Introducing ARveo

Digital Augmented Reality Microscope

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PCP

Leica MICROSYSTEMS

ARveo Platform

- AR Imaging
- 3D in the OR
- Sharing Beyond the OR
- Groundbreaking Optics
- Workflow and Ergonomics
- Safety
- Video Library
- Case Studies
- The Leica Demo Experience

VIDEO ARveo Introduction

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Augmented Reality Imaging

GLOW800

ARveo Platform

AR Imaging

- GLOW AR Technology
- GLOW800
- Pioneering Fluorescence
- IGS with Brainlab
- Image Injection

3D in the OR

Sharing Beyond the OR

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The Leica Demo Experience

Vascular fluorescence augmented with GLOW800

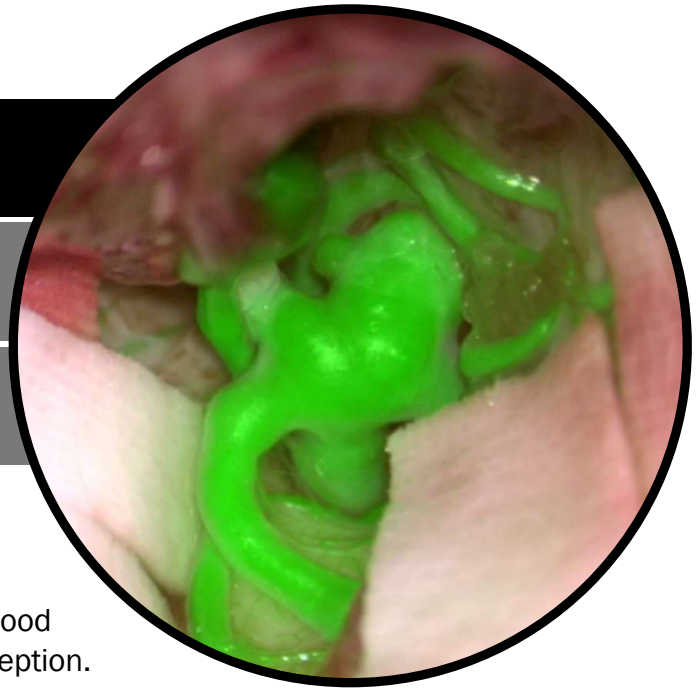
Observe cerebral anatomy in natural color, augmented by real-time vascular flow, with full depth perception. GLOW800 AR fluorescence takes the high contrast of ICG and combines it with white light.

Touch to see this technology at work

GLOW800
AR Fluorescence

White Light

NIR Fluorescence



Real-time GLOW800 visualization. Natural color anatomy and high-contrast, colored blood flow with full depth perception.

- No more interrupting surgery to switch between the natural microscope image and a flat black and white NIR video, no more mental gymnastics to recall and reconcile the different views
- Crisp delineation helps you limit potential compromise or obstruction of surrounding perforators and small vessels.
- Full depth perception and no dark peripheries supports clear spatial orientation to aid manipulation of vessels.

"GLOW800 worked straight away. Suddenly we had the blood vessels lighting up but we could still see the brain structures around them. Now we can keep oriented in the surgical environment."

Professor Raphael Guzman MD

GLOW800 cannot be viewed in 3D

VIDEO GLOW800 First Impressions | VIDEO GLOW800 Comparison | VIDEO GLOW800 AV Fistula | VIDEO GLOW800 ICA Aneurysm | VIDEO GLOW800 MCA Aneurysm | VIDEO GLOW800 Pericallosal Aneurysm

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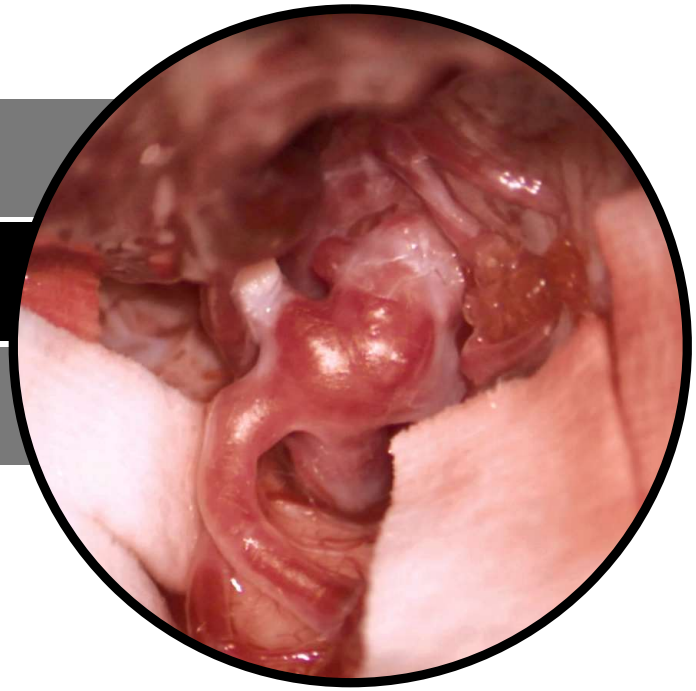

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White Light

NIR Fluorescence

Delay with NIR fluorescence. Flat image lacks anatomical detail and has dark peripheries.

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Augment Your Reality

Augmented Reality Imaging

A Decade of Pioneering Fluorescence

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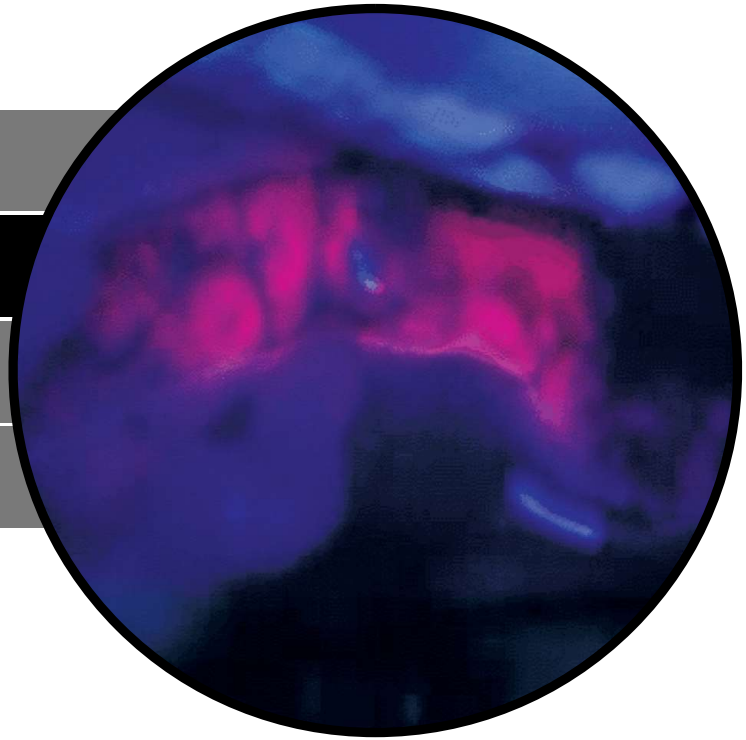
Touch to see the options

- Fluorescence Options
- FL400
- FL800
- FL560



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10 A DECADE OF PIONEERING FLUORESCENCE

FL400 oncological fluorescence

> The fluorescence module FL400 is used during open neurosurgery in conjunction with the active substance 5 aminolevulinic acid (5-ALA). It supports resection by allowing differentiation of tumor tissue from healthy brain tissue.

VIDEO FL400 VIDEO FL560

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Augmented Reality Imaging

A Decade of Pioneering Fluorescence

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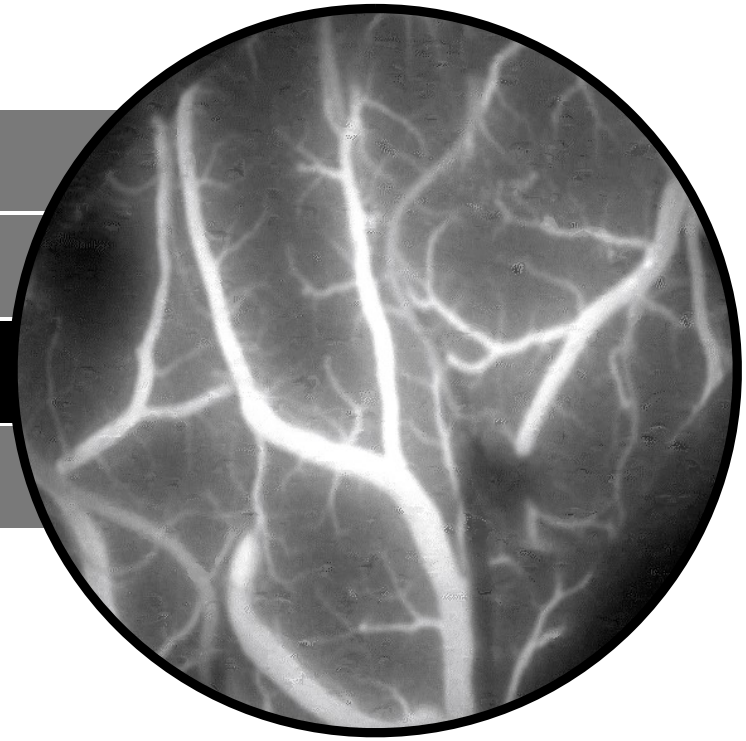

10 A DECADE OF PIONEERING FLUORESCENCE

FL800 intraoperative video-angiography module

> When used in conjunction with ICG fluorescent dye, this feature allows neurosurgeons to clearly visualize blood flow in real-time.

VIDEO FL400

VIDEO FL560

GLOW800 cannot be viewed in 3D

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Augmented Reality Imaging

A Decade of Pioneering Fluorescence

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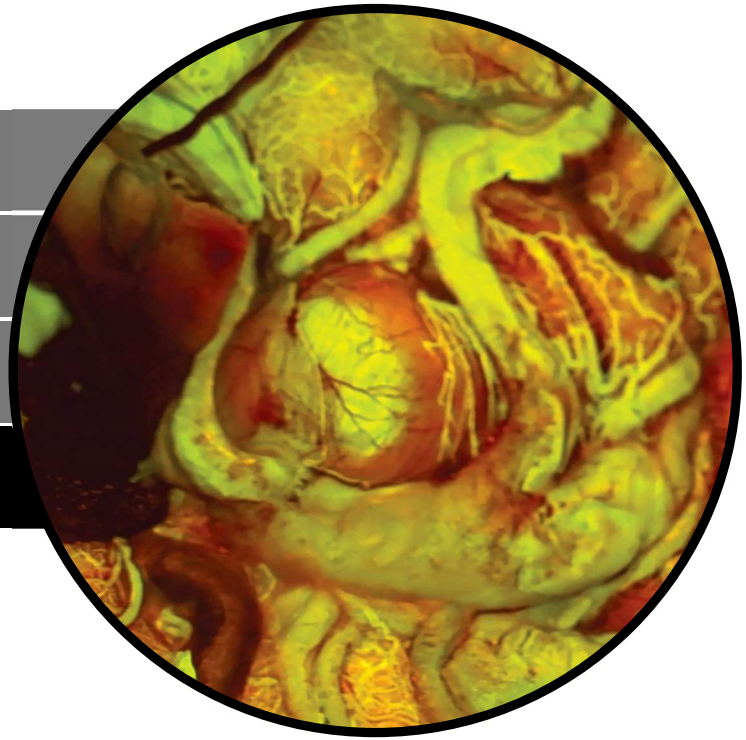

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10 A DECADE OF PIONEERING FLUORESCENCE

FL560

> The FL560 fluorescence module enables simultaneous, real-time observation of both non-fluorescent tissue and fluorescent areas, with clear differentiation and contrast.

VIDEO FL400

VIDEO FL560

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IGS and microscope navigation

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View images from IGS systems to further augment your surgical insight and enjoy robotic control for seamless workflow. Inject data into the oculars with CaptiView or display on a large 4K 3D screen.

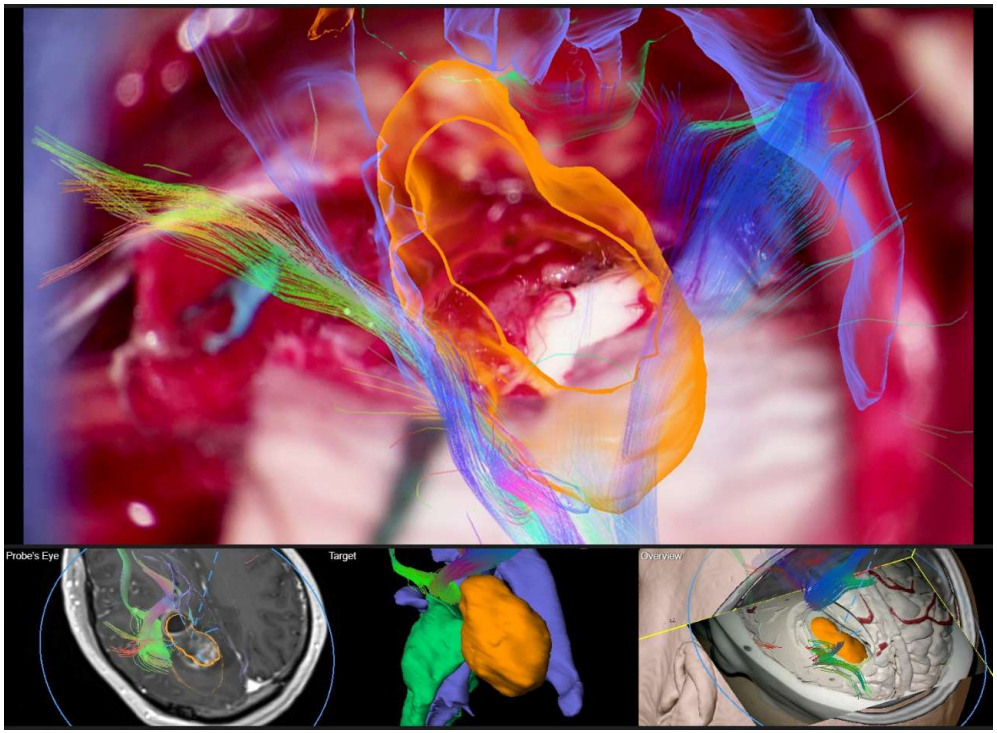

Image shows Cranial Navigation from Brainlab. Brainlab is a trademark of Brainlab AG.

Cranial and Microscope Navigation from Brainlab

- Stay focused on your patient with an all-in-one visualization tool
- Augmented Reality view within the microscope
- Guiding tools for improved decision making
- Anatomical and functional information brought into the surgical field
- Shift correction with reference to anatomical structures
- Tool tracking through IGS robotic function

GLOW800 cannot be viewed in 3D

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Augmented Reality Imaging

CaptiView Image Injection

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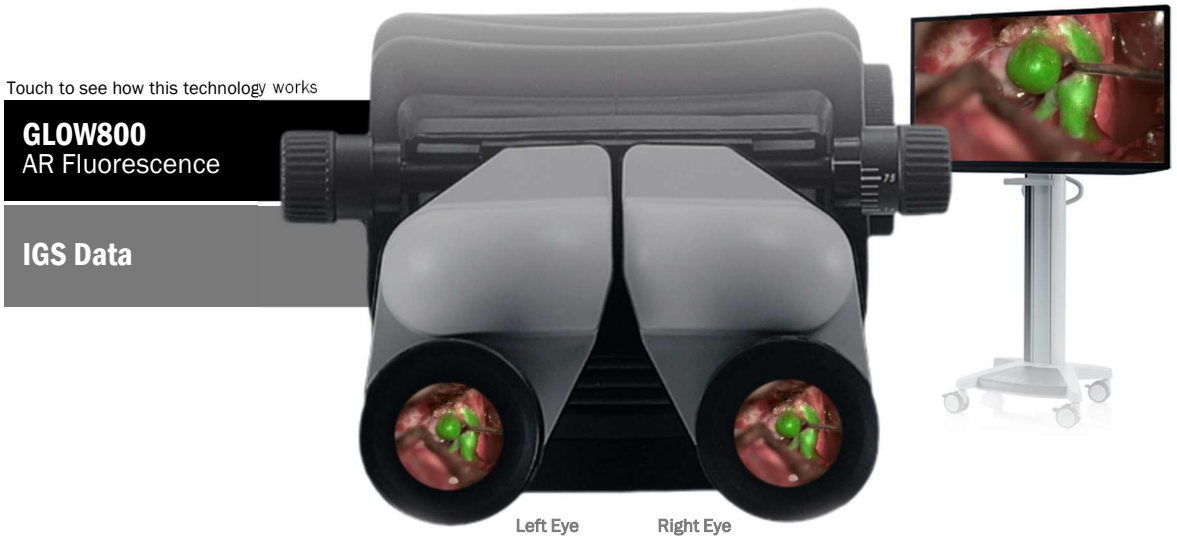
The Leica Demo Experience

Neurosurgical procedures require your complete focus, so we've put you at the core of our design.

With CaptiView image injection there's no need to look away from the surgical site to the monitor during surgery.



- View GLOW AR fluorescence, IGS data from leading manufacturers, endoscope images and microscope information thanks to the OpenArchitecture design
- Rely on full-HD 1080p resolution and 500:1 contrast
- Overlay data on the live surgical image or view as non-correlated in left, right or both eyepieces

VIDEO CaptiView Image Injection

GLOW800 cannot be viewed in 3D

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Augmented Reality Imaging

CaptiView Image Injection

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ARveo
Augment Your Reality

3D in the OR

Heads-up Surgery

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Heads-up Surgery
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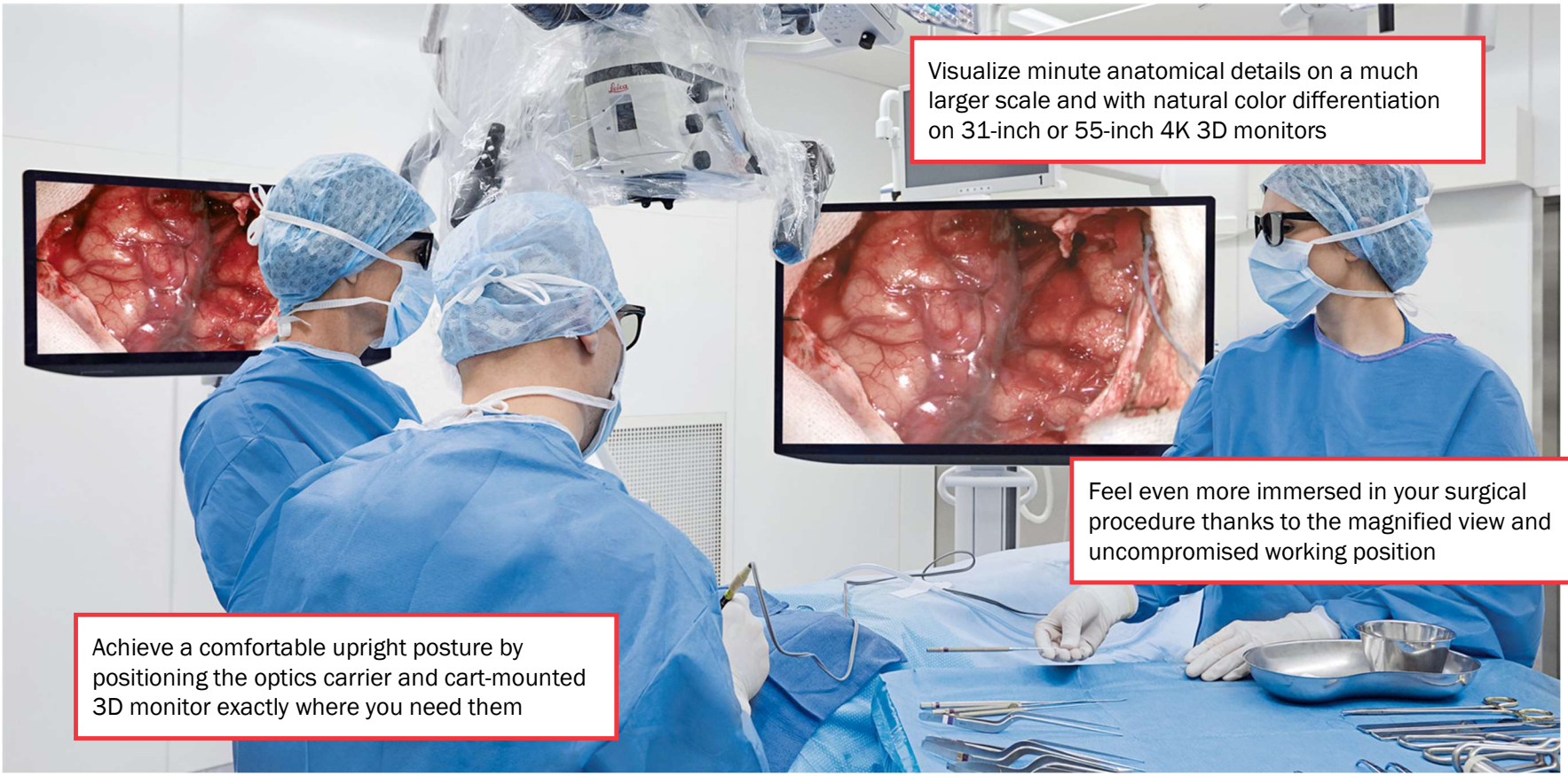
Choose to work heads-up and enjoy the full depth perception and high resolution you require without needing to look through the oculars.



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3D in the OR
Teaching

ARveo Platform
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Heads-up Surgery
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While you're focused on the task at hand, the whole team can follow in detail in 2D or 3D on one of the large 4K monitors

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3D in the OR

Choose Your Monitor

Leica MICROSYSTEMS

- 55-inch 4K 3D cart system
- 31-inch 4K 3D microscope monitor
- Cart mounted system for positioning flexibility in your OR

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Sharing Beyond the OR

See the Difference Beyond the OR

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AR Imaging
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Sharing Beyond the OR
- Live Streaming
- Recording and Documenting
- Full Security
- Application

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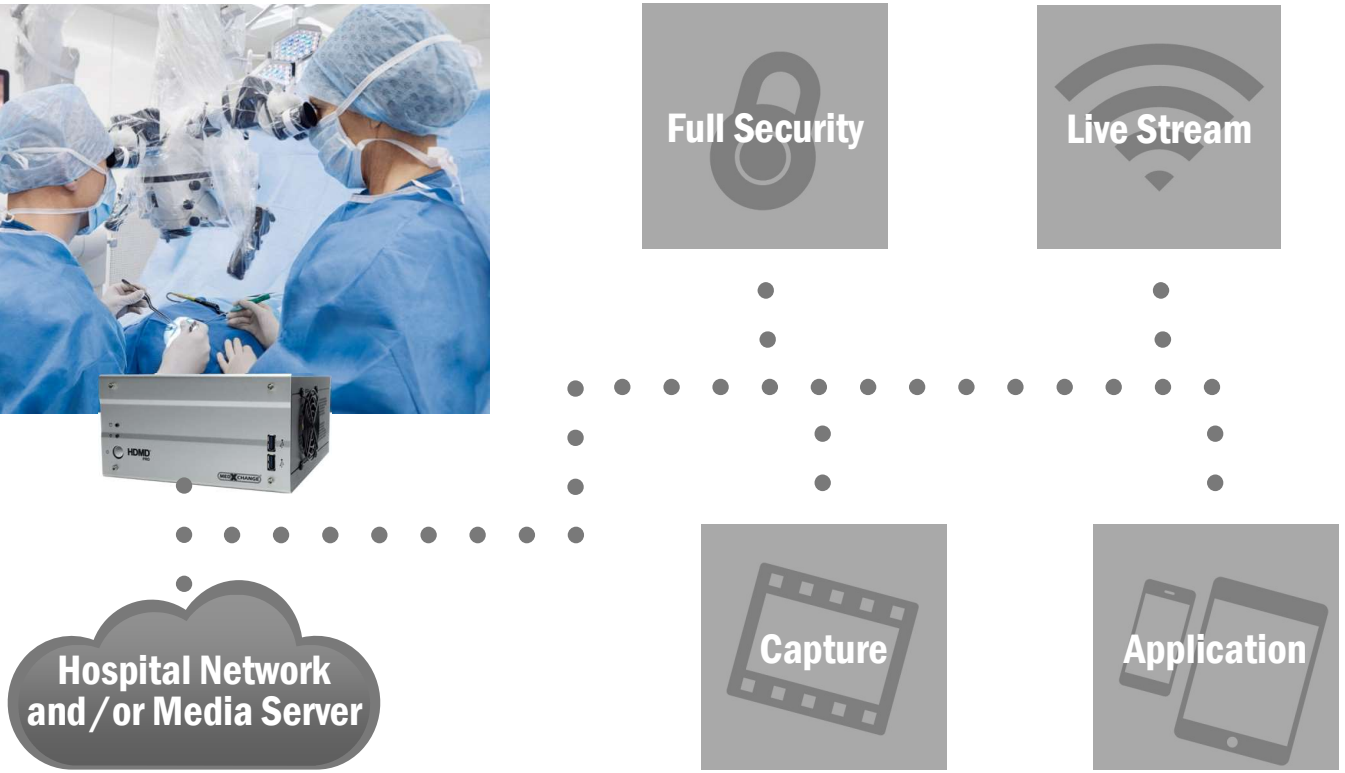

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Sharing Beyond the OR

Live Streaming

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Hospital Network and / or Media Server

Live Stream

Stream live video* instantly to mobile or desktop devices for flexible viewing and education beyond the OR with the integrated Med X Change HDMD Pro.

> Share your skills live with students and peers

> Remotely observe your residents as they prepare the surgical site, without leaning over their shoulders

GLOW800 cannot be viewed in 3D
*Live streaming is not certified for supporting remote operations

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Sharing Beyond the OR

Recording and Documenting

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Hospital Network and / or Media Server

Capture, Save and Share with Ease

Ready to capture and save it all

> With built-in workflow features, you don't lose time setting up a camera or recording system

> Customize your recording, editing and video replay with the fully compliant and secure HDMD Pro from Med X Change

Customize your recording, editing and video replay for later teaching and documentation.

> Record video and still images to USB or your hospital network via cable or Wifi

> DICOM/PACS integration allows you to document cases and save with patient data

> Easily edit your recordings for teaching and peer presentations

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Sharing Beyond the OR

Application

ARveo Platform

AR Imaging

3D in the OR

Sharing Beyond the OR

- Live Streaming
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- **Application**

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Hospital Network and / or Media Server

Application

MEDXSTREAM® wireless iOS app

- Add patient information
- Wi-Fi / Auto transfer of HD still images
- Create PDF surgical reports with image annotation / mark-ups
- Audio dictation embedded into PDF surgical reports
- Export to video editing apps
- Record 1080p video directly to the MedXStream app via USB 3.0 (lightning connector)

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Groundbreaking Optics

Small Angle Illumination

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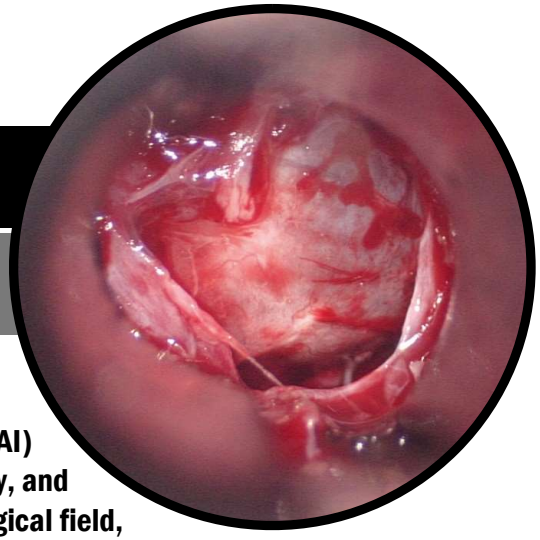
Deeper light penetration, increased detail visibility and improved depth perception.

Touch to see the benefits of this technology

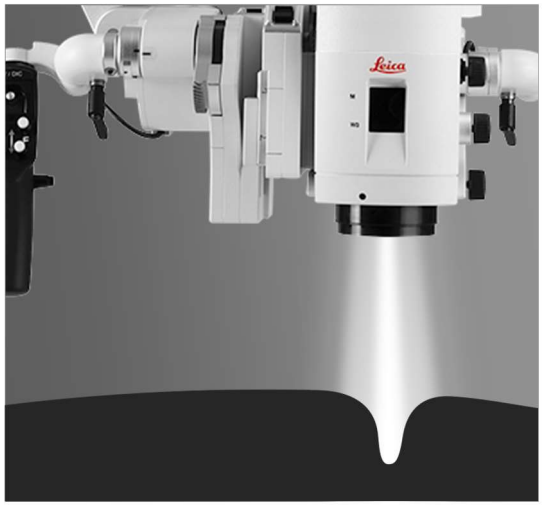
With
Small Angle Illumination

Without
Small Angle Illumination



Small Angle Illumination (SAI) distributes light more evenly, and reduces shadows in the surgical field, providing: increased detail visibility, improved depth perception, and deeper light penetration.

Optimal Field of Illumination
AutoIris automatically adjusts the diaphragm so that only the visible area is illuminated. This prevents the possibility of drying or burning exposed tissue outside the field of view.



The more you know, the more empowered you become to make the right decisions for your patients. Small Angle Illumination (SAI) combined with bright 400 W Xenon illumination allows light to penetrate to the bottom of deep, narrow cavities.

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Groundbreaking Optics

Small Angle Illumination

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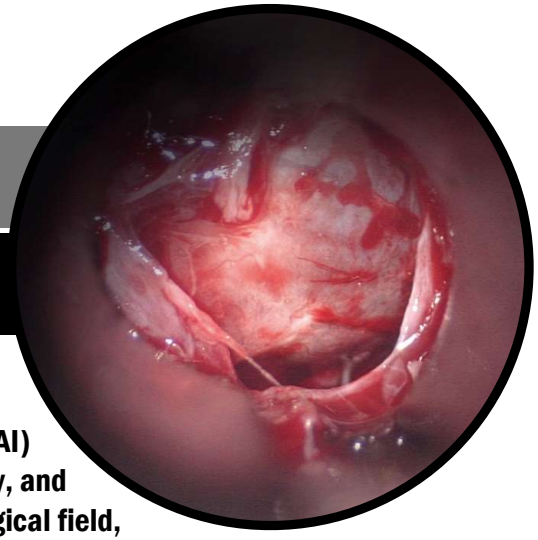
With
Small Angle Illumination

Without
Small Angle Illumination



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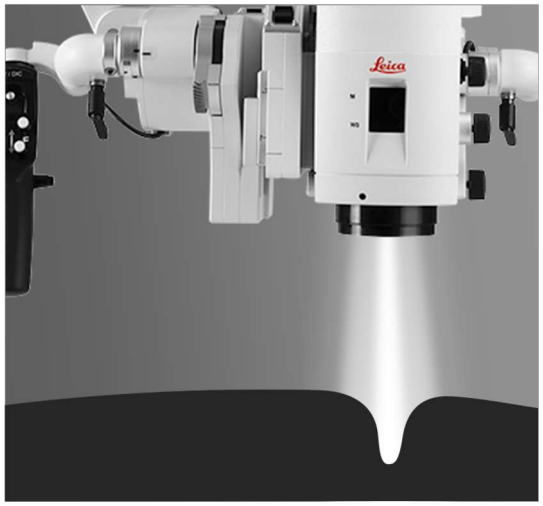

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Workflow that simply flows

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Groundbreaking Optics
Workflow and Ergonomics
Robust and Maneuverable
Optimized Ergonomics
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Thoughtfully designed for your comfort and efficiency.

Any giant leap in technology is only useful if it's used. The ARveo has been expertly designed so that it easily adapts to your preferred style of working and body frame. With ergonomics and efficiency factored into every design decision, from software to switch, you can experience all the benefits of augmented reality-enhanced surgery, without interrupting workflow.

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ARveo
Augment Your Reality

Workflow and Ergonomics

New Features

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Robust and Maneuverable

Optimized Ergonomics

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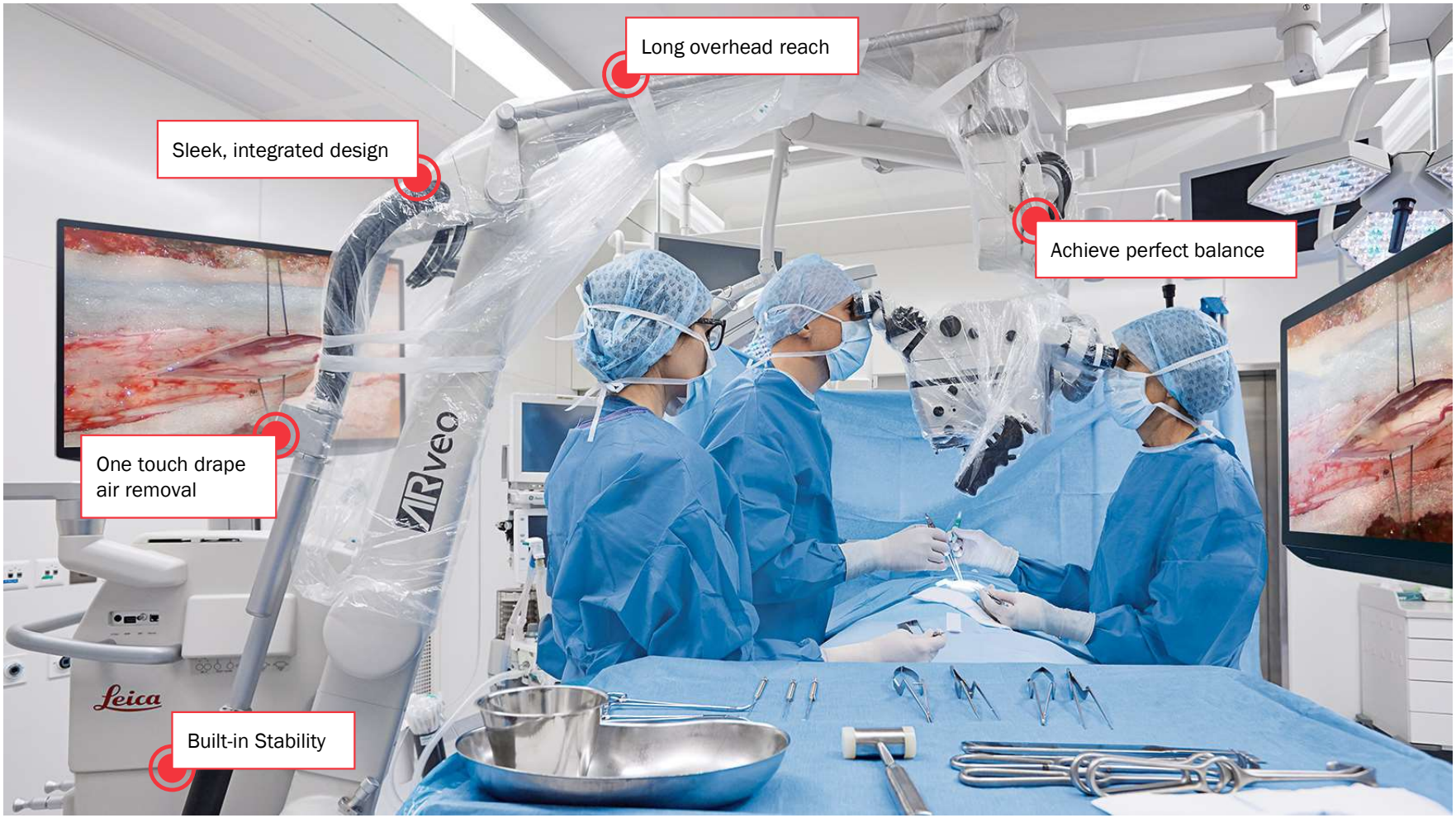

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Safety

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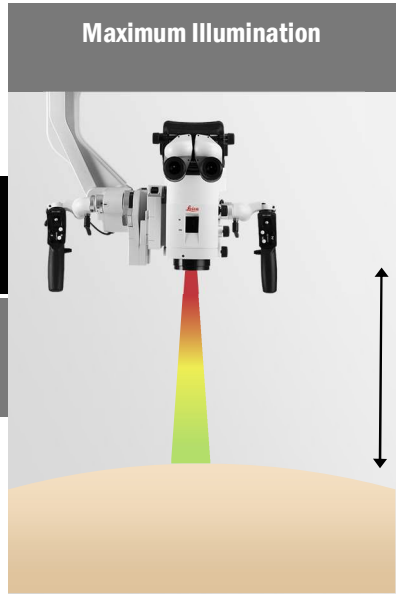
BrightCare Plus optimizes the light intensity relative to the working distance.

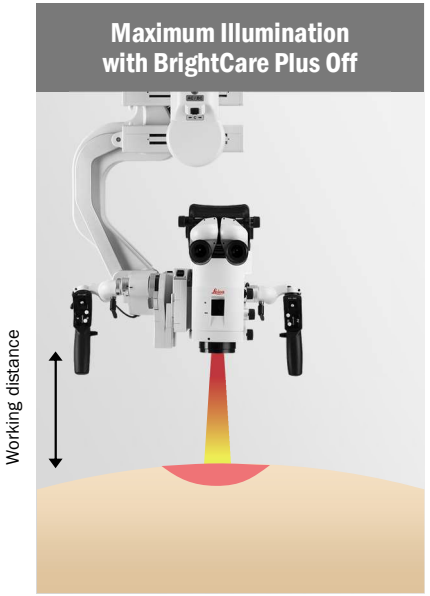
Touch to see how these technologies work

BrightCare Plus
Light Intensity

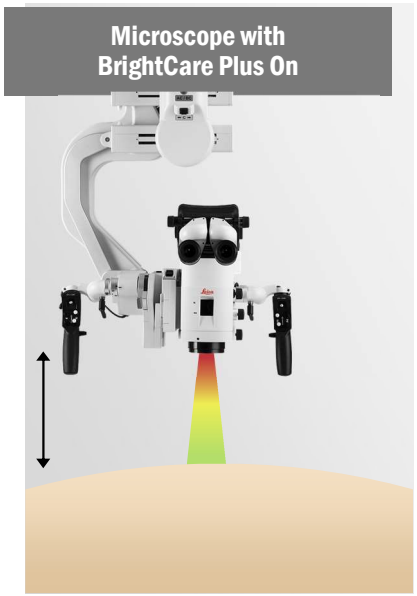
AutoIris
Light Diameter



Long working distance.



Decreased working distance at same illumination setting (left) creates burn potential in conventional microscopes.



BrightCare Plus automatically adapts light intensity to the working distance, providing safer illumination (up to 60% reduction of intensity).

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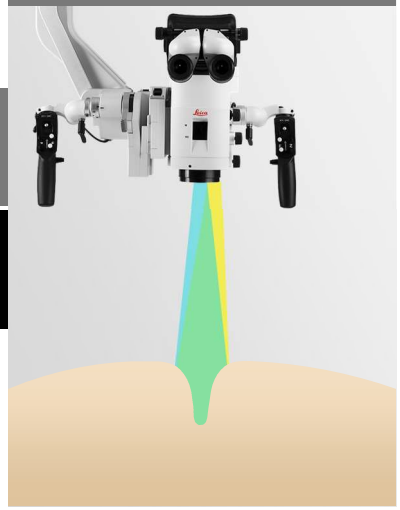
AutoIris automatically adjusts the diaphragm so that only the visible area is illuminated.

Touch to see how these technologies work

BrightCare Plus
Light Intensity

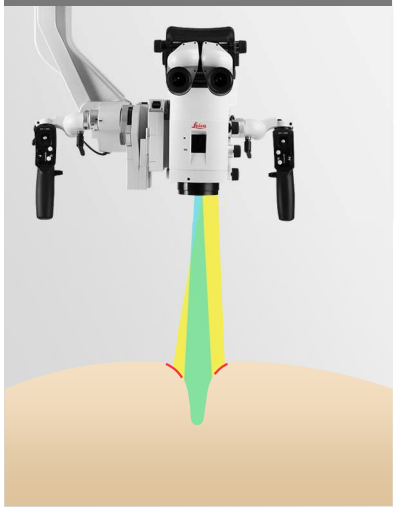
AutoIris
Light Diameter

Conventional Microscope at Low Magnification



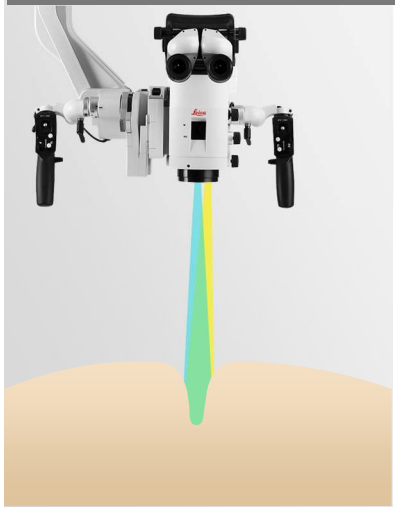
At low magnification, the field of illumination (yellow) fills the field of view (green) completely.

Conventional Microscope at High Magnification



Previously, as magnification increased, the field of view became smaller, but the illumination outside the field of view could potentially cause tissue burns (red).

Leica Microscope with AutoIris



AutoIris automatically works with the zoom, decreasing the field of illumination as the field of view decreases. There is no peripheral illumination to cause tissue burns outside the field of view.

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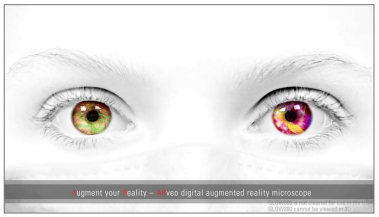

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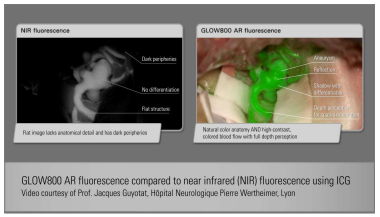
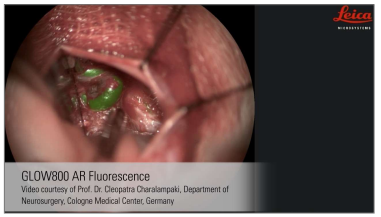
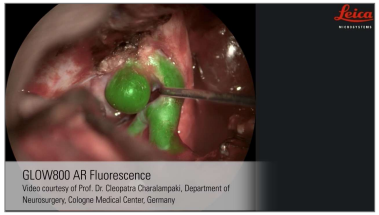


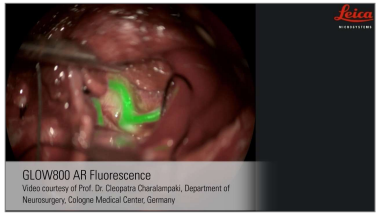
GLOW800
Comparison



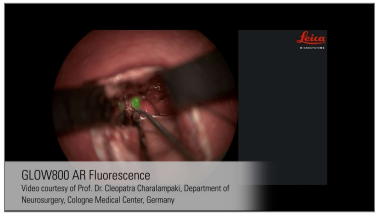
GLOW800
AV Fistula



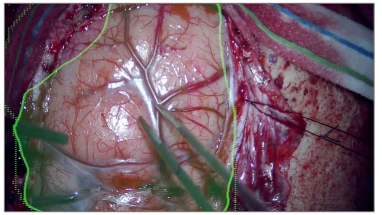
GLOW800
ICA Aneurysm



GLOW800
MCA Aneurysm

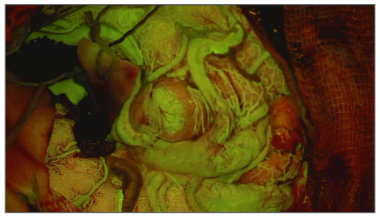


GLOW800
Pericallosal Aneurysm

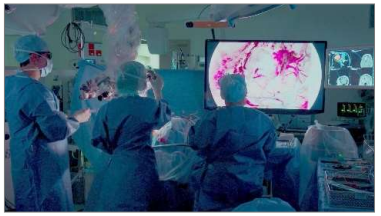


CaptiView
Image Injection

FL400



FL560



Heads-up surgery
A new era in neurosurgery

GLOW800 cannot be viewed in 3D

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GLOW800 Augmented Reality Fluorescence in Aneurysm Treatment

GLOW800 Augmented Reality Fluorescence in AVM Treatment

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CASE STUDY

GLOW800 Augmented Reality Fluorescence in Aneurysm Treatment

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Leica Microsystems would like to thank the University of Sao Paulo for the good cooperation for this case study, and especially Prof. Dr. Feres Chaddad for his work on this report.

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GLOW800 Augmented Reality Fluorescence in Aneurysm Treatment

I. INITIALPATIENT PRESENTATION AND FIRST SURGERY

Patient:

A 58-year-old female, with a medical history of well controlled hypertension presented with confusion and complete left hemiparesis.

Diagnosis:

- A ruptured right MCA M1 aneurysm
- Unruptured left MCA (Middle Cerebral Artery) and PCOM (Posterior Communicating Artery) aneurysms
- Her only medications were antihypertensives.

Treatment decision:

The decision was made to urgently treat the ruptured right MCA aneurysm with microsurgical clipping, in order to protect the patient from rebleeding from the unstable aneurysm.

The unruptured aneurysms were on the contralateral side and needed another craniotomy. Therefore we opted to wait for full recovery from the first surgery and subsequently treat the unruptured aneurysms with microsurgical clipping.

Outcome first surgery: Treatment of the ruptured right MCA with microsurgical clipping

The surgery on the ruptured right MCA aneurysm was successful and she was discharged 24 days post op. At the time of her discharge she had recovered the strength in her left leg and arm, but the left facial weakness remained. The cardiologist that evaluated her during hospitalization maintained her previous medications, with good control of her hypertension.

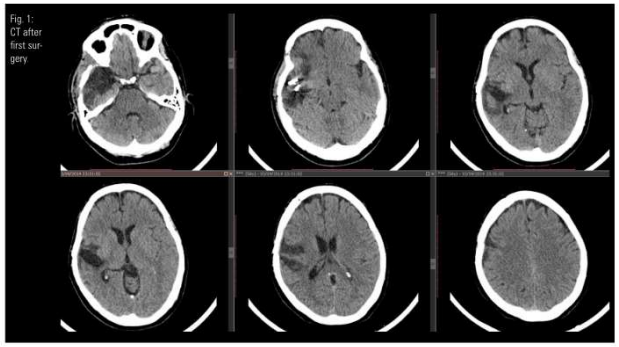


Fig. 1: CT after first surgery

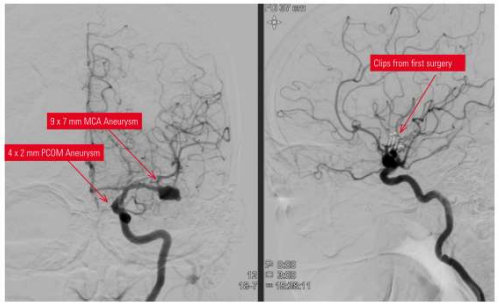
Image courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

II. PRE-OPERATIVEASSESSMENT BEFORE SECOND SURGERY

Three 3 months after the first surgery to treat the right-sided ruptured MCA, the patient returned for microsurgical clipping of the unruptured left MCA and PCOM aneurysms. Her physical examination at this time showed her to have a good general appearance, no cardiac abnormalities or signs of peripheral vascular compromise, or other signs of disease. Her neurological examination showed persisting left central facial weakness but no other neurological abnormalities, including of the cranial nerves.

Pre-operative images

Fig. 2: Pre-Operative DSA showing the unruptured aneurysms and the clips from the prior surgery.



Pre-operative images

Fig. 3: Showing the posterior circulation. Since we had a PCOM aneurysm to treat, we needed to know if the posterior circulation was dependent on the ICA (a persistent fetal circulation).

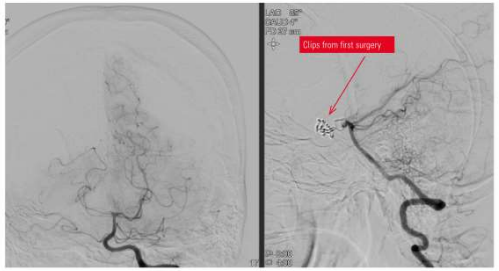


Image courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

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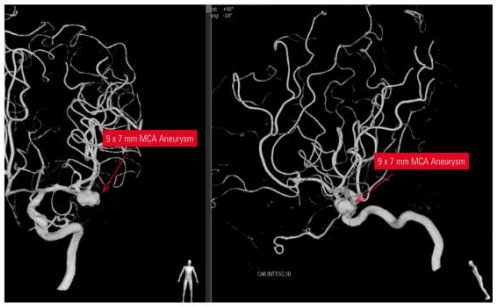
The following images show the injection of the left ICA. We can see both aneurysms in the 3D reconstruction. Since we had both a PCOM and an MCA aneurysm to treat, we decided on a Transsylvian approach, through a Pterional craniotomy.

Pre-operative images

Fig. 4:
3D reconstruction showing the MCA aneurysm.



Pre-operative images

Fig. 5:
3D reconstruction showing the MCA aneurysm.

Image courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

Pre-operative images

Fig. 6:
3D reconstruction showing both the MCA and PCOM aneurysms.

Pre-operative images

Fig. 7:
3D reconstruction showing both the MCA and PCOM aneurysms.

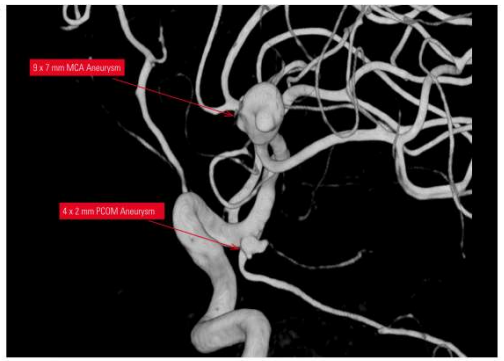


Image courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

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III.INTRA-OPERATIVECOURSE AND IMAGES

We performed a Pterional craniotomy with the withdrawal of the lesser sphenoid wing. With this craniotomy, we exposed the superior and part of the middle temporal gyrus, the Sylvian fissure, and the inferior and part of the middle frontal gyrus. For the approach, we opened Sylvian fissure, separating the frontal lobe from the temporal lobe, where we could find the MCA with its branches (and the aneurysm on the M1 segment). On the proximal M1 MCA, we entered the carotid cistern, where we could find the MCA and the PCOM aneurysms. Prof. Feres Chaddad opened the Sylvian fissure using sharp dissection, maintaining the dissection on the arachnoid space.

Pre-Clipping Videos (click to watch online)

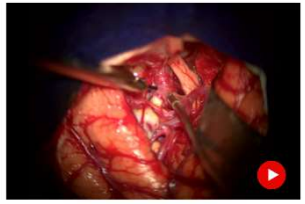
Identification of MCA & PCOM aneurysms with GLOW800 Augmented Reality Fluorescence from Leica Microsystems

Before clipping, GLOW800 helped to see the flow running through all the vessels and the aneurysms. GLOW800 also helped to distinguish the areas that were thrombosed, on the MCA aneurysm.

Fig. 8: GLOW800: Pre-Clipping. Courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

After the recognition of the main structures – ICA, ACA (A1), optic nerve, PCOM, choroidal arteries, and MCA (M1 and M2 branches) – the PCOM aneurysm was clipped. It is vital to be sure that both PCOM and the anterior choroidal arteries are preserved.

PCOM Aneurysm clipping (click to watch online)



Visual confirmation of the clip position (click to watch)

Fig. 9-10: PCOM clipping & visual confirmation of PCOM clipping. Courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

We then performed the occlusion of the MCA aneurysm. When this aneurysm was clipped we had to be sure that the superior and inferior trunks of M1 did not have a kink or a torsion that could lower the flow in these vessels.

MCA Aneurysm during clipping (click to watch online)

Visual confirmation of the clip position (click to watch)

Fig. 11-12: MCA clipping & visual confirmation of MCA clipping. Courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

Post-Clipping Videos (click to watch online)

Visual confirmation of clip position with GLOW800 Augmented Reality Fluorescence from Leica Microsystems

Post clipping, GLOW800 was fundamental to show the patency of the PCOM and the anterior choroidal arteries, as well as the superior and interior trunks of MCA. GLOW800 is an instant tool to check the flow distal to the clip, which allows one to continue to work during its acquisition, even positioning the clip.

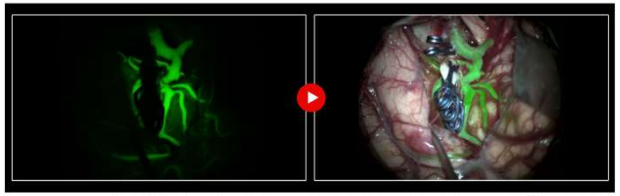


Fig. 13: GLOW800: Post-clipping video. Courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

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IV.POST SURGERY

CT showing the clip positions

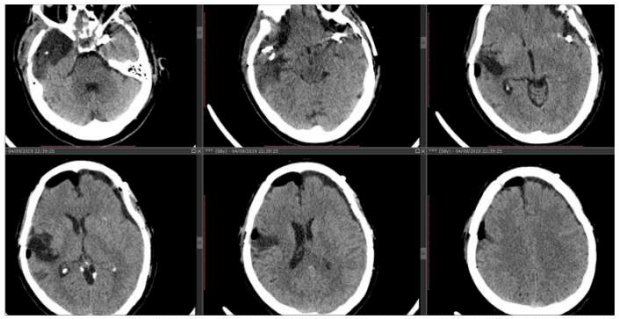

Fig. 14: CT showing clip positions. Courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

CT Angiogram showing the clip positions

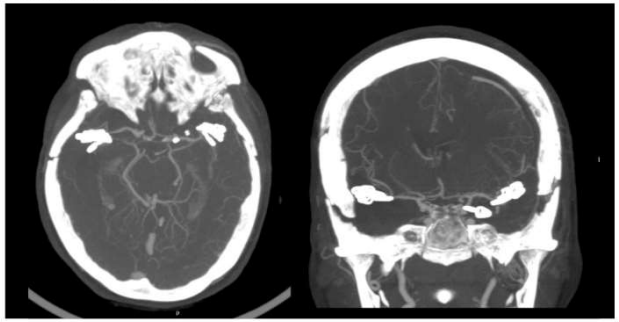

Fig. 15: CT Angiogram showing clip positions. Courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

No flow into the clipped aneurysms confirmed on the 3D reconstruction

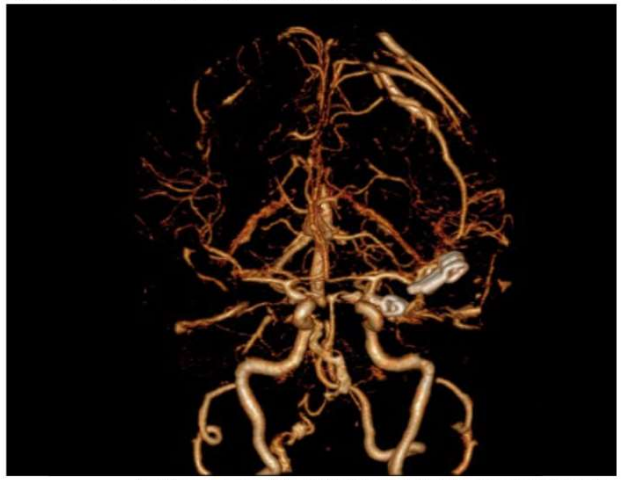

Fig. 16: 3D-reconstruction image. Courtesy of Prof. Dr. Chaddad, Head of Vascular Neurosurgery, UNIFESP, Sao Paulo, Brazil.

Post Surgery Examination and Discharge

- GCS 15, pupils equal, round, and reactive to light
- Left central facial weakness
- Normal motor function with muscle strength 5/5 bilaterally
- She was discharged 4 days post surgery

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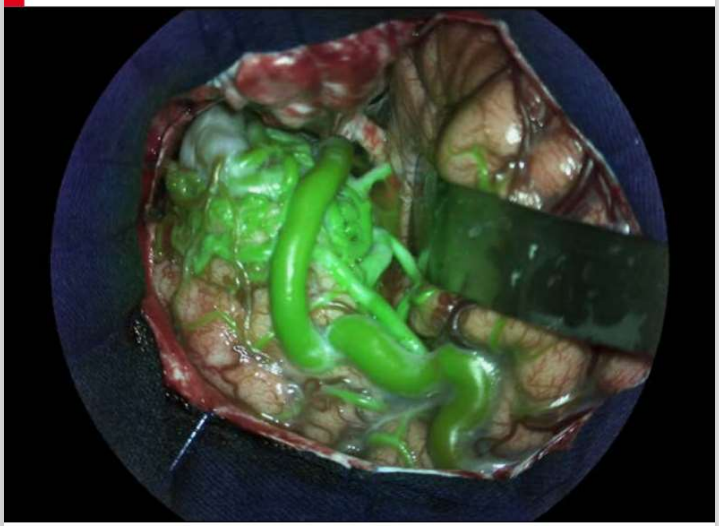

CASE STUDY

GLOW800 Augmented RealityFluorescence in AVM (Arteriovenous Malformation) treatment

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1. Initial Patient Presentation

Patient:

A 24 year old male patient with a four month history of

- Multiple seizures, two of which were described as tonic-clonic seizures. The others were focal onset seizures, characterized by loss of conciousness, rapidly followed by left hand automatisms, collapses, and return to consciousness after a few minutes
- Impaired awareness
- Severe headaches, especially after the seizures

Neurological examination showed slightly decreased attention and memory function, compared to healthy people of similar age and education. No abnormalities of motor, gait, balance, or sensory function were noted.

The patient was treated with carbamazepine (200 mg, 3 x day), which did not improve the seizures. Further assessments and imaging were performed to investigate an underlying cause (see Figures 1-8).

Diagnosis:

- Left temporal pole AVM: Spetzler-Martin Grade II
- Nidus size 2.5 cm
- Multiple supply sources: mostly from the middle cerebral and posterior cerebral arteries
- Multiple drainage points including superior anastomotic vein to the superior sagittal sinus, and tributaries to the inferior petrous sinus, basal vein, and great cerebral vein

Treatment Decision:

At multidisciplinary review, the decision was made to surgically resect the AVM due to the following reasons:

- Patient had poor response to anticonvulsant treatment
- Risk of hemorrhage from this malformation remains high if not resected
- Treatment of choice for Spetzler-Martin Grade II AVMs is microsurgical resection, because this can provide immediate cure with low risk of a recurrence

The aim of the surgery is to achieve control of the seizures and to prevent a hemorrhagic episode that could lead to a neurological sequelae.

2. Pre-operative Assessment

Pre-operative Imaging

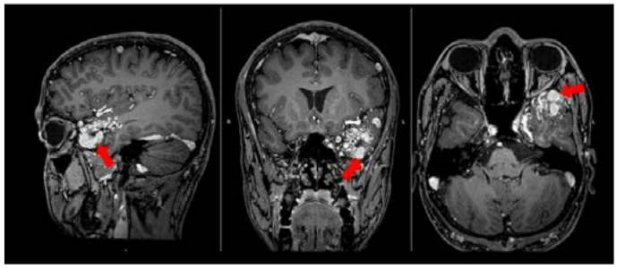

Figure 1: T1-weighted brain MRI showing the AVM nidus at the left temporal pole with a venous aneurysm (red arrows).

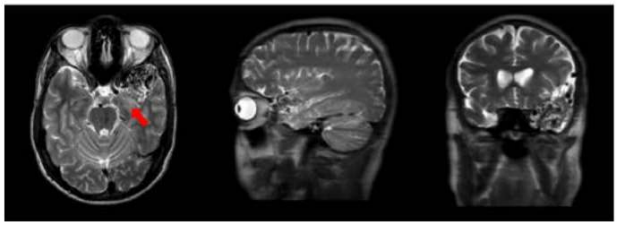

Figure 2: T2-weighted brain MRI showing the AVM nidus located at left temporal pole, with classic flow voids showing blood flow. The lesion induces left hippocampus edema (hyperintensity signal, red arrow).

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Pre-operative Imaging: AVM Supply

Figure 3: Pre-operative DSA. AP projection showing the AVM with a nidus measuring 2.5 cm, fed partially by the middle cerebral artery through an early branch (blue arrow) and terminal branches of the interior trunk (purple arrow).

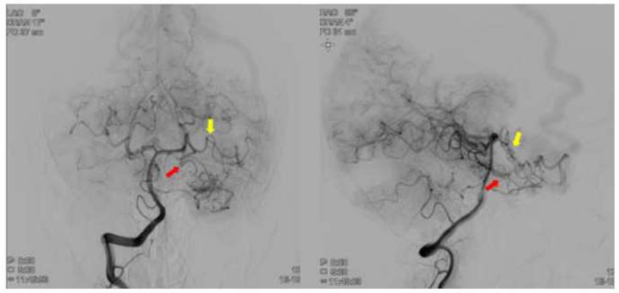

Figure 4: Lateral projection. The AVM was also partially supplied by the posterior cerebral artery through the anterior and middle inferior temporal arteries (yellow and red arrows, respectively).

Pre-operative Images: AVM Drainage

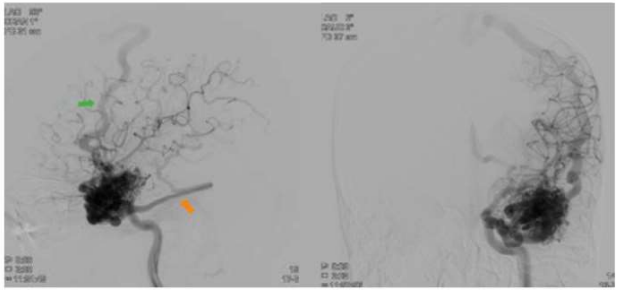

Figure 5: AP and lateral projection. The AVM has a superficial drainage through the superior anastomotic vein to the superior sagittal sinus (green arrow) and also a deep drainage through the inferior petrous sinus (orange arrow).

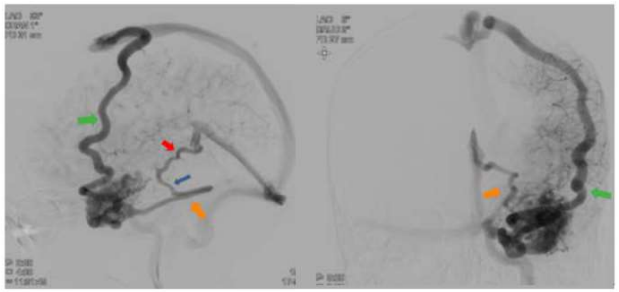

Figure 6: AP and lateral projection. Drainages to the basal vein (red arrow), great cerebral vein (green arrow), straight sinus and confluence of sinuses (orange arrow) were also present. The blue arrow indicates the inferior petrous sinus anastomosing with the lateral mesencephalic vein.

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Pre-operative Assessment Images - Steal

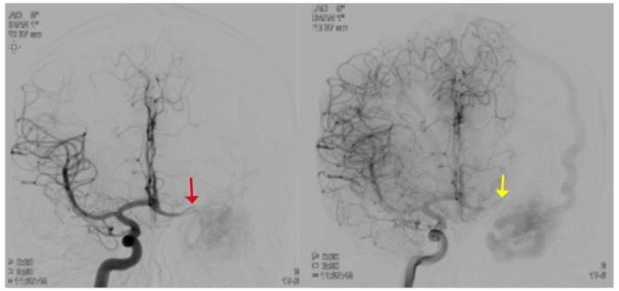


Figure 7: AP projection. It is possible to observe a vascular steal from the contralateral carotid system (red arrow) as well as from the ipsilateral anterior cerebral artery (yellow arrow).

3. Intra-operative Course and Images

A pretemporal craniotomy was performed to take advantage of the transsylvian, lateral subfrontal, subtemporal and temporoporal corridors. With this craniotomy the superior, middle and inferior temporal gyrus, the Sylvian fissure, the inferior and part of the middle frontal gyrus were exposed.

AVM First Assessment

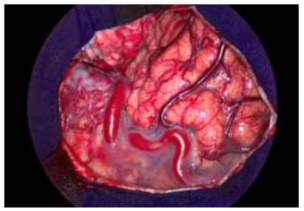
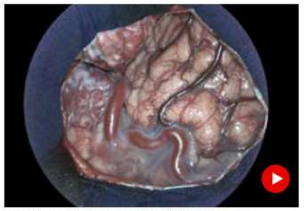
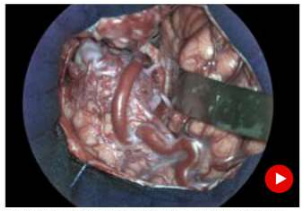


Figure 8: After opening the dura the AVM was evident on the temporal lobe and was also assessed using GLOW800.

GLOW800 Initial Assessment



Video 1: AVM First Assessment with GLOW800. Surgeon able to manipulate and explore with stereoscopic view while simultaneously assessing blood flow.



Video 2: AVM assessed on deeper dissection – clearly showing filling during arterial phase. During surgery GLOW800 shows the presence of fistulas that need to be disconnected and their relation to the AVM nidus, surrounding vessels and brain parenchyma.

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AVM Resection

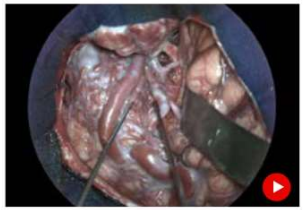
GLOW800 helped to understand the superficial configuration of the AVM and to confirm the surgical strategy that was decided earlier.

Following the initial assessment of the AVM, Prof. Chaddad opened the Sylvian fissure using sharp dissection in the arachnoid space. He separated the frontal lobe from the temporal lobe in order to gain a better exposure of the AVM and expose the middle cerebral artery, which was the principal feeder of the AVM.

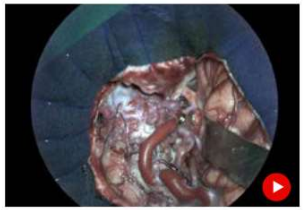
GLOW800 showed the flow through the vessels and the brain parenchyma in real time, which allowed to continue working while assessing the anatomical structures. The superficial feeders and shunts were then disconnected from the AVM.

Deeper circumferential dissection was then done, coagulating and cutting off feeder vessels in order to progressively decrease the flow through the AVM.

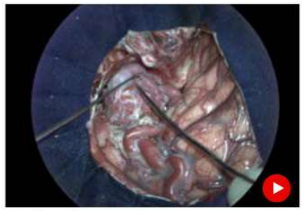
The branches of the posterior cerebral artery were accessed through the subtemporal corridor.



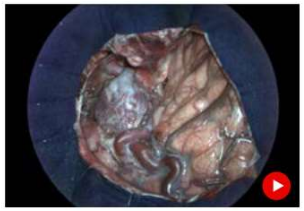
Video 3: Clipping of Fistula under GLOW800. This shows GLOW800 tolerating movement that aids uninterrupted workflow.



Video 4: Delayed filling of the AVM as the fistulas and feeders are excluded. This helped the surgeon better assess treatment as the surgery progressed.

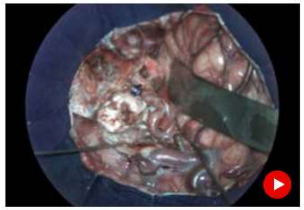


Video 5: Delayed filling of the AVM as more feeders were excluded prior to total exclusion from the normal circulation.



Video 6: AVM excluded from circulation but not yet excised. No flow into the nidus of the AVM.

GLOW800 Post AVM Exclusion



Video 7: GLOW800 after the AVM was excised. GLOW800 confirmed complete exclusion from the normal circulation, patency of the vessels proximal to the lesion and absence of any abnormal early drainage veins.

4. Post Surgery

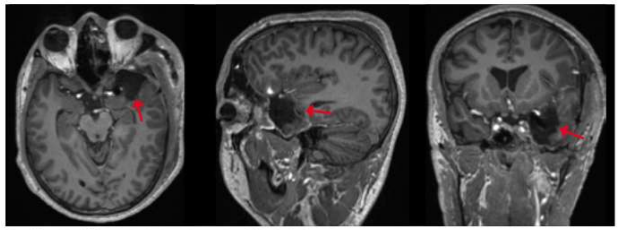


Figure 9: T1-weighted MRI images showing the complete resection of AVM nidus (red arrows).

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