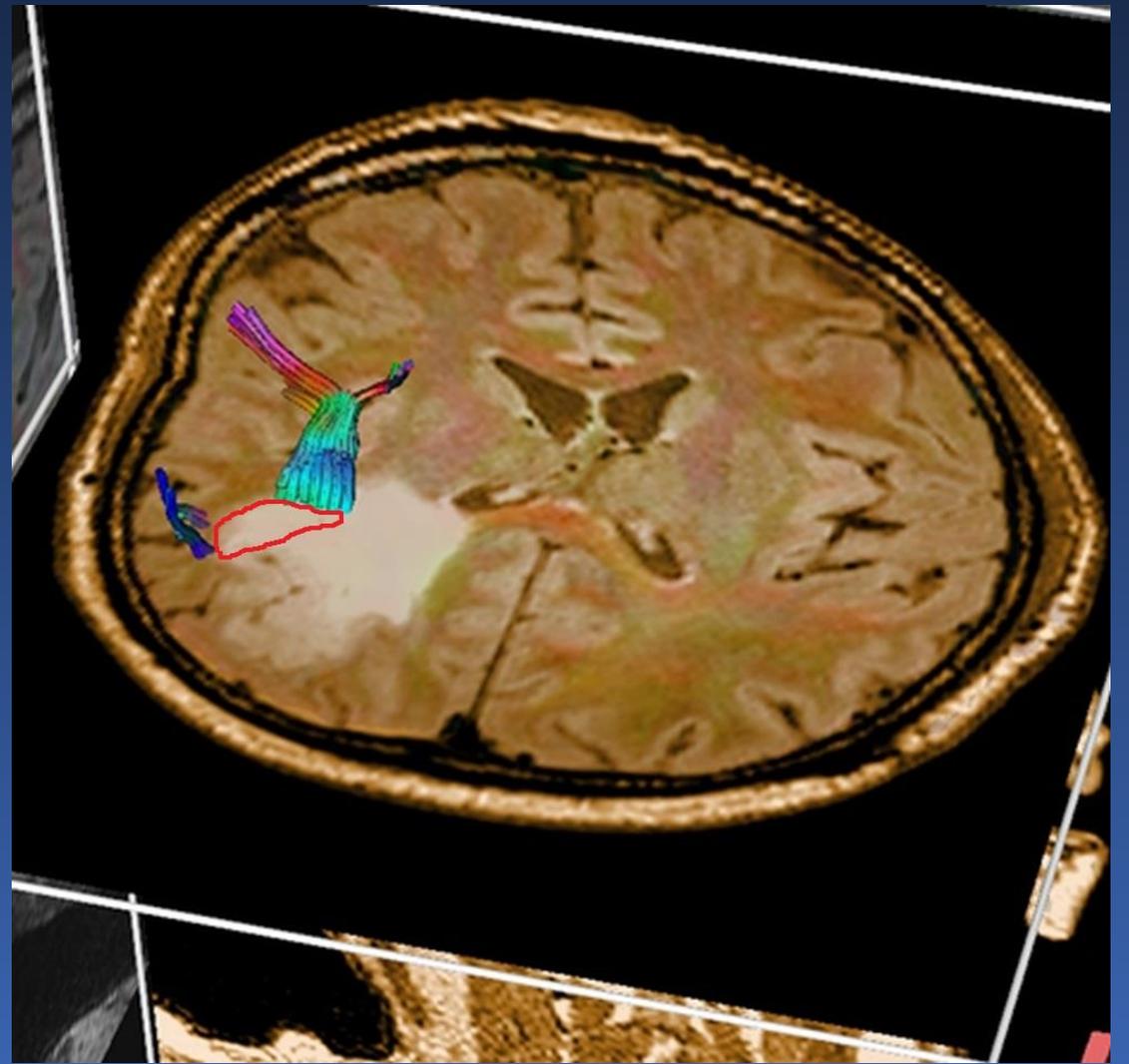
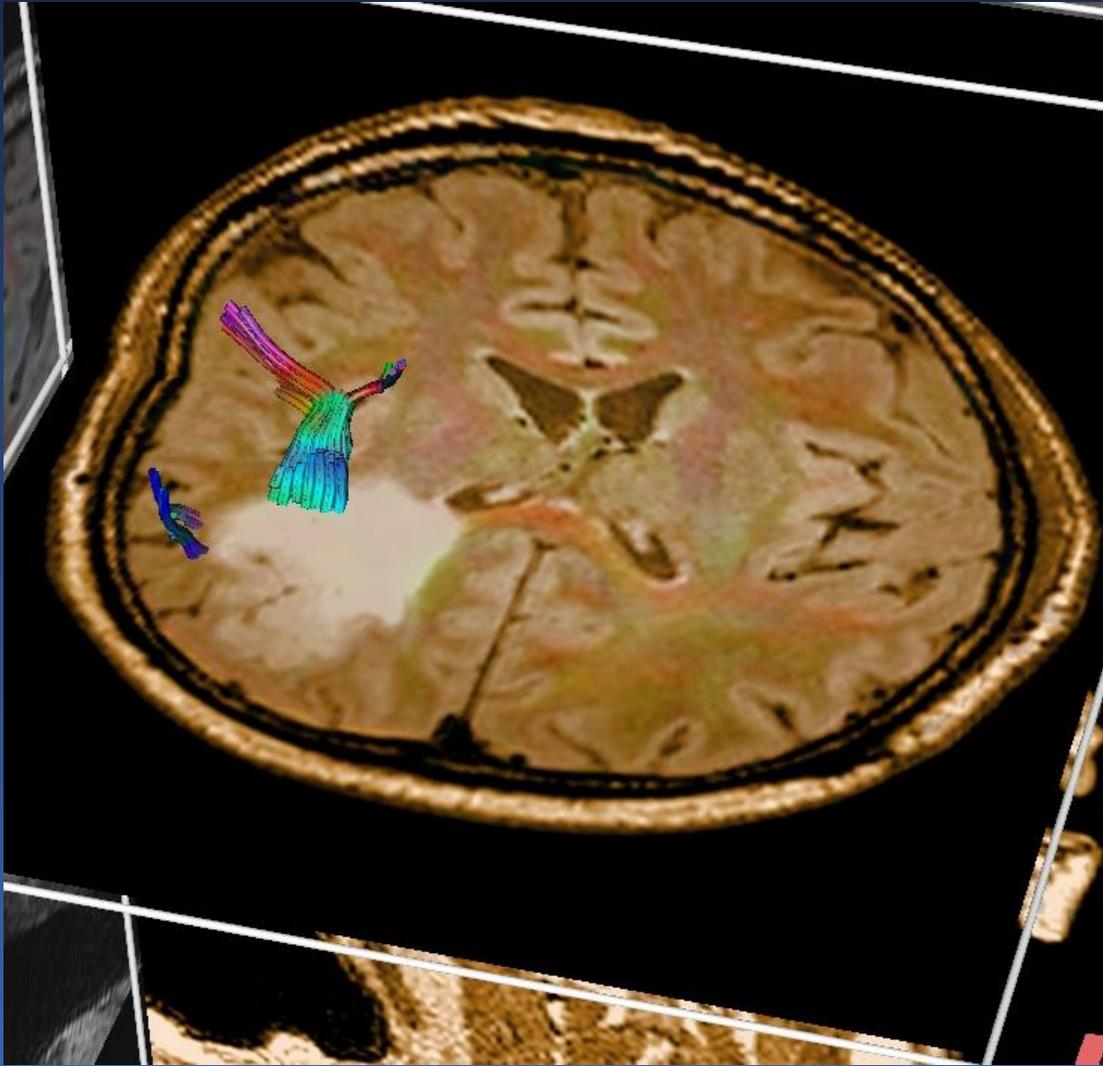


Zdroj: Young et al., Neurooncology, 2023, AI modif.

Problém 3 – prerastanie stále fungujúcich štruktúr mozgu

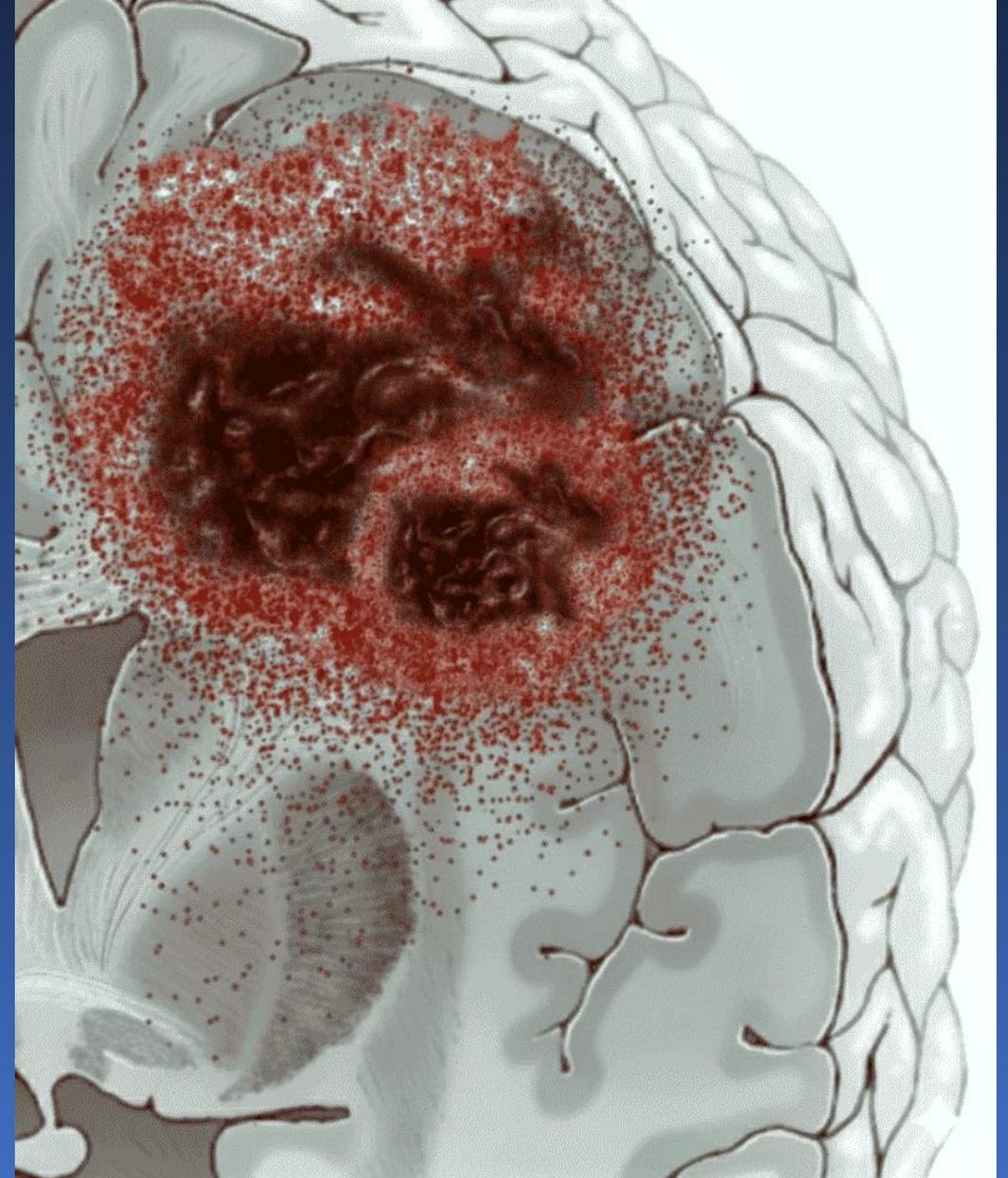
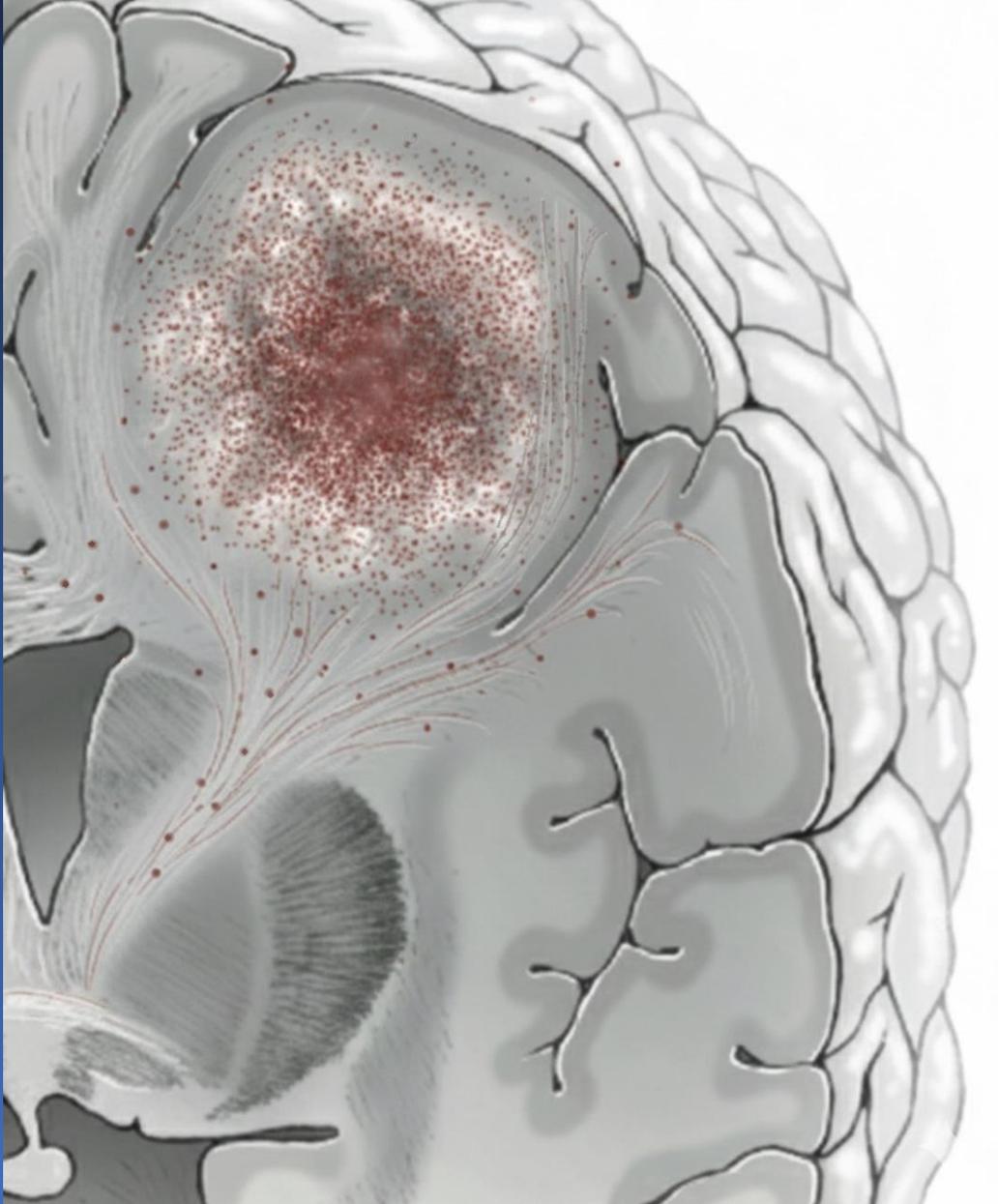


Zdroj: Young et al., Neurooncology, 2023, AI modif.



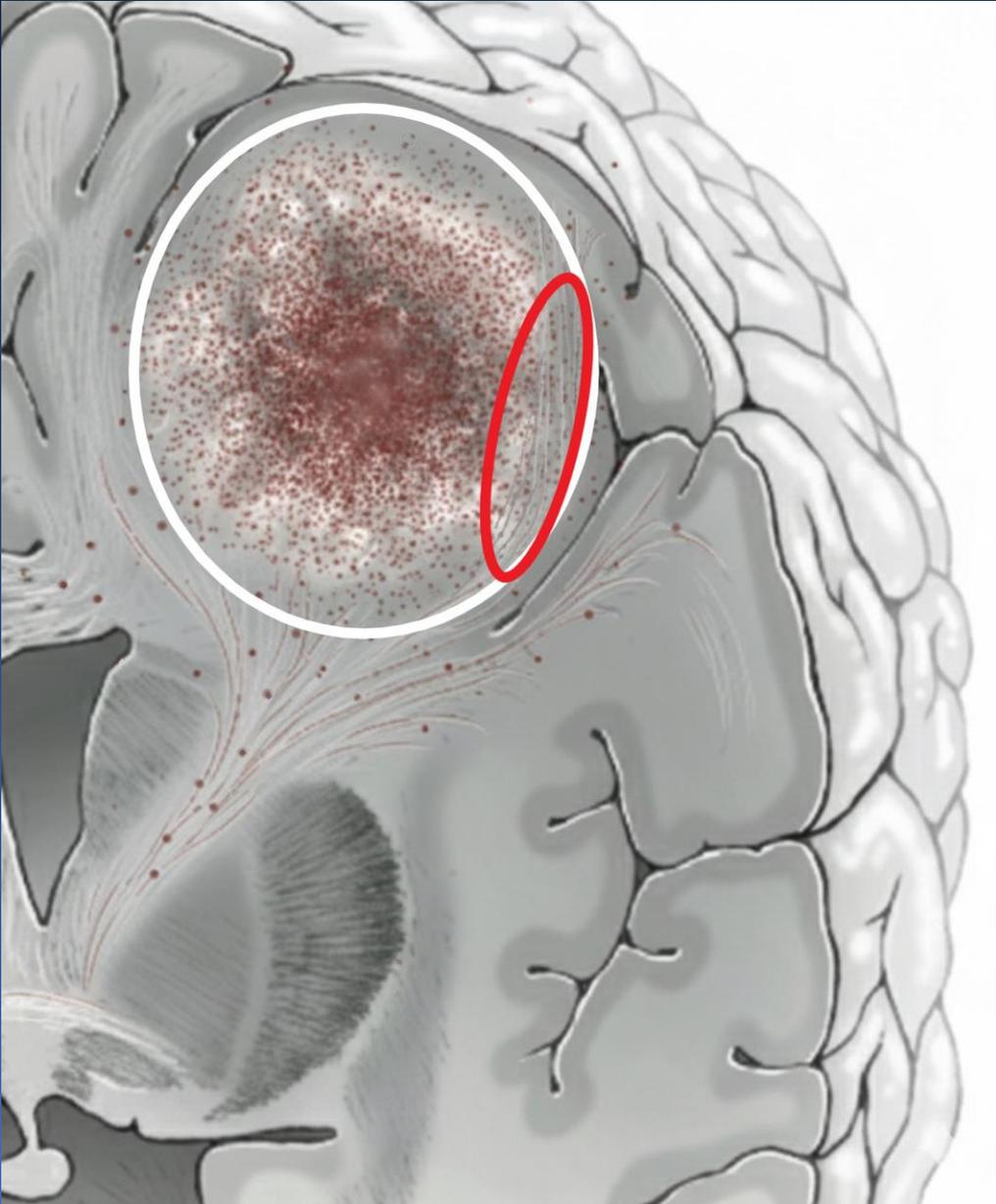
Toto nie je raritná situácia

Problém 4 – neodvrátiteľná malígna transformácia (prechod do stupňov 3. a 4., tzv. high-grade)



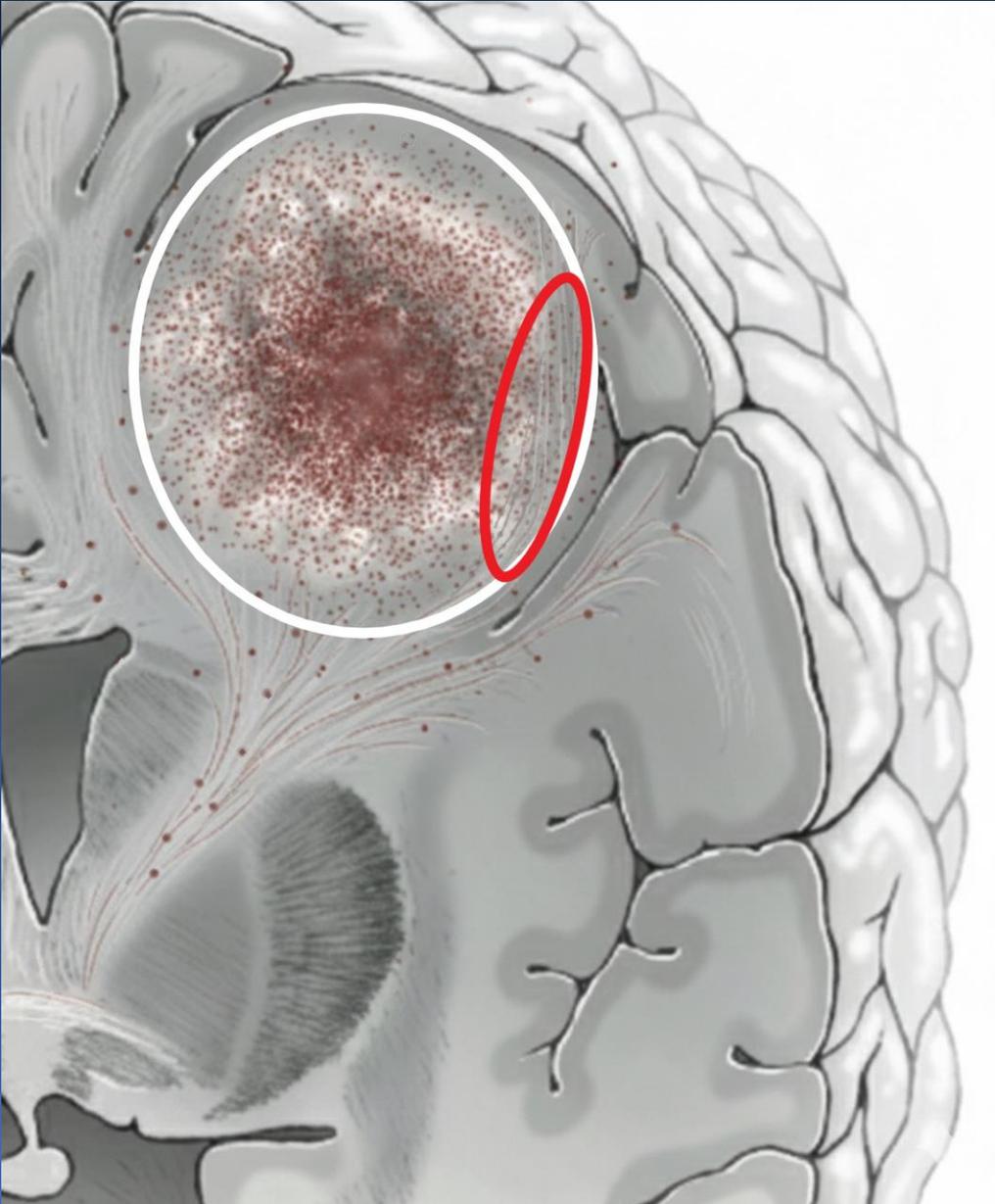
Zdroj: Young et al., Neurooncology, 2023, AI modif.

Prečo ich operujeme?



1. Infiltratívne – neohraničené
2. Čiastočne/úplne neviditeľné
3. Prerastajúce fungujúci mozog
4. Vždy malígne transformujúce

Prečo ich operujeme?



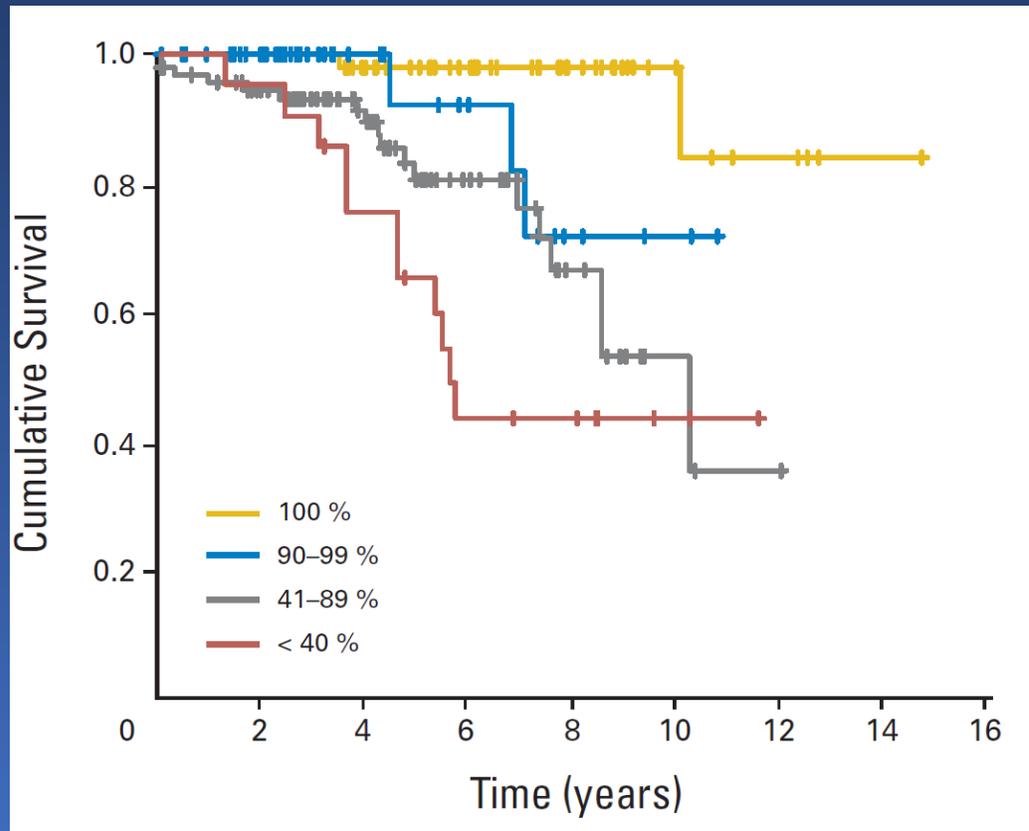
Zdroj: Young et al., Neurooncology, 2023, AI modif.



Zdroj: Young et al., Neurooncology, 2023, AI modif.

Role of Extent of Resection in the Long-Term Outcome of Low-Grade Hemispheric Gliomas

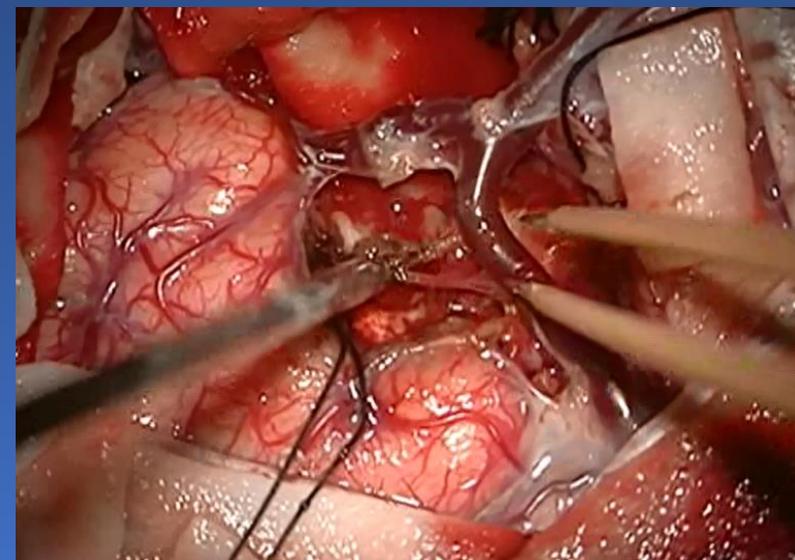
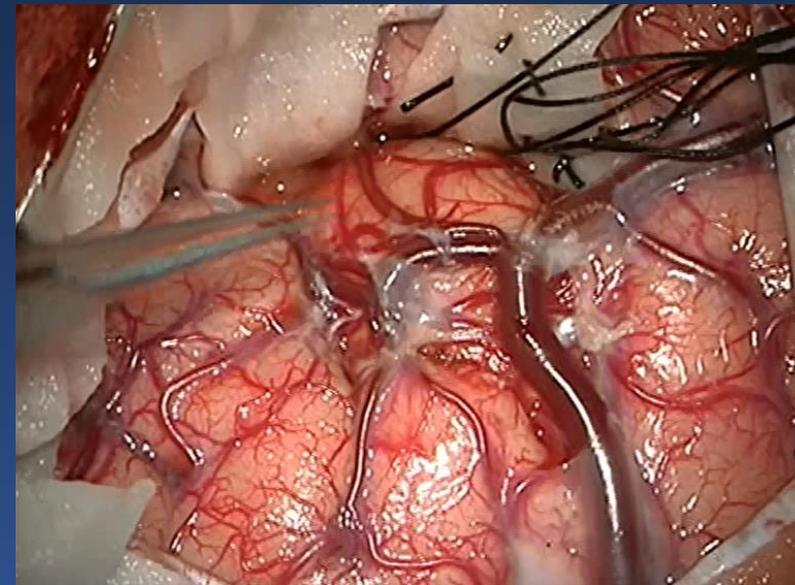
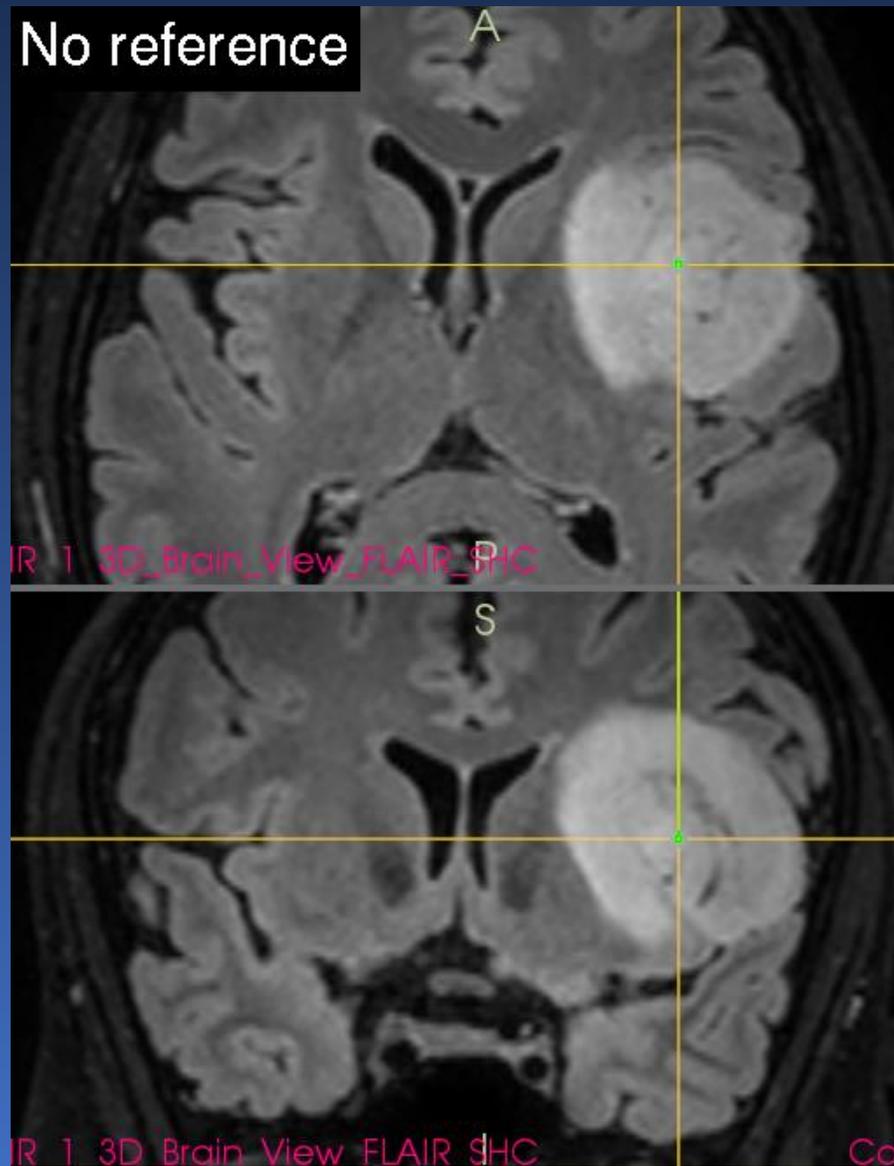
Justin S. Smith, Edward F. Chang, Kathleen R. Lamborn, Susan M. Chang, Michael D. Prados, Soonmee Cha, Tarik Tihan, Scott Vandenberg, Michael W. McDermott, and Mitchel S. Berger



Po zohľadnení vplyvu veku, KPS, lokalizácie nádoru a podtypu nádoru zostal rozsah resekcie signifikantným prediktorom dlhšieho prežívania aj v prípade, že rozsah resekcie bol aspoň 80 % ($P = 0,016$)

- Volumetria na základe FLAIR sekvencie

Resekcia zdanlivo normálneho tkaniva mozgu



Intraoperačné zobrazovacie metódy

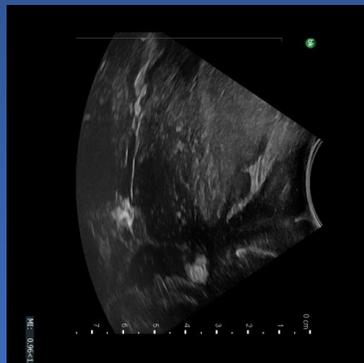
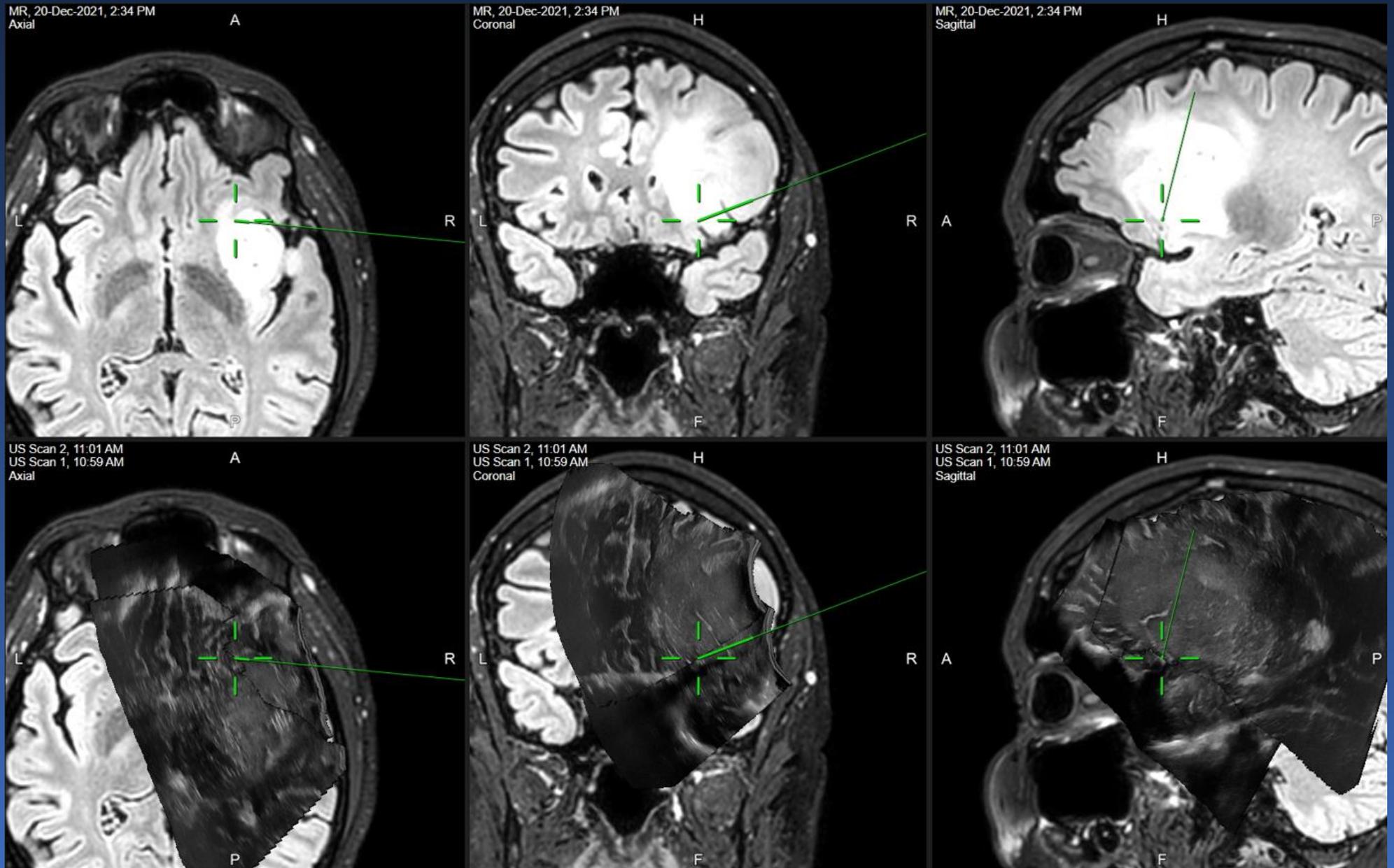
Intraoperačné MR



Zdroj: ÚVN Praha

Intraoperačné USG





Pomer 1:1



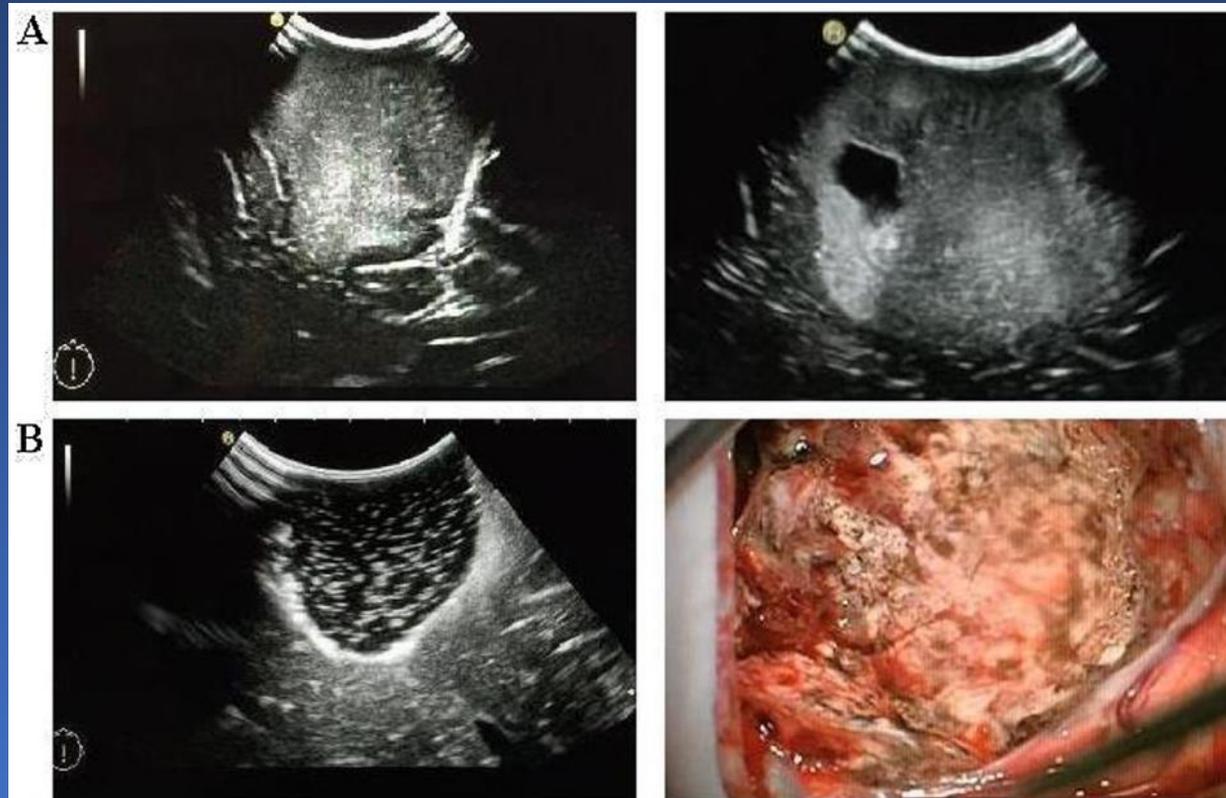
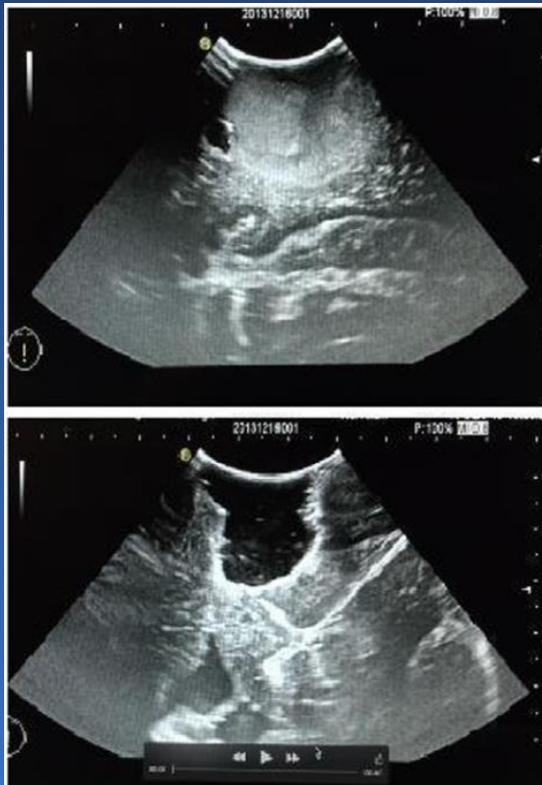
The value of intraoperative sonography in low grade glioma surgery

Athanasios K. Petridis^{a,*,1}, Maxim Anokhin^{a,1}, Jan Vavruska^a,
Mehran Mahvash^b, Martin Scholz^a

^a Wedau Kliniken Duisburg, Sana Konzern, Department of Neurosurgery, Duisburg, Germany

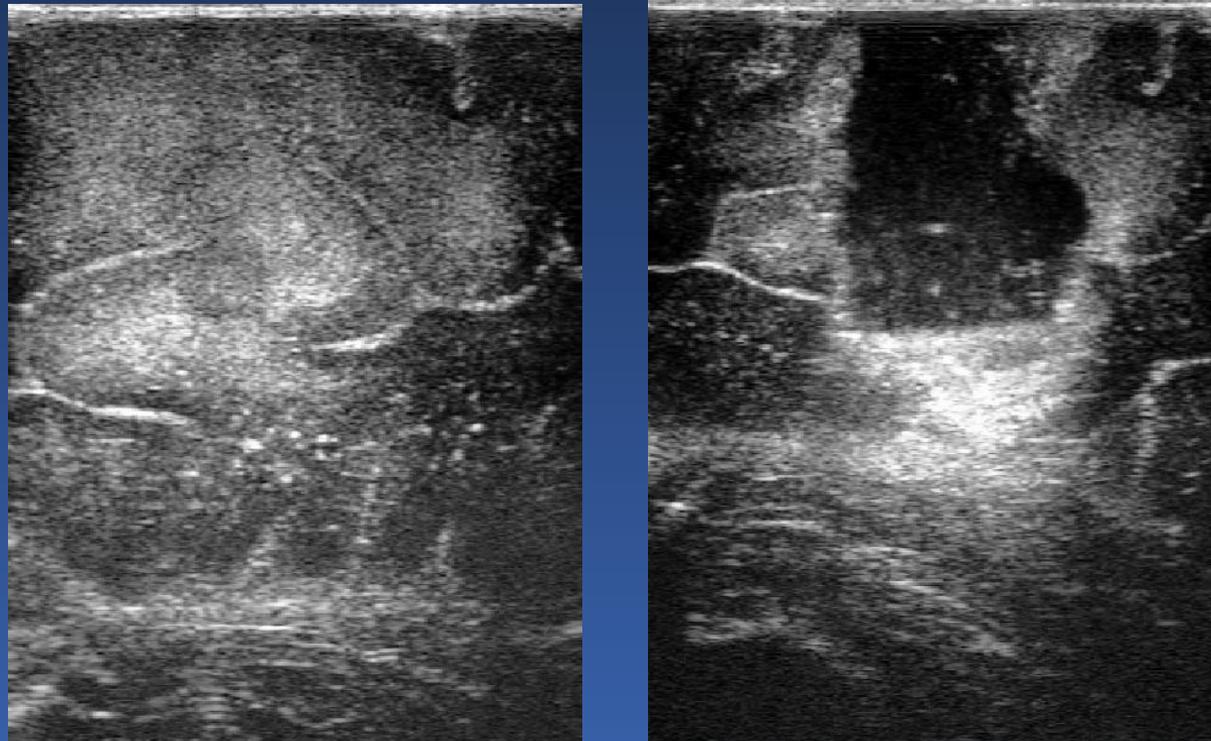
^b Department of Neurosurgery, Clinic of Cologne University of Witten-Herdecke, Duisburg, Germany

„V dôsledku obrazových artefaktov je ultrazvuk v súčasnosti nespoľahlivý“



„Acoustic enhancement artifacts“

Objavujú sa, keď ultrazvuk preniká cez vyšší stĺpec vody (fyziologického roztoku).

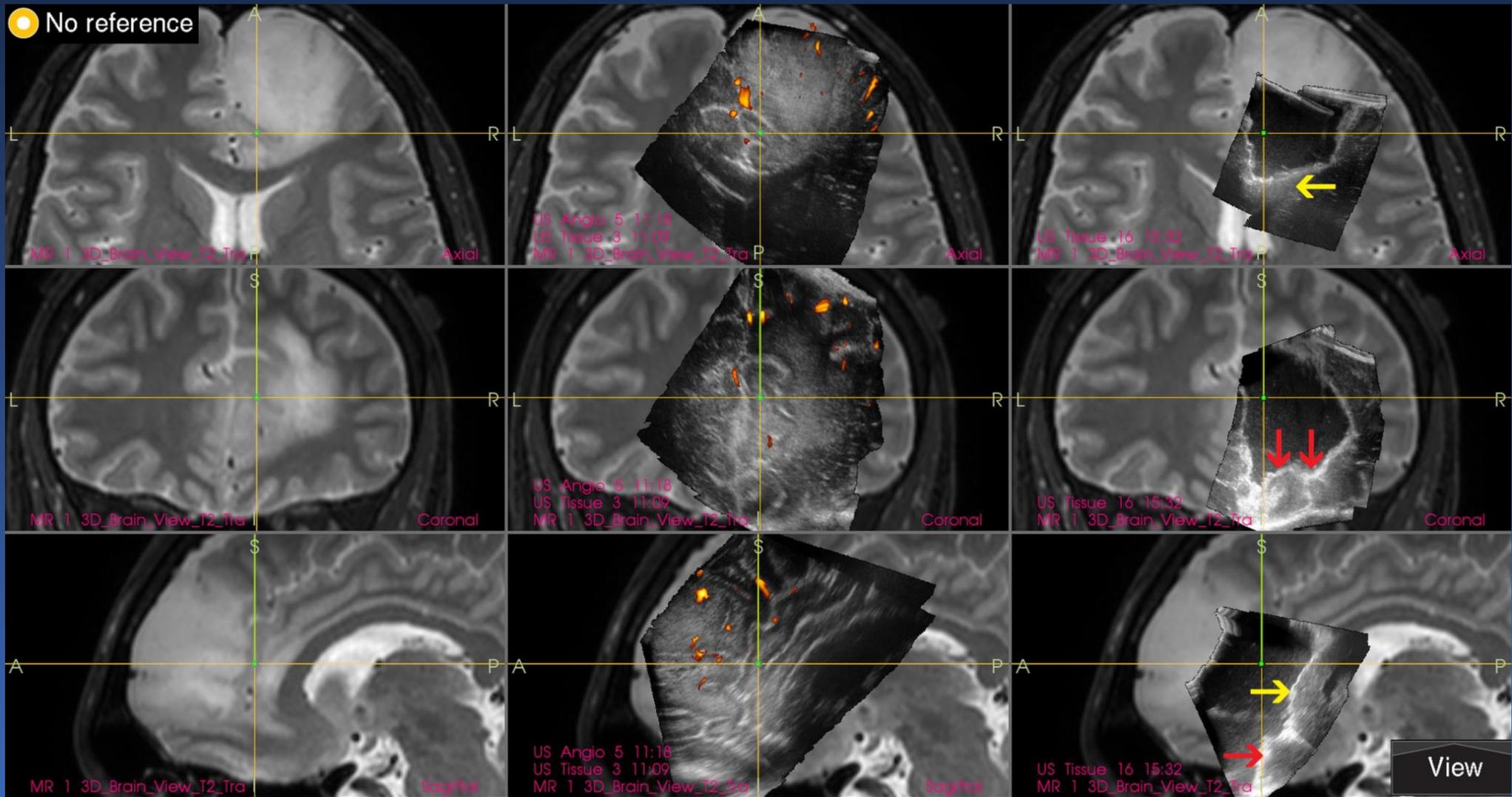


Môžu brániť detekcii zvyškov nádoru na dne resekčnej dutiny.

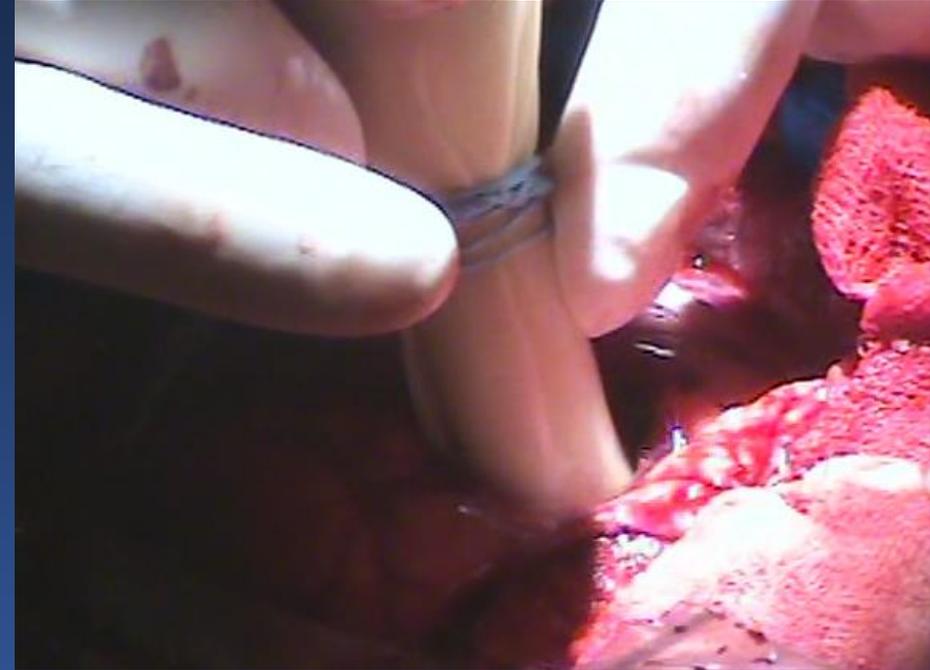
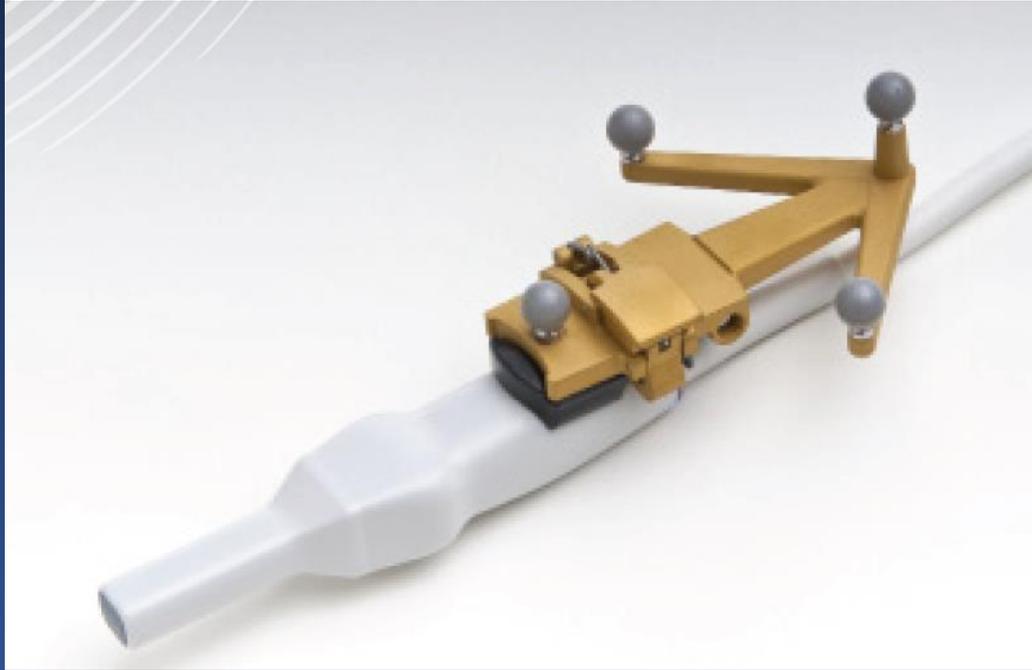
(Hentschel and Lang, 2005; Gerganov et al., 2009; Wang et al., 2011)

Môžu imitovať nádor v miestach, kde sa v skutočnosti nenachádza (Jakola et al., 2014)

● No reference



3D ultrazvukové scanovanie s minisondou zavedenou do resekčnej dutiny

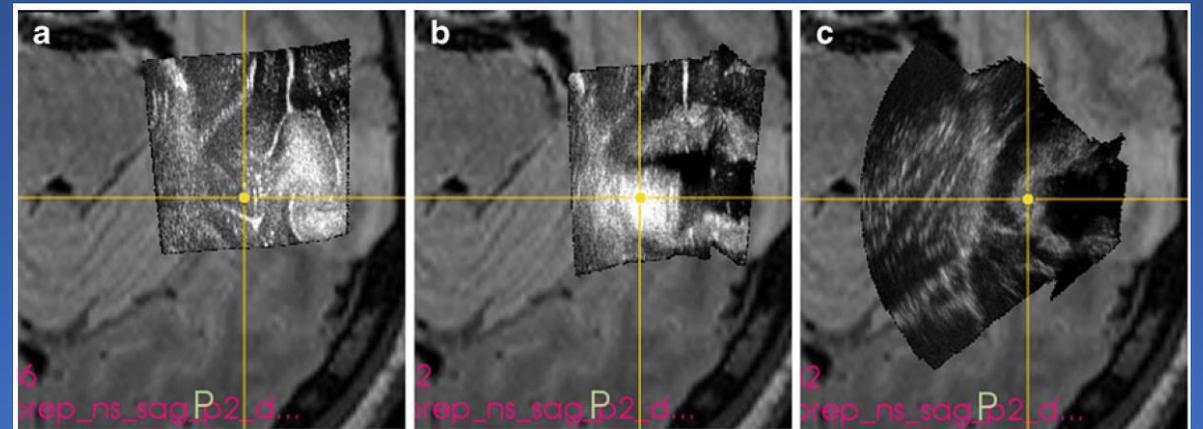


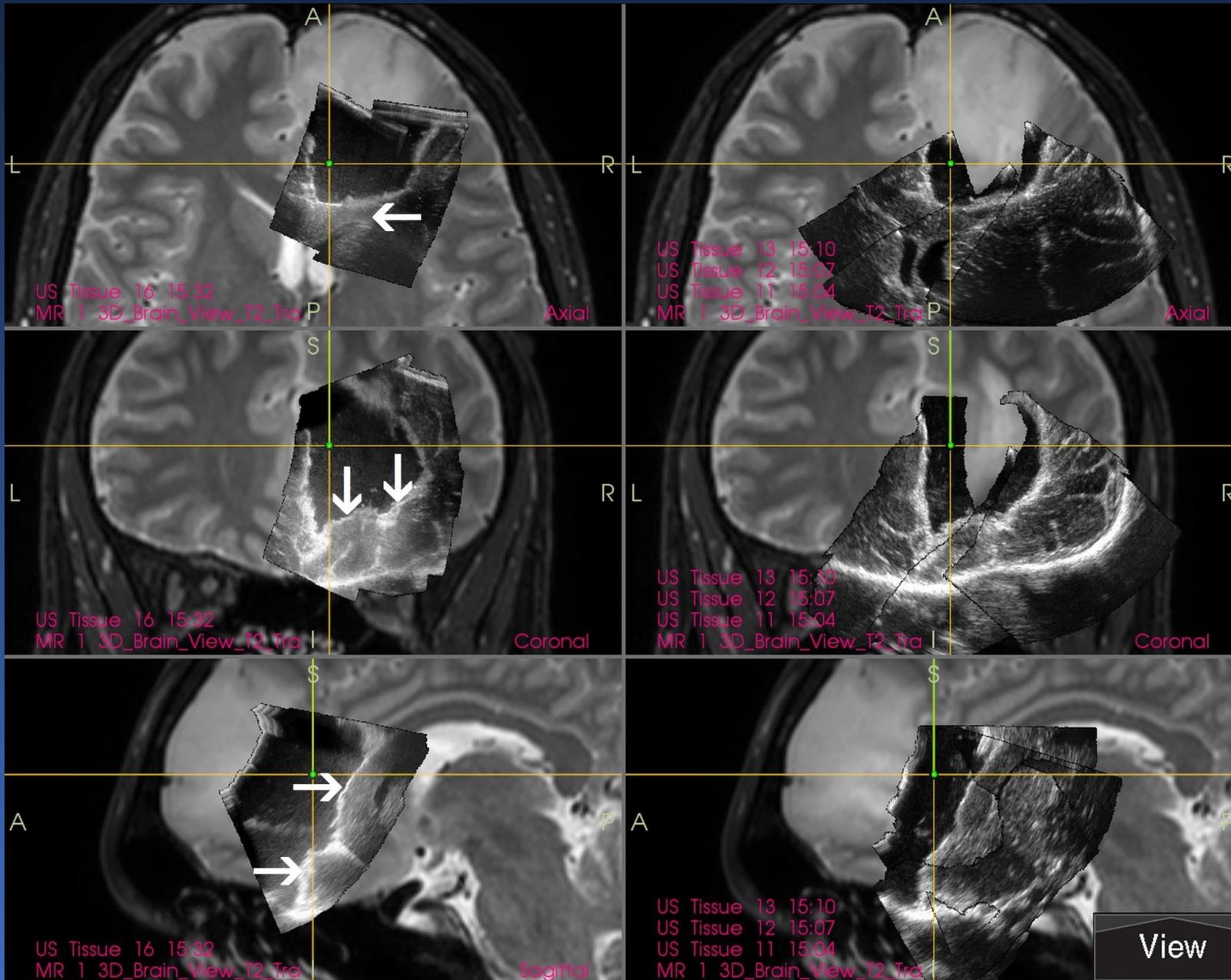
Acta Neurochir (2012) 154:1255–1262
DOI 10.1007/s00701-012-1357-6

CASE REPORT

**Navigated three-dimensional intraoperative
ultrasound-guided awake resection of low-grade glioma
partially infiltrating optic radiation**

Andrej Šteňo · Martin Karlík · Peter Mendel ·
Miroslav Čík · Juraj Šteňo





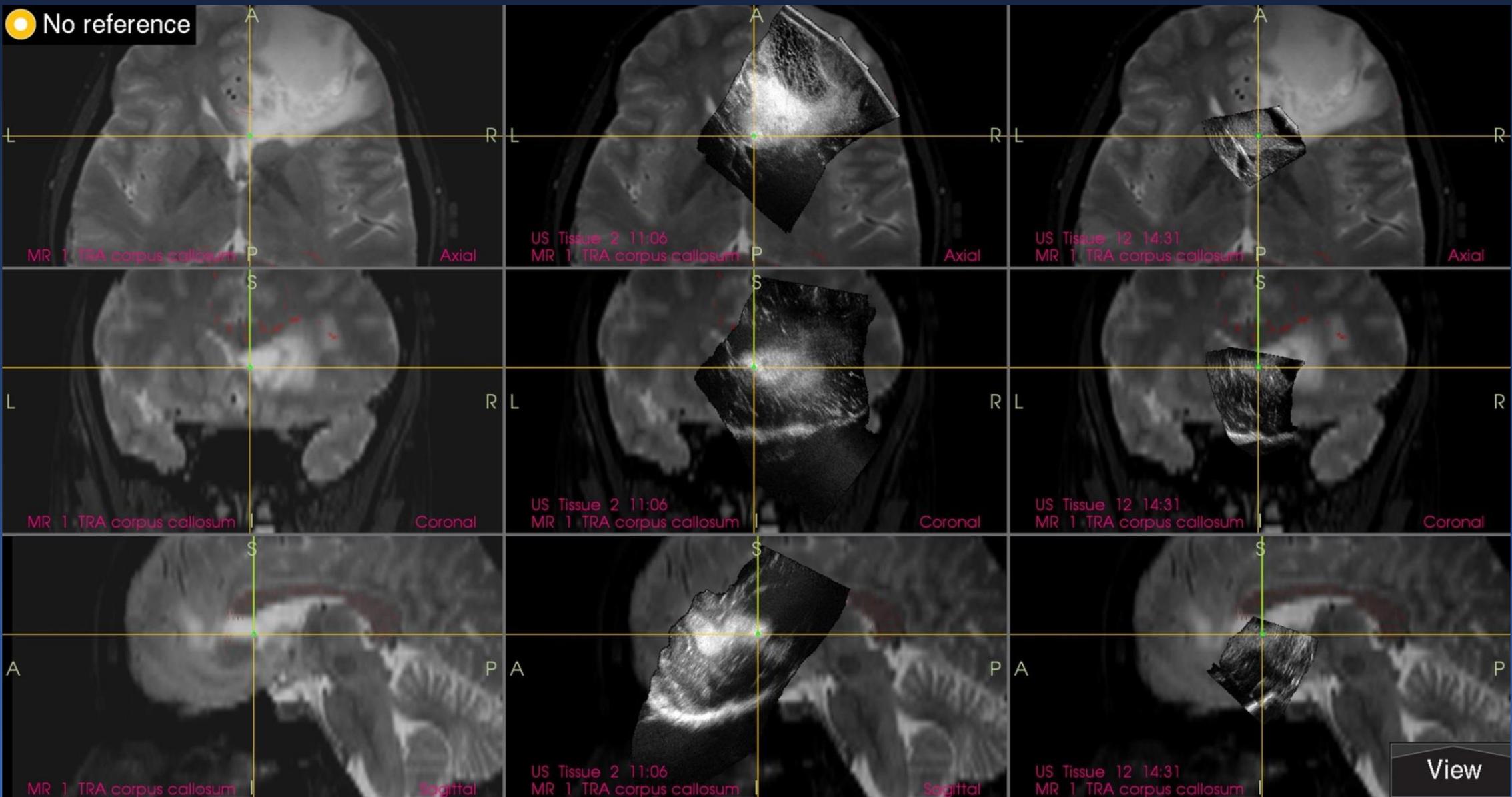
Letter to the Editor

Intraoperative ultrasound in low-grade glioma surgery

Andrej Šteňo*
Viktor Matejčík
Juraj Šteňo

Clinical Neurology and Neurosurgery 135 (2015) 96–99

● No reference



Letter to the Editor: Identification of residual glioma using ultrasound miniprobes

Andrej Šteňo MD, PhD, Viktor Matejčík MD, PhD, and Juraj Šteňo MD, PhD

NEUROSURGICAL
FOCUS

2016

Intraoperative Ultrasound (IOUS) in Neurosurgery

From Standard B-mode to Elastosonography

Francesco Prada
Luigi Solbiati
Alberto Martegani
Francesco DiMeco *Editors*

 Springer

Andrej Šteňo, Carlo Giussani, and Matteo Riva

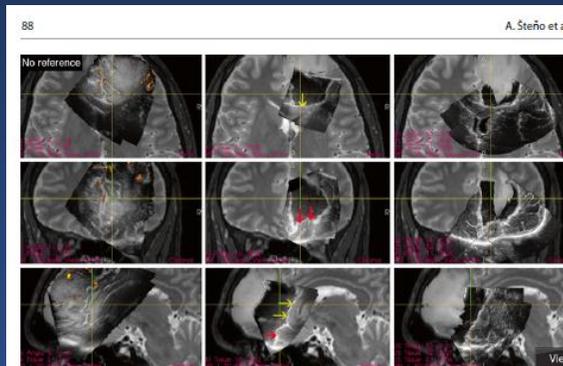
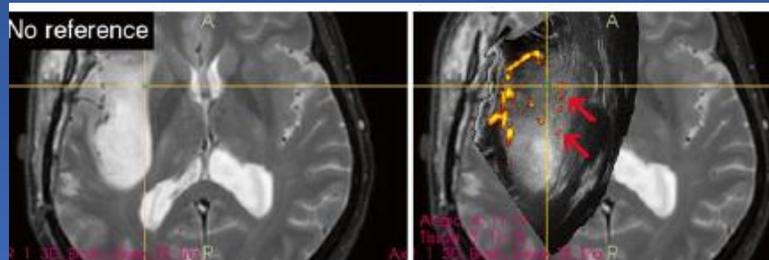
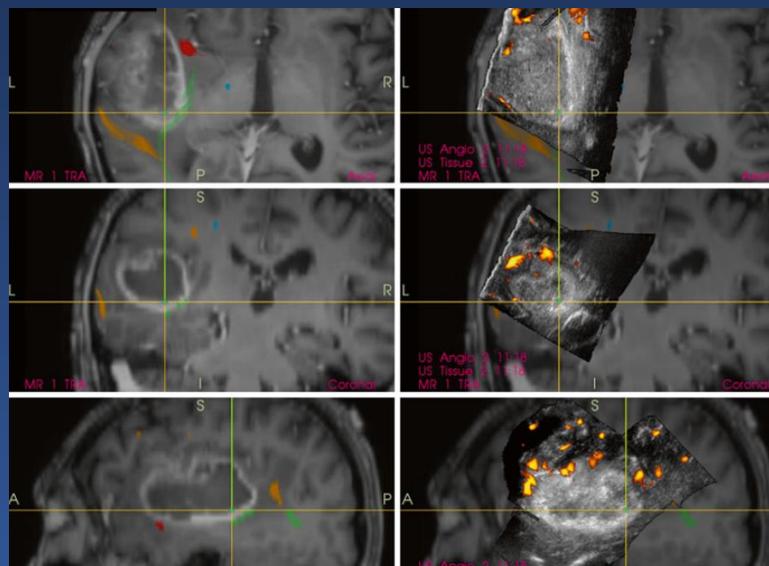


Fig. 8.5 Right-sided frontal grade II astrocytoma. *Left column:* Initial 3D-ultrasound image scanned from the dural surface fused with the preoperative navigation MRI showing a right-sided frontal grade II astrocytoma. *Middle column:* 3D-ultrasound scan performed from the dural surface during the resection. Note the hyperintensity at the bottom of the resection cavity; *yellow arrows*, corpus callosum and *red arrows*, inferior part of the right frontal lobe. Because these structures were not infiltrated (see initial 3D-ultrasound scan), the hyperintensity should be evaluated as the AEA and not as a tumor remnant. *Right column:* AEAs were minimized by 3D-ultrasound data acquisition with a miniature probe inserted into the resection cavity; no hyperintense residual tumor is present at the bottom of the resection cavity. Surgery performed at the Department of Neurosurgery in Bratislava

ize glioma tissue [6–10, 52–56, 73]. Nevertheless, as mentioned before, the accuracy of neuronavigation is limited due to the brain-shift [28], and 2D-ultrasound is prone to image interpretation difficulties, especially after some tumor tissue debulking [43–45]. Due to these drawbacks, intraoperative MRI [30, 74–81] or navigated 3D-ultrasound [40, 49, 82] is used in several centers during AR of eloquently localized gliomas.

The most prominent problem of AR is the limited time of the surgery due to patient fatigue [83]. Despite the described successful course of AR lasting up to 9 h [84], some patients can become tired within 1–2 h of resection [85]. In such cases, patients often demonstrate slowness in their language in the last stages of resection,

and it is not easy to differentiate language disturbances due to fatigue from the fact that the resection has interfered with language pathways [83].

Because the duration of AR is limited, intraoperative imaging modality used during these procedures should apart from distinct depiction of normal and pathological structures also allow fast update of navigation data. In this regard, 3D-ultrasound represents a very well-balanced intraoperative imaging modality. In addition to high-quality visualization of brain and tumor tissue, intraoperative data update may be repeatedly performed during the whole course of AR. Usually, the 3D-ultrasound navigation data update takes only 2–3 min [61], and therefore, the prolongation of the surgery is acceptable even in cases when several navigation data updates are needed.

Another important benefit of 3D-ultrasound is the possibility of intraoperative 3D visualization of normal and pathological vessels by power Doppler. According to the experiences gained

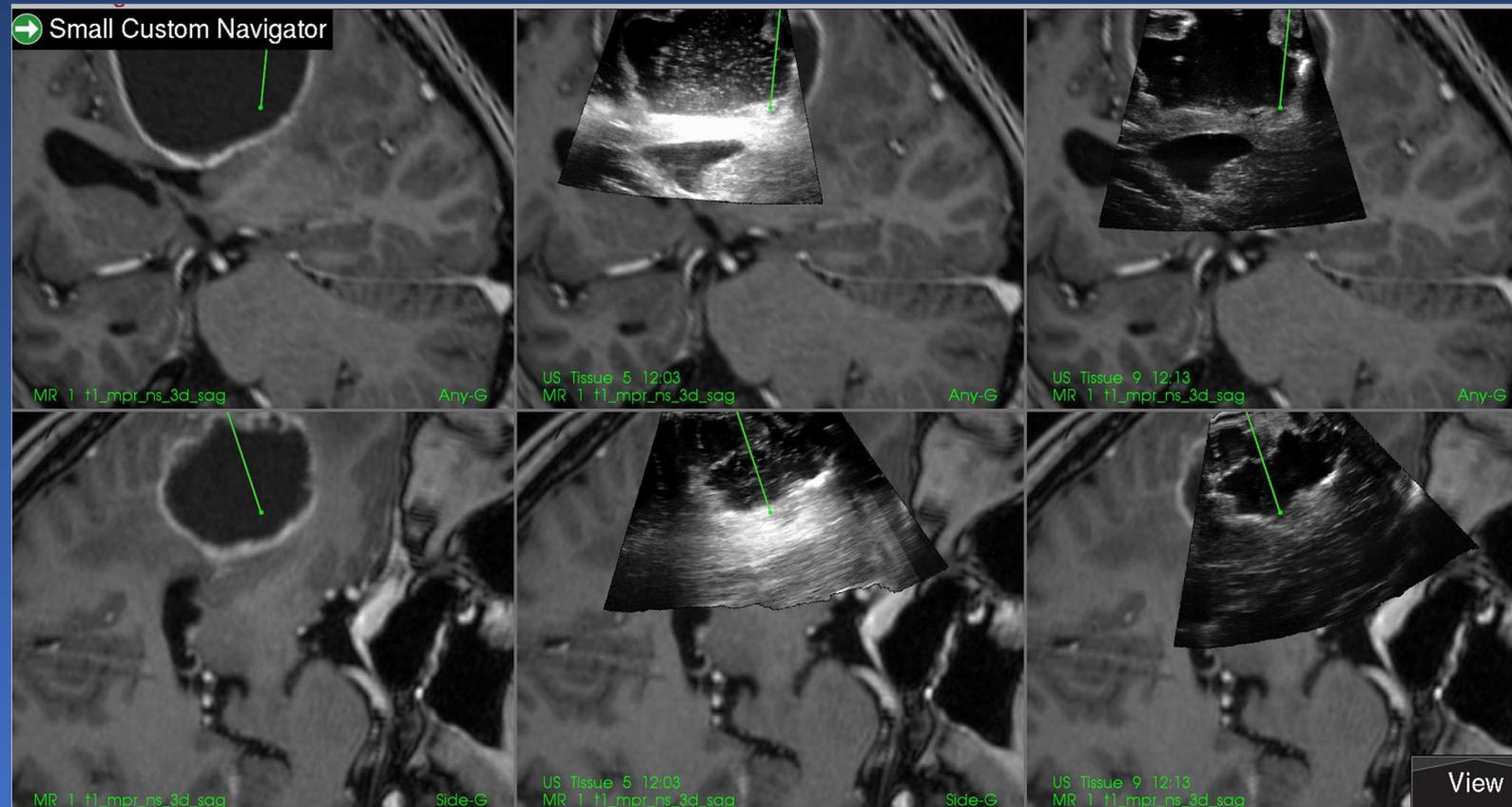
A new acoustic coupling fluid with ability to reduce ultrasound imaging artefacts in brain tumour surgery—a phase I study

Geirmund Unsgård^{1,2,3}  • Lisa Millgård Sagberg^{2,4} • Sébastien Müller⁵ • Tormod Selbekk^{3,5}

Received: 10 April 2019 / Accepted: 3 May 2019



NTNU, Trondheim, Norway



September, 2021: ACF Study



Centre	Subjects
4211 - Bratislava	4
3901 - Milan	Set up
4901 - Ulm	Set up
4902 - Marburg	Set up

Prof. Unsgaard
H-index = 45



Invitation to collaborate on AI-guided ioUS study

Od Cepeda Chafla, Santiago Miguel <scepedac@saludcastillayleon.es>

Dátum Str 25. 6. 2025 17:36

Do Šteňo Andrej <andrej.steno@fmed.uniba.sk>

Kópia andrej.steno@gmail.com <andrej.steno@gmail.com>



Dear Professor Šteňo,

I hope this message finds you well. My name is Santiago Cepeda, a neurosurgeon at the Río Hortega University Hospital in Valladolid, Spain. I lead a research line focused on the application of artificial intelligence to enhance intraoperative ultrasound for brain tumor surgery.

We have recently published a couple of articles addressing real-time detection and segmentation of brain tumors in ioUS, and we are now aiming to take this project to the next stage. Our ultimate goal is to clinically validate a practical system capable of real-time, automatic segmentation not only of the tumor, but also of the peritumoral region, the resection cavity, and key brain structures. We believe such a tool could assist neurosurgeons during their learning curve and complement the expertise of more experienced surgeons.

Beyond our published work, our group has developed improved models specifically optimized for detecting residual tumor. We are currently planning a non-randomized, multicenter clinical study to evaluate the clinical utility of this AI-based solution. While we have extended this invitation to members of the BraTioUS consortium, your recognized expertise and leadership in the field of intraoperative imaging make your involvement particularly valuable.

At this stage, we are assessing the number of centers that might be interested in participating, aiming to estimate a feasible sample size. The study is expected to last one year, and we would evaluate the model's performance in segmenting the tumor before dural opening, during resection, and at its completion, with the ultimate goal of understanding its potential integration into routine surgical workflows.

In parallel, we are actively exploring funding opportunities to support the study. If you are aware of potential sponsors or industrial partners who may be interested in collaborating or supporting this initiative, we would be truly grateful for your guidance or help in establishing such contacts.

I am attaching two of our recent publications, along with a short video demonstrating the first prototype we developed.

I would be honored to hear your thoughts and discuss the possibility of collaborating on this ambitious project.

Warm regards,

Santiago Cepeda, MD., PhD

Department of Neurosurgery

GEIBAC (Specialized Group in Biomedical Imaging and Computational Analysis)

<https://geibac.uva.es/>

Río Hortega University Hospital

Valladolid - Spain

Santiago Cepeda ^{a,b,*} , Olga Esteban-Sinovas ^{a,b} , Roberto Romero ^c, Vikas Singh ^d, Prakash Shett ^d , Aliasgar Moiyadi ^d, Ilyess Zemmoura ^{e,f}, Giuseppe Roberto Giammalva ^g, Massimiliano Del Bene ^{h,i}, Arianna Barbotti ^h, Francesco DiMeco ^{h,j,k}, Timothy R. West ^l, Brian V. Nahed ^l, Ignacio Arrese ^{a,b}, Roberto Hornero ^{b,m,n} , Rosario Sarabia ^{a,b} 

^a Department of Neurosurgery, Rio Hortega University Hospital, Dulzaina 2, Valladolid, 47014, Valladolid, Spain

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^c Biomedical Engineering Group, University of Valladolid, P. de Belen 15, Valladolid, 47011, Valladolid, Spain

^d Department of Neurosurgery, Tata Memorial Centre, Homi Bhabha National Institute, Parel East, Mumbai, 400012, Maharashtra, India

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^f Department of Neurosurgery, CHRU de Tours, 2 Bd Tonnelle, Tours, 37000, France

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ⁱ Department of Pharmacological and Biomolecular Sciences, University of Milan, Via Festa del Perdono 7, Milan, 20122, Italy

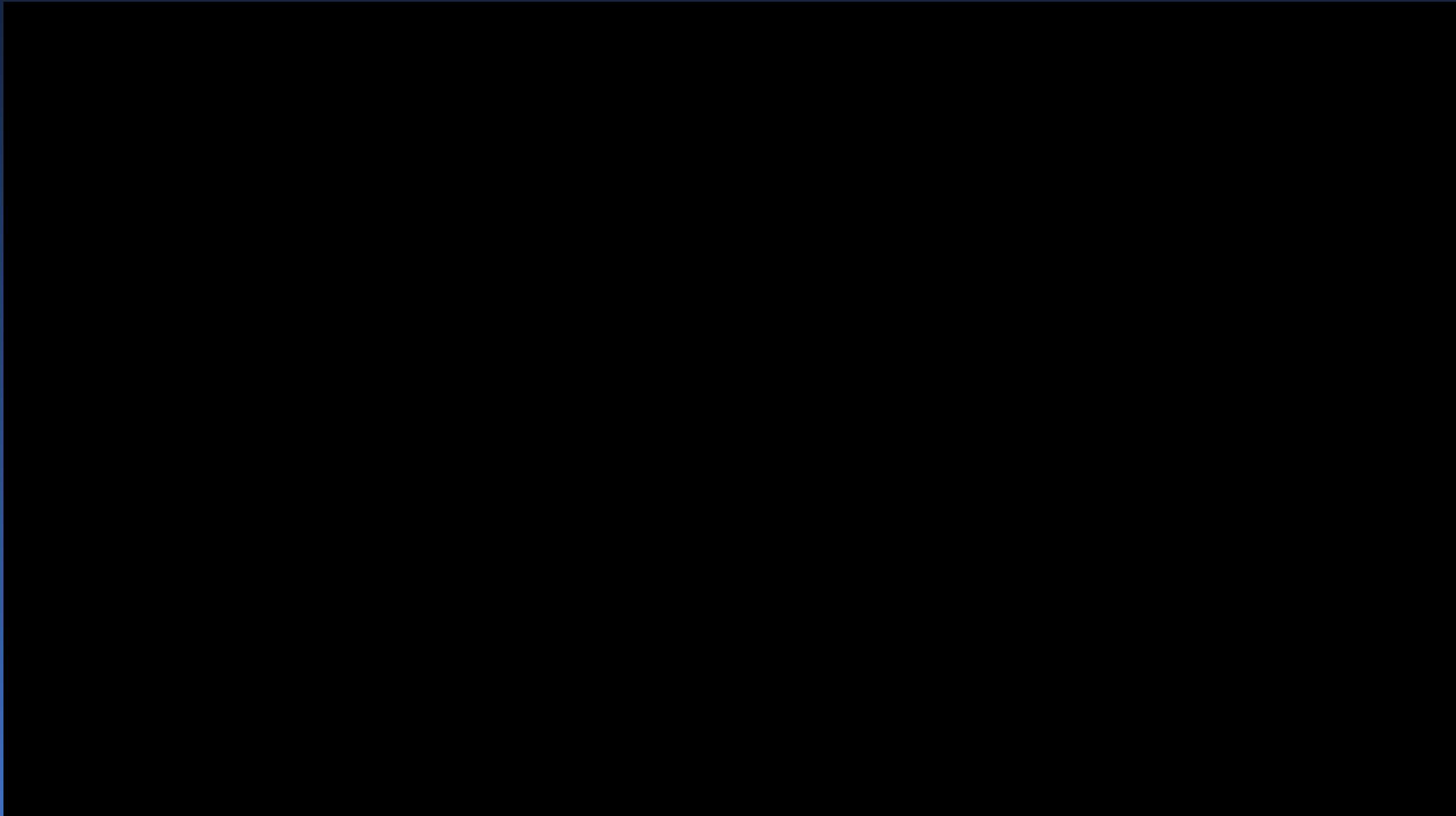
^j Department of Oncology and Hematology-Oncology, Universit'a Degli Studi di Milano, Via Festa del Perdono 7, Milan, 20122, Italy

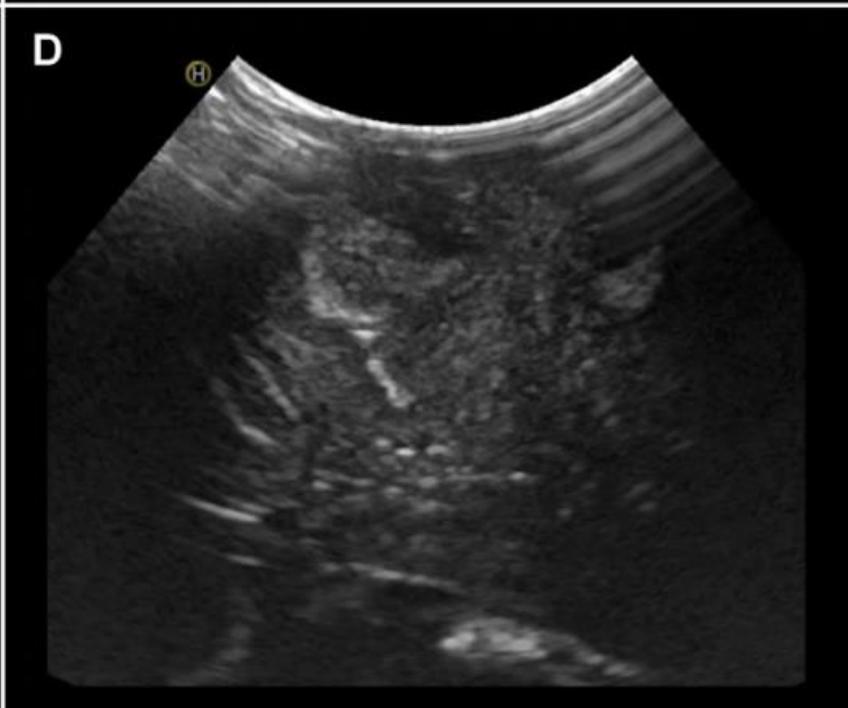
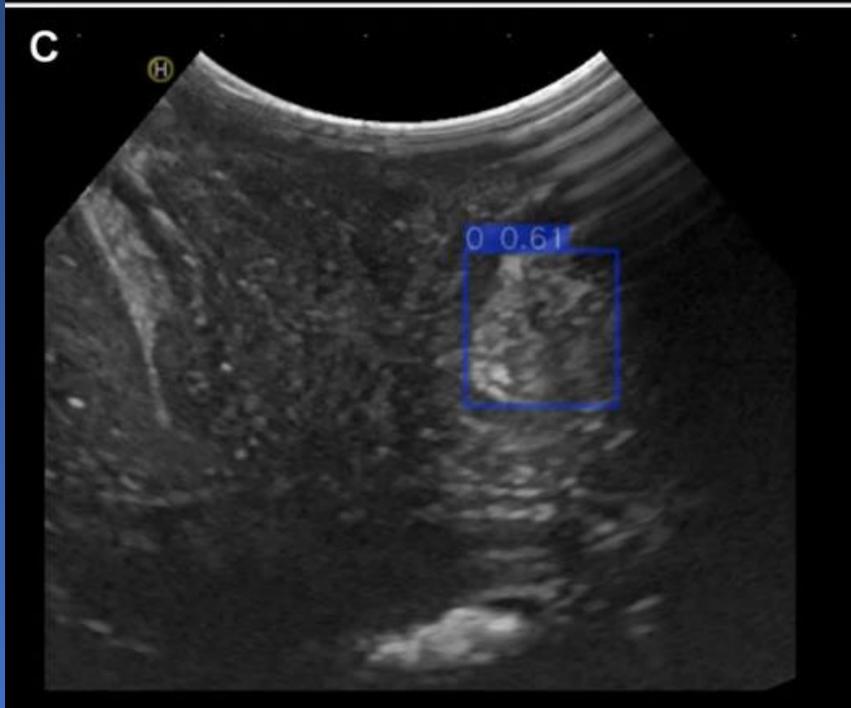
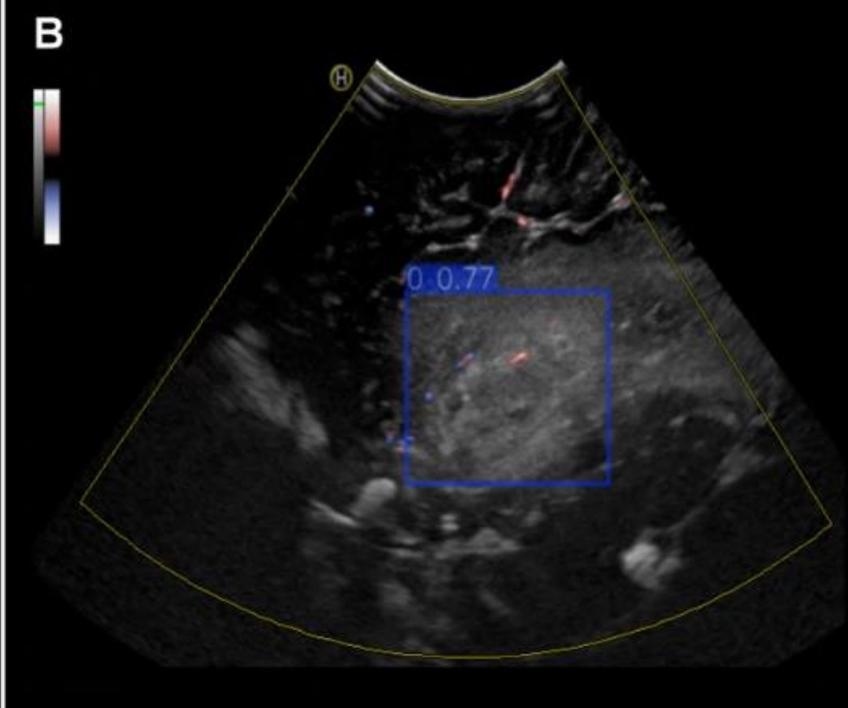
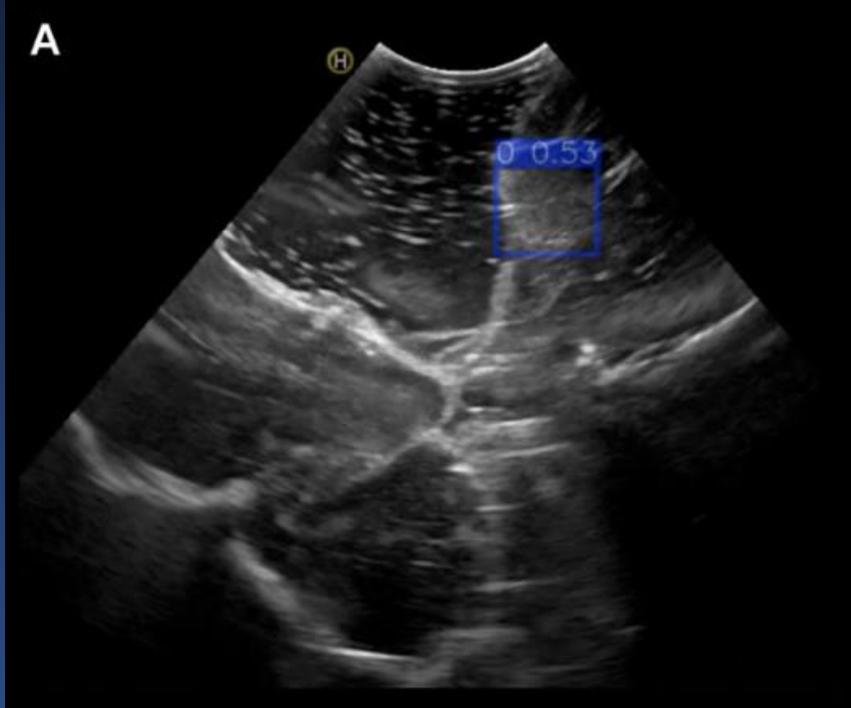
^k Department of Neurological Surgery, Johns Hopkins Medical School, 733 N Broadway, Baltimore, 21205, Maryland, USA

^l Department of Neurosurgery, Massachusetts General Hospital, Harvard Medical School, 55 Fruit St, Boston, 02114, Massachusetts, USA

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ⁿ Institute for Research in Mathematics (IMUVA), University of Valladolid, P. de Belen 15, Valladolid, 47011, Spain







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journal homepage: www.elsevier.com/locate/combiomed



Real-time brain tumor detection in intraoperative ultrasound: From model training to deployment in the operating room

Santiago Cepeda^{a,b,*}, Olga Esteban-Sinovas^{a,b}, Roberto Romero^c, Vikas Singh^d, Prakash Shett^d, Aliasgar Moiyadi^d, Ilyess Zemmoura^{e,f}, Giuseppe Roberto Giammalva^g, Massimiliano Del Bene^{h,i}, Arianna Barbotti^h, Francesco DiMeco^{h,j,k}, Timothy R. West^l, Brian V. Nahed^l, Ignacio Arrese^{a,b}, Roberto Hornero^{b,m,n}, Rosario Sarabia^{a,b}

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ⁱ Department of Pharmacological and Biomolecular Sciences, University of Milan, Via Festa del Perdono 7, Milan, 20122, Italy

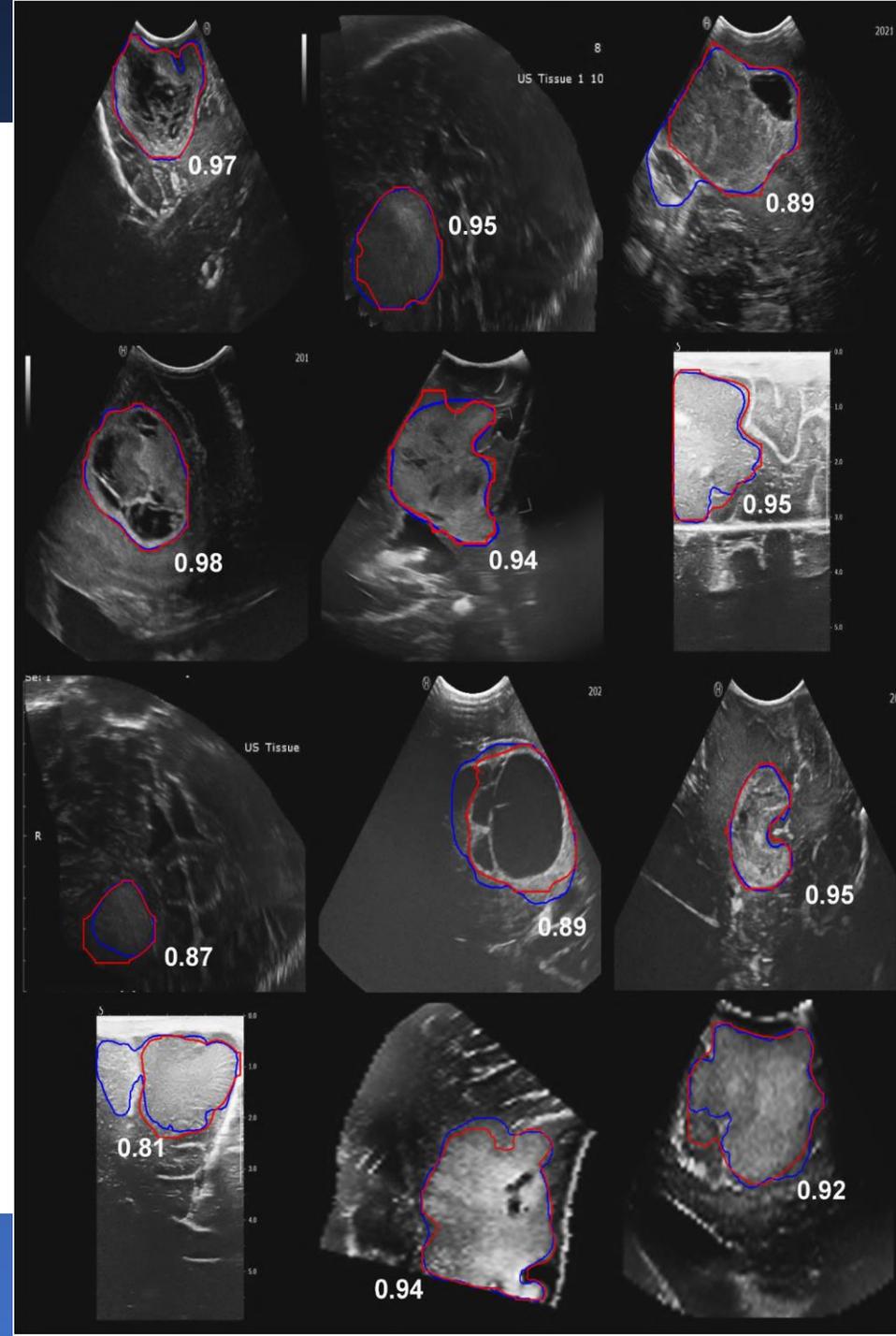
^j Department of Oncology and Hematology-Oncology, Università Degli Studi di Milano, Via Festa del Perdono 7, Milan, 20122, Italy

^k Department of Neurological Surgery, Johns Hopkins Medical School, 733 N Broadway, Baltimore, 21205, Maryland, USA

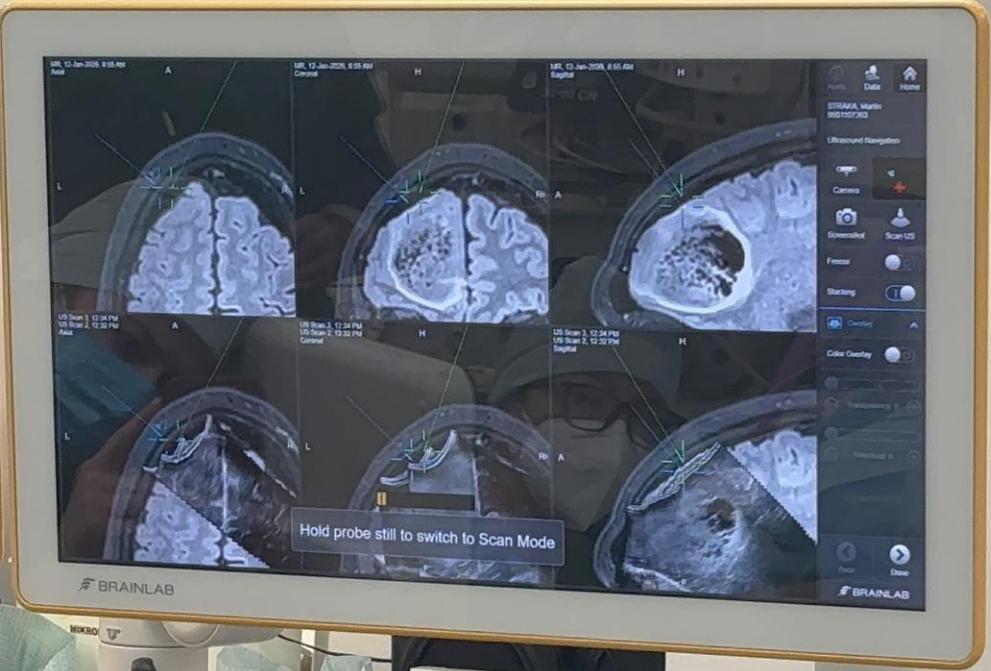
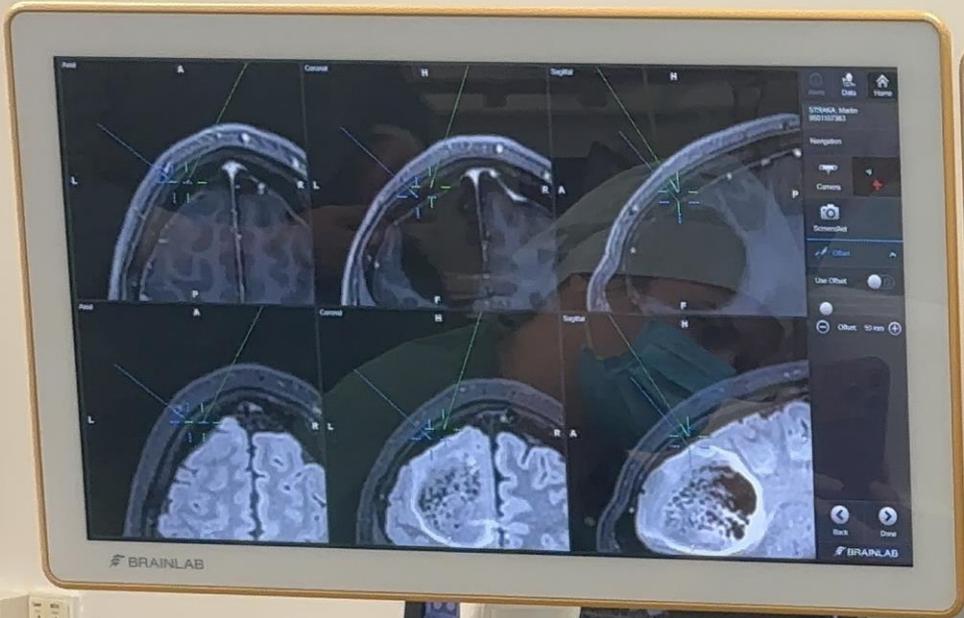
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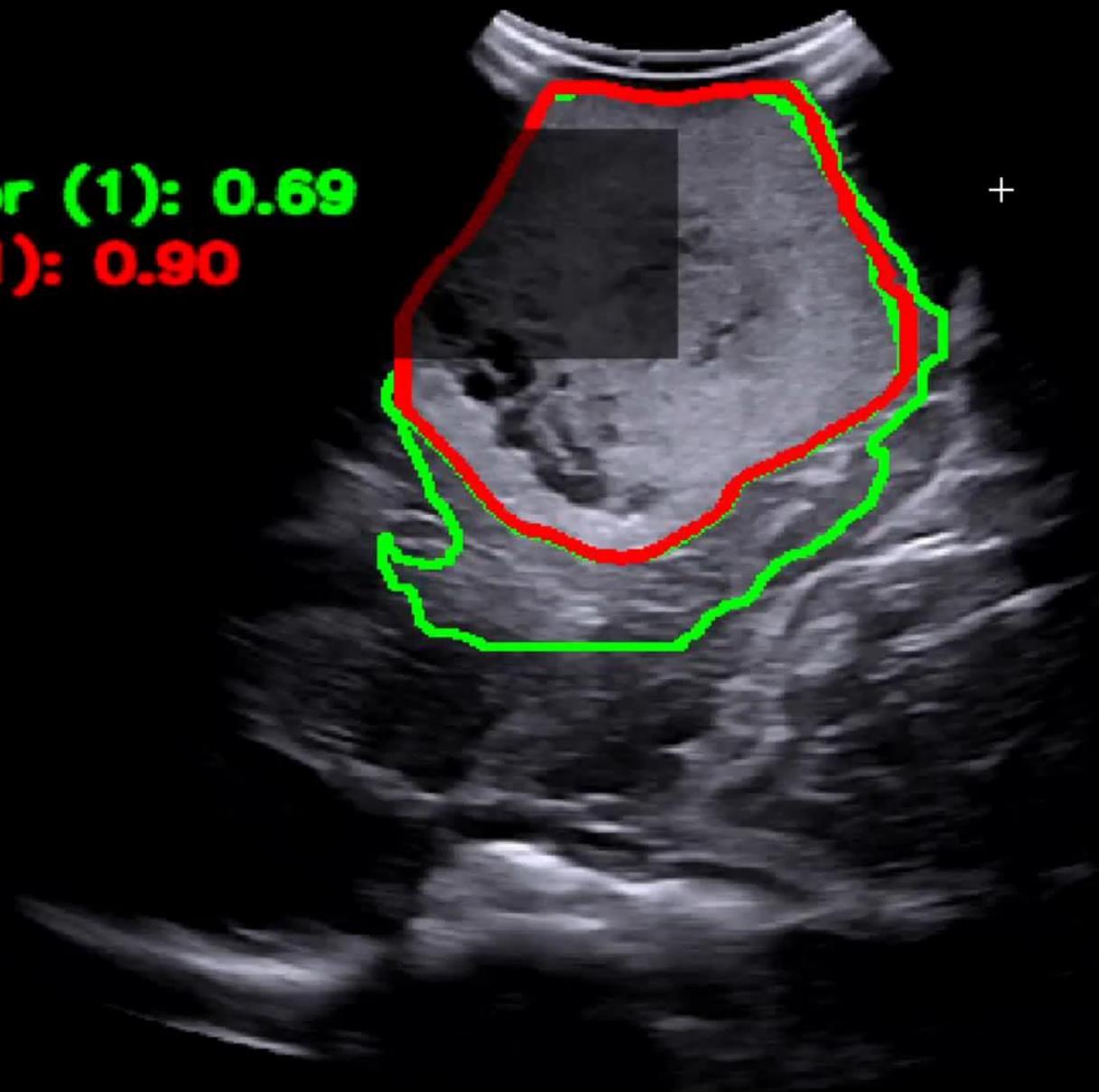






bk
peritumor (1): 0.69
tumor (1): 0.90

bk



0 cm -



2 -

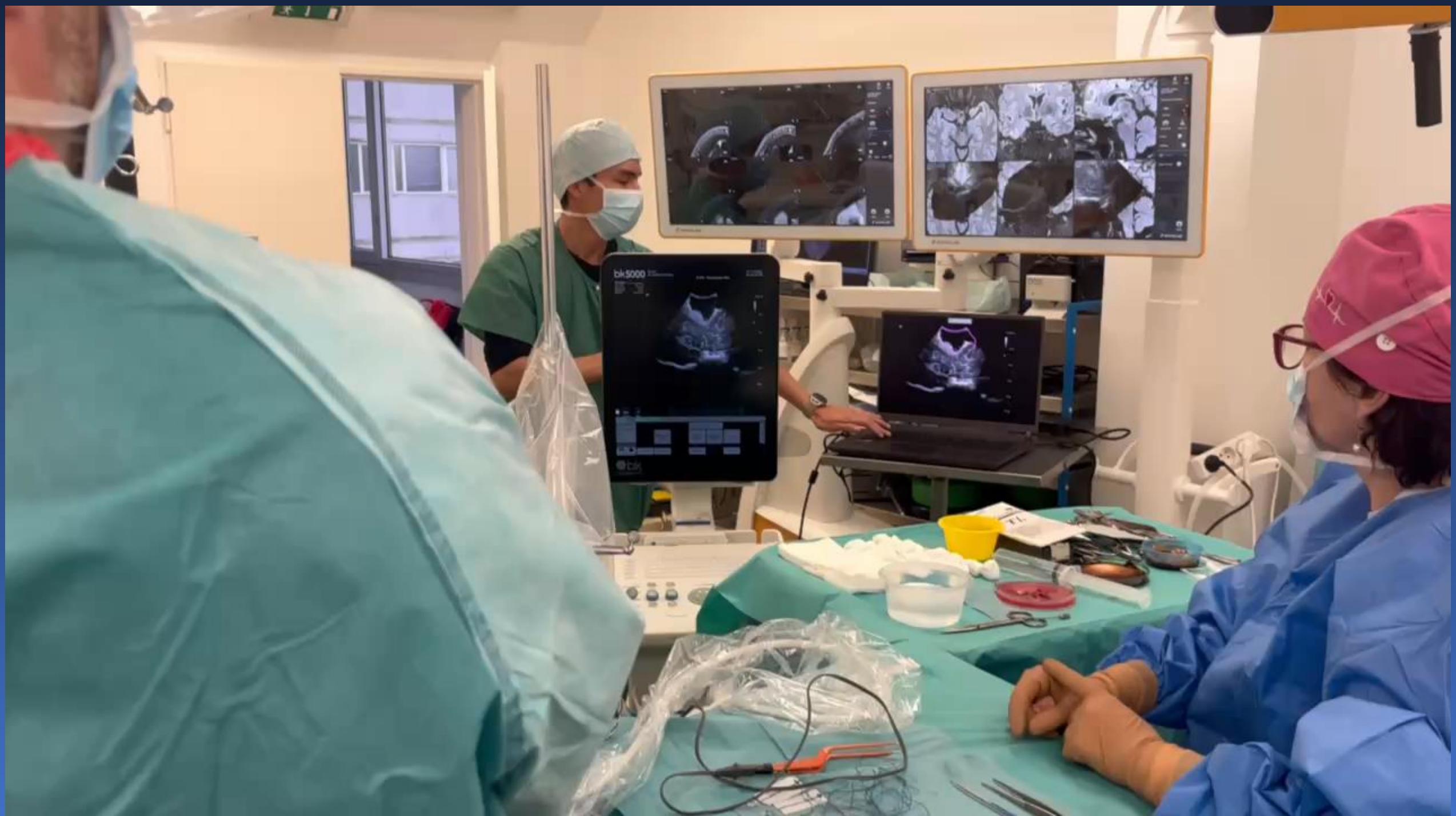
M1

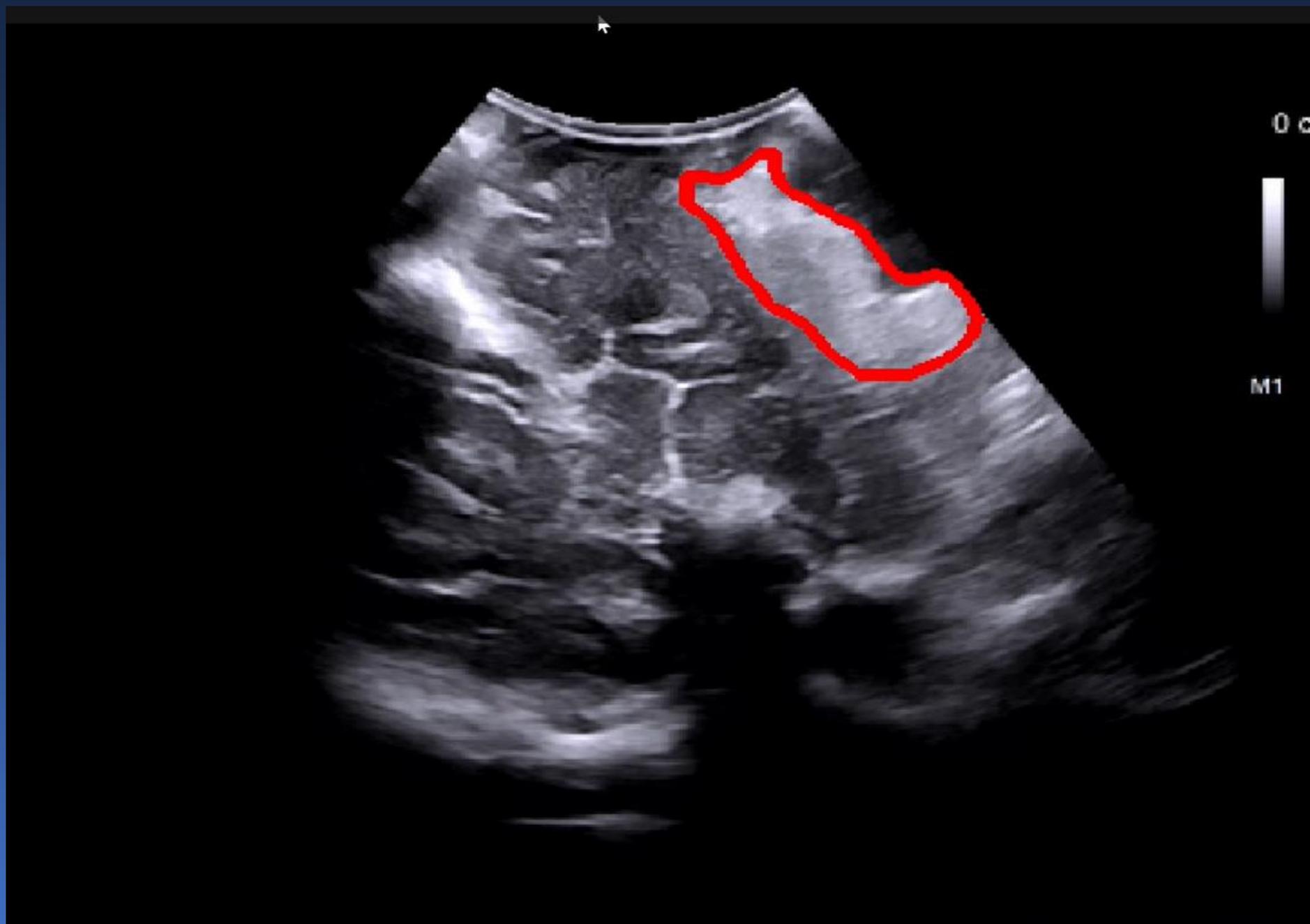
4 -

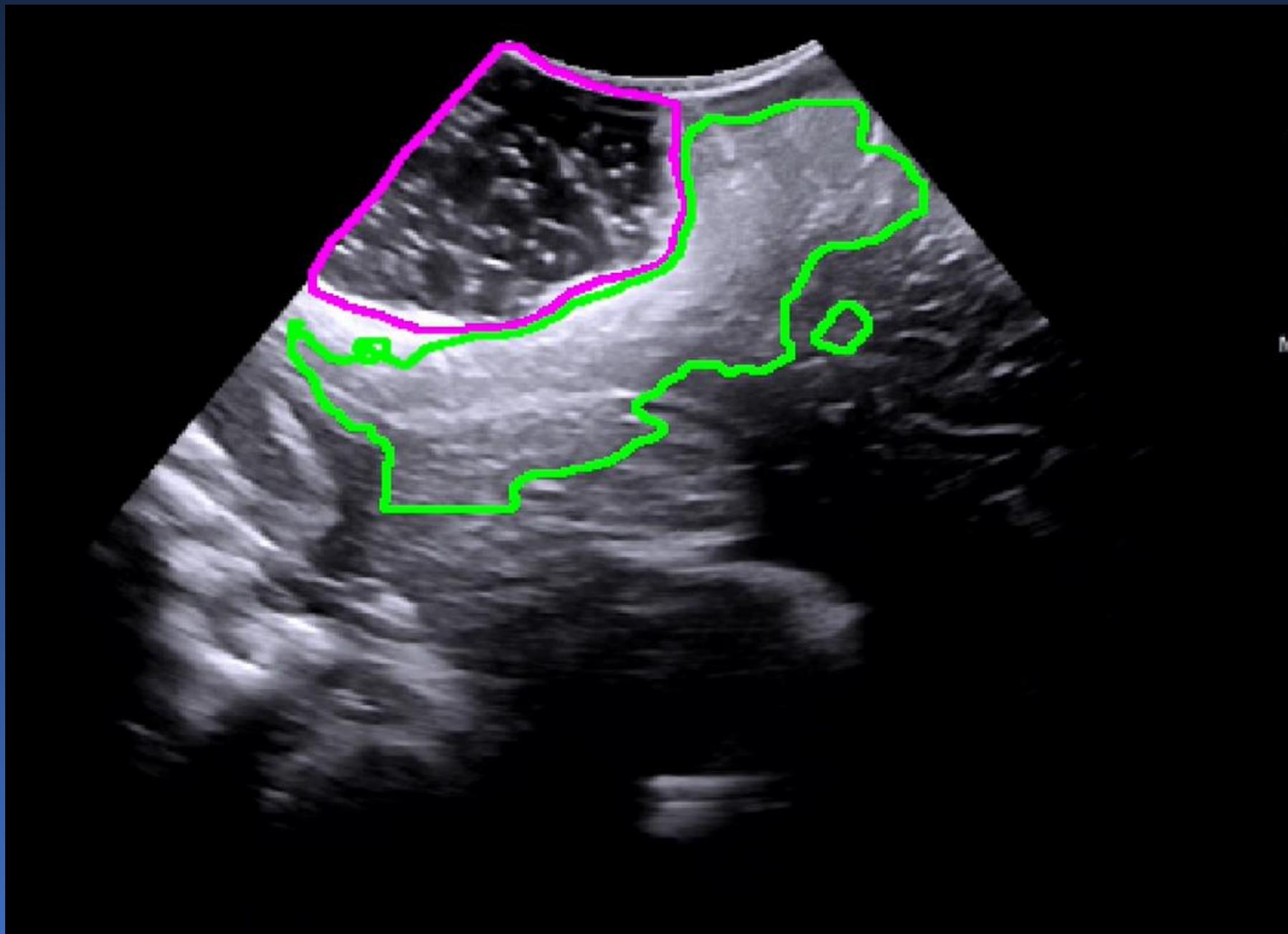
6 -

8 -

10.0







Skúmaný A.I. model sa nateraz ukazuje ako potenciálne užitočná pomôcka.

ALE...



A.I. má nezanedbateľné riziká už v súčasnosti

1. Halucinácie s medicínskym dopadom aj v A.I. určenej lekárom
2. Kognitívny úpadok (postupná strata schopnosti rozmýšľať)
3. Genetický dopad

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Halucinácie: OE má najnižšiu mieru medicínskych halucinácií vďaka striktnému RAG (Retrieval-Augmented Generation). Ak informácia nie je v peer-reviewed zdrojoch, OE si ju na rozdiel od GPT-4/5 zriedkakedy "vymyslí".



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found no reduced risk of CCM-related hemorrhage with β -blocker use.

Neurosurgical R... + 1

There is no consensus or guideline supporting propranolol as a routine therapy for CCMs adjacent to developmental venous anomalies, and its use remains investigational. For patients with surgically inaccessible CCMs and disabling symptoms such as drop attacks, management is limited to symptomatic therapy and risk factor control (e.g., blood pressure management), with surgical or radiosurgical intervention reserved for select cases. Further large-scale, prospective trials are needed to clarify the role of propranolol and other beta-blockers in CCMs.  Lancet + 4

can you cite me the part of the original paper corresponding to: "For example, during awake craniotomy for tumor resection, the neurosurgeon may use gentle palpation to identify tumor margins, assess tissue consistency, or facilitate intraoperative mapping of functional cortex, as described in the context of awake brain surgery and intraoperative mapping techniques.[1]"

Answered on 16. septembra 2025

✓ Finished thinking

The following excerpt from the medical literature directly supports the statement: "For example, during awake craniotomy for tumor resection, the neurosurgeon may use gentle palpation to identify tumor margins, assess tissue consistency, or facilitate intraoperative mapping of functional cortex, as described in the context of awake brain surgery and intraoperative mapping techniques":

From Gogos AJ et al., "Awake Glioma Surgery: Technical Evolution and Nuances" (Journal of Neuro-Oncology, 2020):

During awake craniotomy, the surgeon may use direct tactile feedback to assess tumor consistency and margins, in addition to visual and electrophysiological cues. Gentle manipulation and palpation of the cortex and subcortical structures are often necessary to optimize exposure and facilitate functional mapping, especially when distinguishing tumor from normal brain tissue in eloquent areas.



Žiadne výsledky
Skúste inú hľadajú položku

Check for updates

Awake glioma surgery: technical evolution and nuances

Andrew J. Gogos¹ · Jacob S. Young¹ · Ramin A. Morshed¹ · Shawn L. Hervey-Jumper¹ · Mitchel S. Berger¹

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Abstract

Introduction Multiple studies have demonstrated that improved extent of resection is associated with longer overall survival for patients with both high and low grade glioma. Awake craniotomy was developed as a technique for maximizing resection whilst preserving neurological function.

Methods We performed a comprehensive review of the literature describing the history, indications, techniques and outcomes of awake craniotomy for patients with glioma.

Results The technique of awake craniotomy evolved to become an essential tool for resection of glioma. Many perceived contraindications can now be managed. We describe in detail our preferred technique, the testing paradigms utilized, and critically review the literature regarding functional and oncological outcome.

Conclusions Awake craniotomy with mapping has become the gold standard for safely maximizing extent of resection for tumor in or near eloquent brain. Cortical and subcortical mapping methods have been refined and the technique is associated with an extremely low rate of complications.

ventral stream mapping commonly leads to errors during picture-word interference testing (Fig. 2b) [47], with semantic paraphasia's occurring commonly in the IFOF [46]. There is conflicting evidence regarding the function of the uncinate fasciculus, with some reporting that its removal impairs the ability to name famous faces [48], whereas other others have shown its removal does not lead to any permanent deficit [49]. We do not specifically test for this phenomenon. During dorsal stream mapping, errors are commonly seen in sentence generation (Fig. 2c), with hesitation, grammatical or semantic paraphasias occurring on the verb (rather than on the subject or object). Picture-word interference errors also occur during dorsal testing, but are seen less commonly than in the ventral stream and are manifest as speech arrest [47].

Motor function is tested subcortical in the same manner as for cortical testing. If errors or movement occur during subcortical mapping, we wait and then repeat the task. We

Outcomes

consistency

1/1



Intraoperative stimulation mapping is the gold for minimizing postoperative deficits [50], and there have been numerous studies examining neurologic outcomes after intraoperative mapping during awake craniotomies (Table 3). In general, awake craniotomies can be performed safely and can allow for significant extent of resection in patients with glioma. The majority of studies report a mean extent of resection greater than 90% or a GTR rate of greater than 50%. Rates of permanent deficits range from 3 to 47.1%, however studies vary in terms of lesion location and degree of involvement of eloquent tissue. There is also a lack of consistency in the definition of a “fixed” or “permanent” neurologic deficit, with groups defining this term as a deficit persisting by anywhere from 1 to 6 months postoperatively.

I have the full article but the part "For example, during awake craniotomy for tumor resection, the neurosurgeon may use gentle palpation to identify tumor margins, assess tissue consistency, or facilitate intraoperative mapping of functional cortex, as described in the context of awake brain surgery and intraoperative mapping techniques" is not there

Answered on 16. septembra 2025

✓ Finished thinking

The statement that "during awake craniotomy for tumor resection, the neurosurgeon may use gentle palpation to identify tumor margins, assess tissue consistency, or facilitate intraoperative mapping of functional cortex" is not explicitly described in the text of Gogos AJ et al. (Journal of Neuro-Oncology, 2020) or in any of the other referenced articles as a direct recommendation or technique. The medical literature on awake craniotomy and intraoperative mapping consistently discusses the use of direct cortical and subcortical stimulation, intraoperative neurological assessment, and functional mapping to guide resection and preserve eloquent cortex. [Neuro-Oncology + 3](#) However, none of these articles provide a direct citation or specific section describing gentle palpation by the neurosurgeon as a standard or recommended method for identifying tumor margins or tissue consistency during awake craniotomy.

Your Brain on ChatGPT: Accumulation of Cognitive Debt when Using an AI Assistant for Essay Writing Task[△]

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Zdeněk Burian: Lovci mamuta

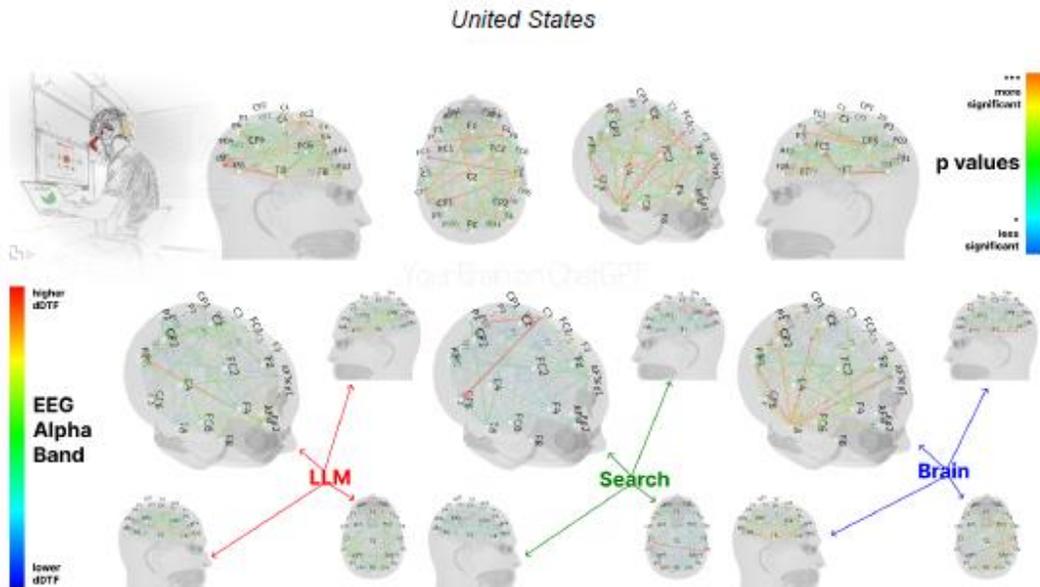


Figure 1. The dynamic Direct Transfer Function (dDTF) EEG analysis of Alpha Band for groups: LLM, Search Engine, Brain-only, including p-values to show significance from moderately significant (*) to highly significant (***)



Ďakujem za pozornosť



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