Le Frontiere dell'Innovazione in Medicina: Esempi e Proposte dalla Neurochirurgia

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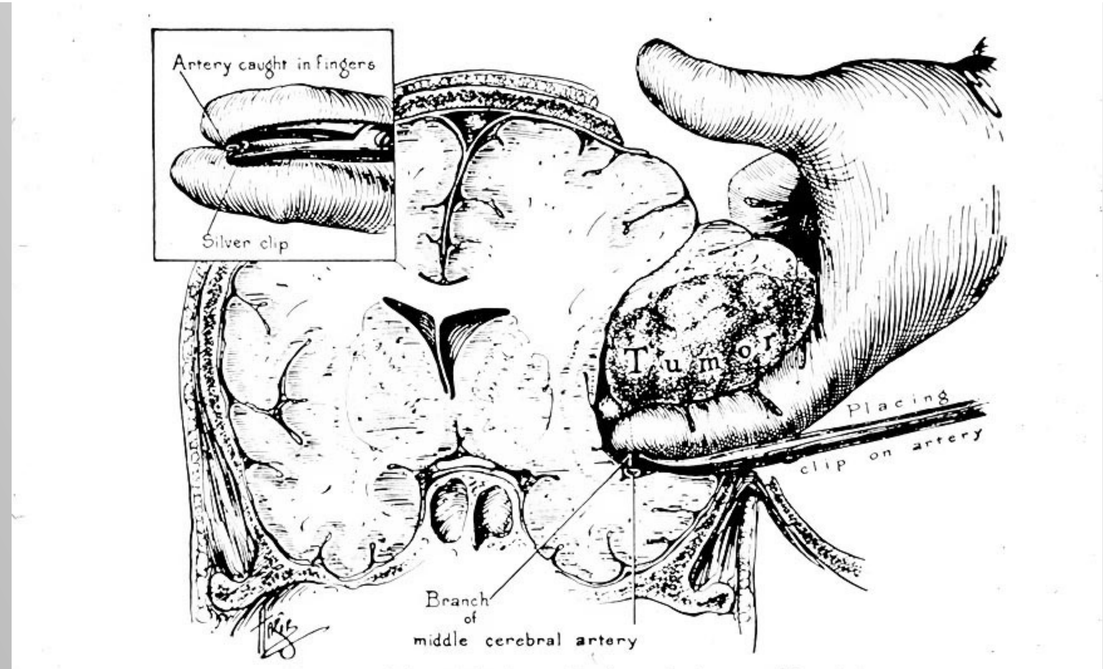
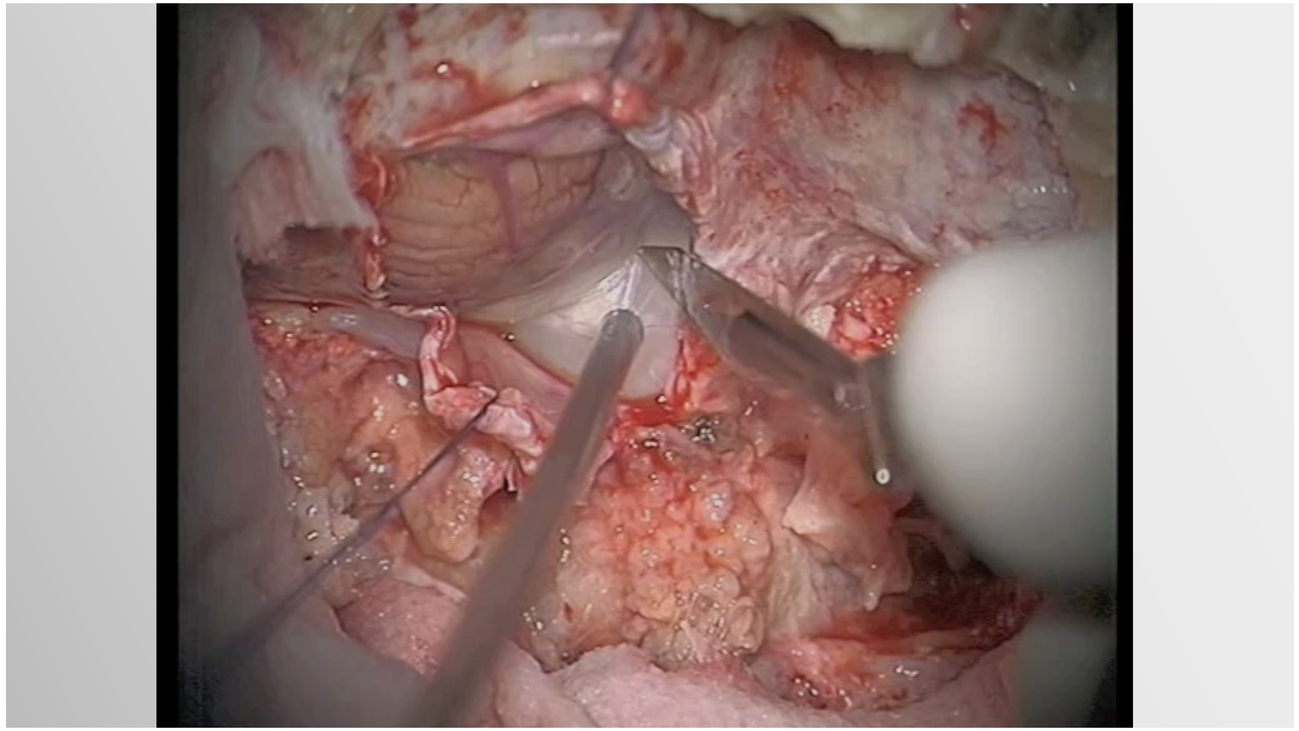


FIG. 35. The digital enucleation of gliomas (Dandy)



Innovation in Neurosurgery

Microsurgery, endoscopy, exoscopy

Imaging evolution, functional imaging and neuromonitoring

Loco-regional therapies

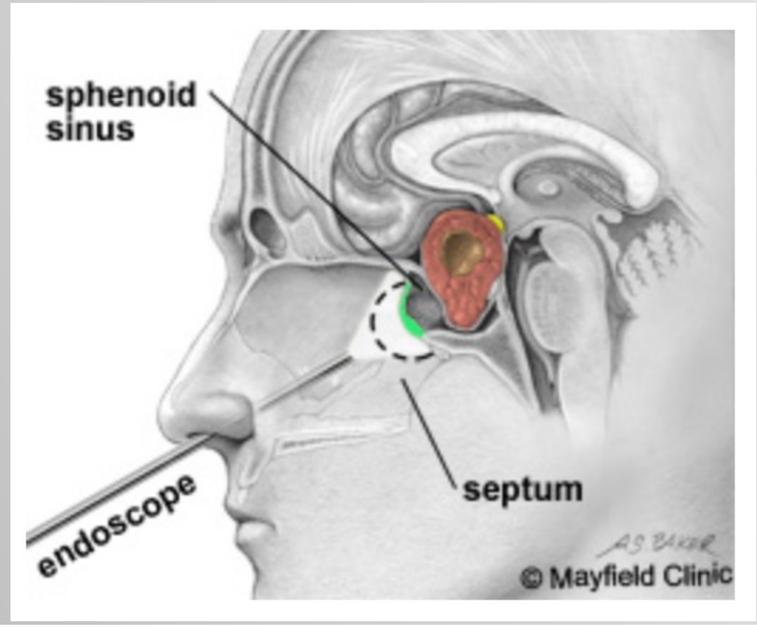
Image guided surgery

Focused Ultrasound

Virtual reality/augmented reality/ simulation

Microscopy

Endoscopy



Brain Tectal Tumors: A Flexible Approach

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Francesco Ugo Prada, MD[‡||]
Marco Saini, MD[‡]
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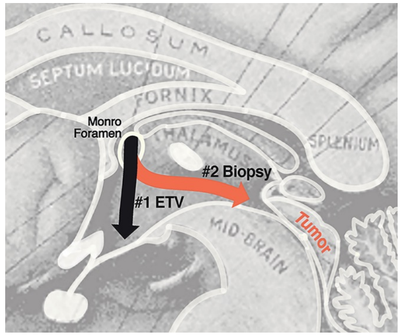
BACKGROUND AND IMPORTANCE: Mesencephalic tectal gliomas represent a subset of midbrain tumors, which are more frequent in children than in adults. They usually become symptomatic when causing hydrocephalus by occluding the aqueduct. Because of their slow progression, due to their benign histology, they are characterized by a relatively good prognosis, although hydrocephalus might jeopardize patients' prognosis. Treatment is usually represented by cerebrospinal fluid diversion associated or not with biopsy.

CLINICAL PRESENTATION: We report 2 illustrative cases of tectal gliomas in adults where endoscopic third ventriculostomy (ETV) and simultaneous endoscopic biopsy were obtained during the same operation by means of a single burr hole with a flexible endoscope.

CONCLUSION: We recommend using this overlooked neurosurgical tool for such cases, since it allows the surgeon to safely perform an ETV, then judge whether biopsy can be done or not, without harming the patient, and possibly achieving an important piece of information (histopathological diagnosis) to manage this subset of oncological patients.

KEY WORDS: Endoscopic third ventriculostomy, Flexible neuroendoscopy, Tectal plate gliomas

Operative Neurosurgery 16:E95–E100, 2019
DOI: 10.1093/ons/opy114



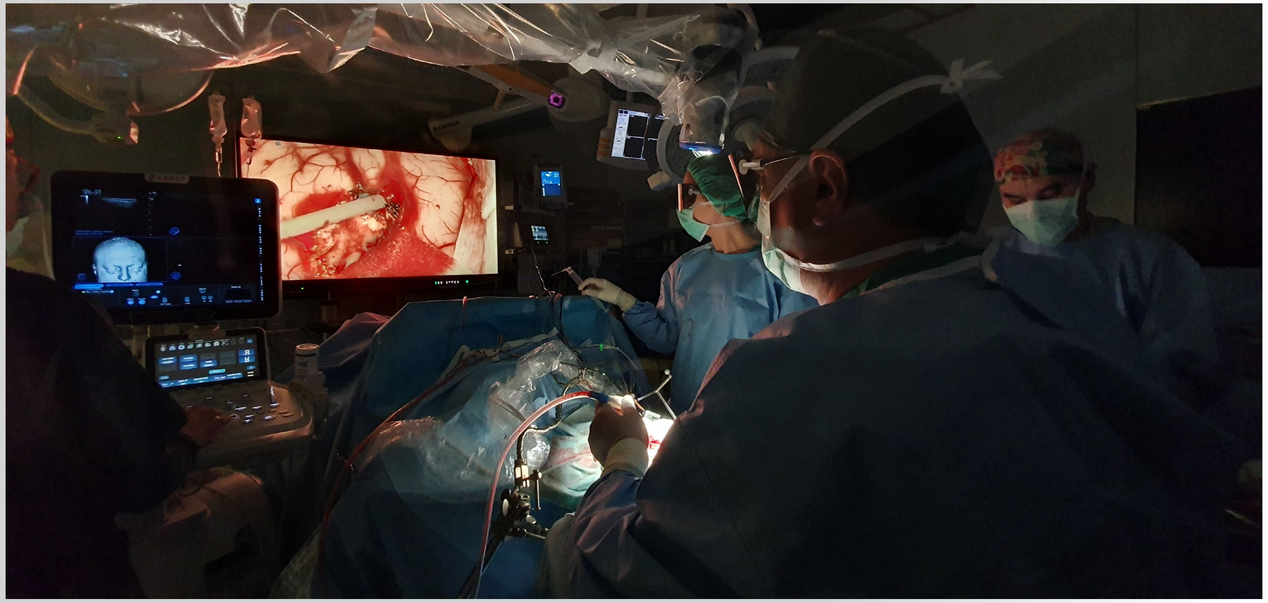
Olympus ENF-VT3

Exoscopy

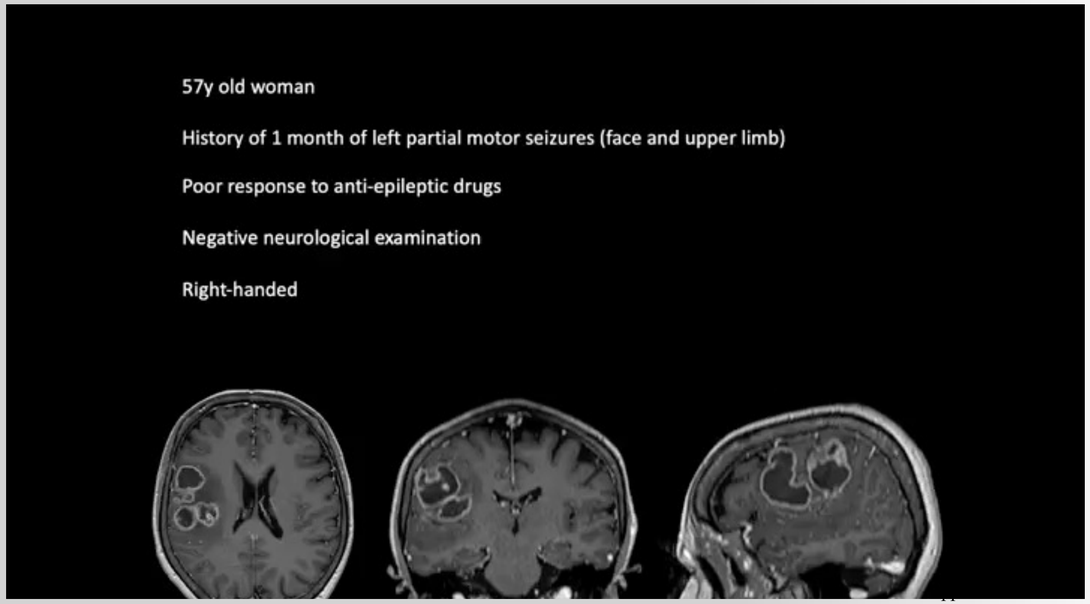

Straight, Simple Arm Design
Easy Draping without Slack
· No balance adjustment required
· X-Y motorized movement
Intuitive Touch
Panel Control
Long-Life and Cold
Light Source for Easy
Maintenance
All-in-one, Plug-and-play
Lightweight, Easy to
Move, Easy to Locate
Large 4K 3D Monitor
Easy sharing with multiple surgeons
Wireless Foot Switch
Control with various functions
ORBEYE

Exoscopy

Exoscopy



Exoscopy


57y old woman
History of 1 month of left partial motor seizures (face and upper limb)
Poor response to anti-epileptic drugs
Negative neurological examination
Right-handed

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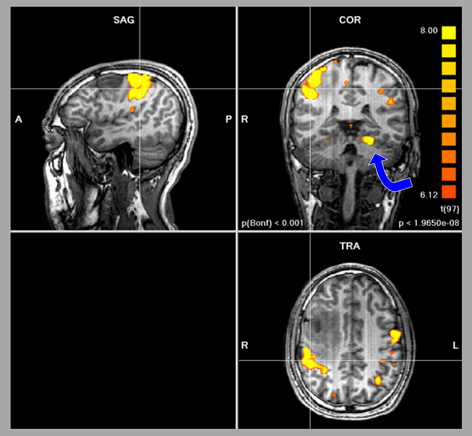
Focused Ultrasound

Virtual reality/augmented reality/ simulation

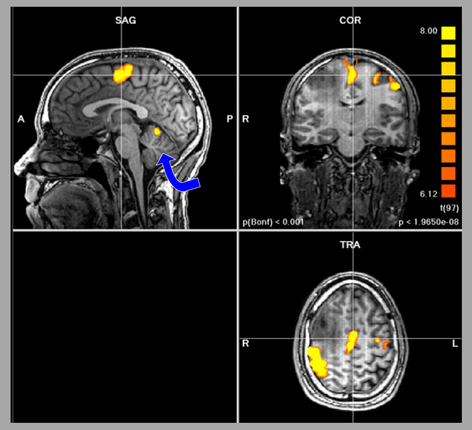
M.A.
37 M

fMRI motor function (left hand)

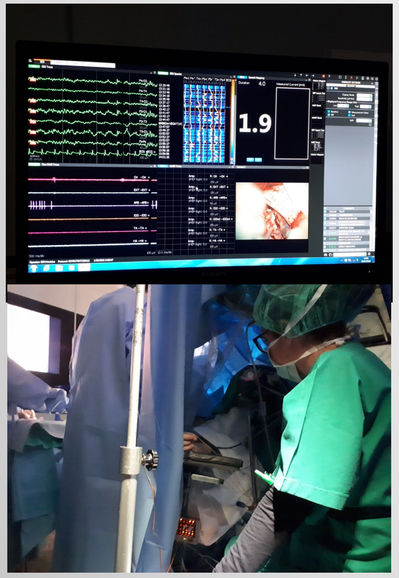
Rt M1



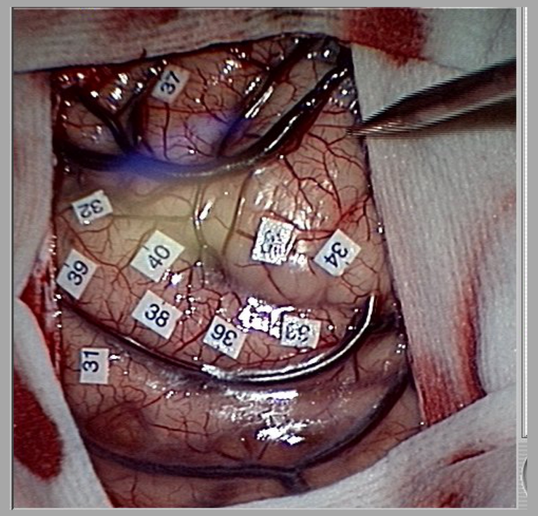
SMA



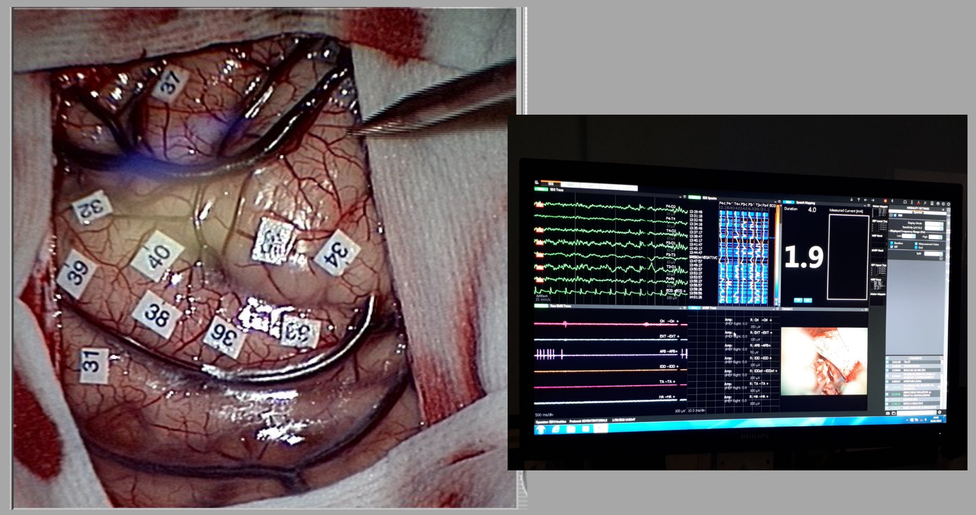
Neurophysiology intraoperative monitoring



Intraoperative Neurophysiology Monitoring



Intraoperative Neurophysiology Monitoring



Neurophysiology intraoperative monitoring

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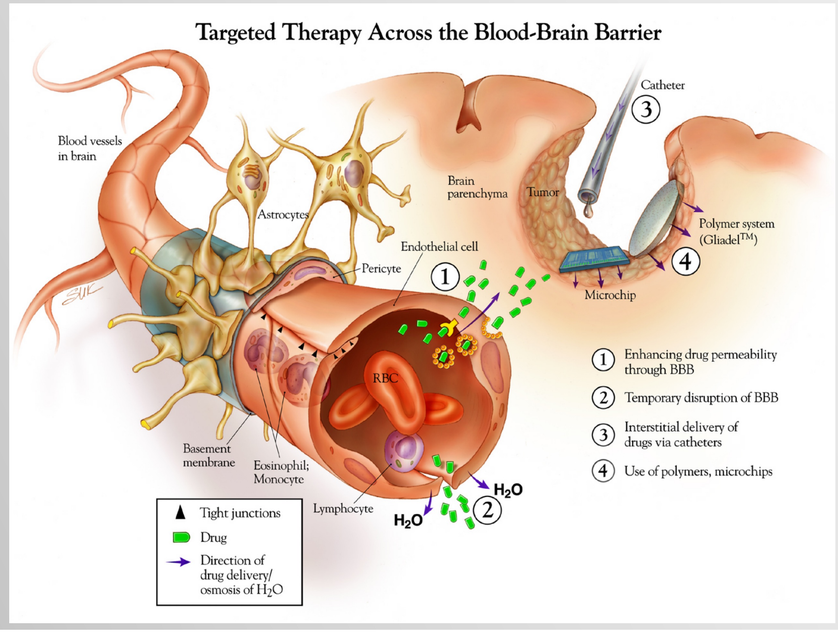
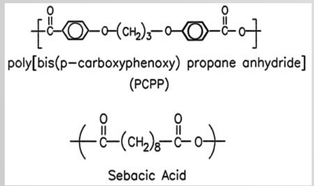
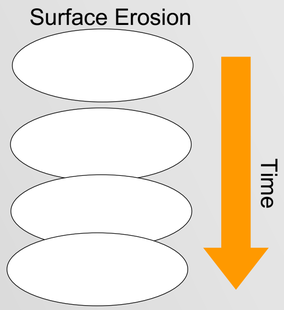


pCPP:SA (Polyfeprosan 20)

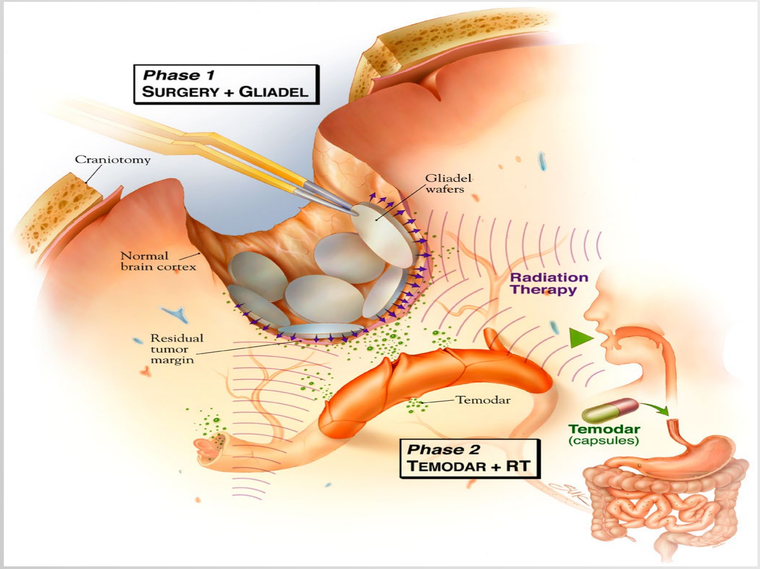


PCPP-SA



Drug release via surface erosion

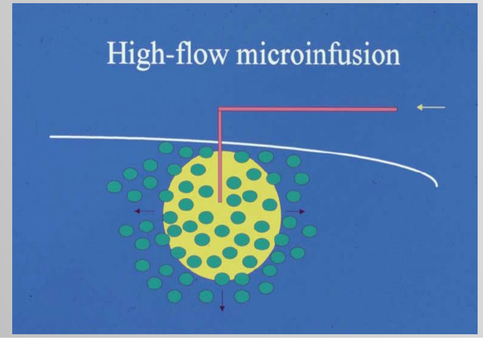
Gliadel

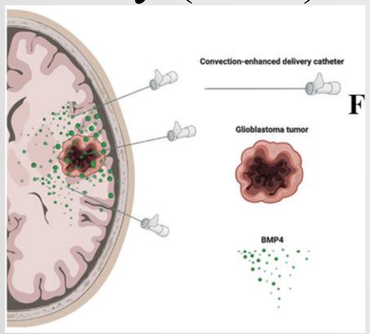

Phase 1
SURGERY + GLIADEL
Craniotomy
Gliadel wafers
Normal brain cortex
Radiation Therapy
Residual tumor margin
Temodar
Temodar (capsules)
Phase 2
TEMODAR + RT

Loco-regional therapies

Biodegradable Polymers

Convection-Enhanced Delivery (CED)

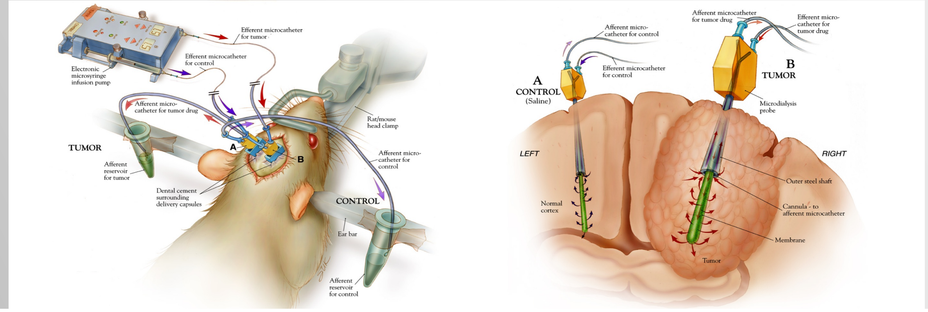




Loco-regional therapies

Biodegradable Polymers

Convection-Enhanced Delivery (CED)



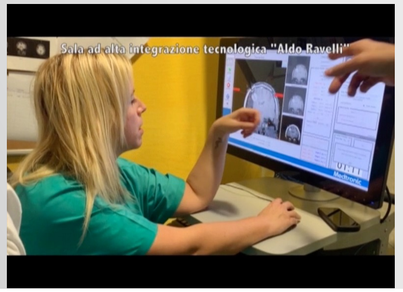
Loco-regional therapies

Laser Interstitial Thermal Therapy

Intraoperative MRI

Laser Catheter Visualase®

Laser Interstitial Thermal Therapy



Laser Interstitial Thermal Therapy

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Image guided surgery

Focused Ultrasound

Virtual reality/augmented reality/ simulation

Image guided surgery

Neuronavigation

Image guided surgery

Neuronavigation

Intra-operative MRI

Image guided surgery

Neuronavigation

Intra-operative MRI

Fluorescence guided surgery

Image guided surgery

Neuronavigation

Intra-operative MRI

Fluorescence guided surgery

Intra-operative ultrasound

Image guided surgery

Neuronavigation

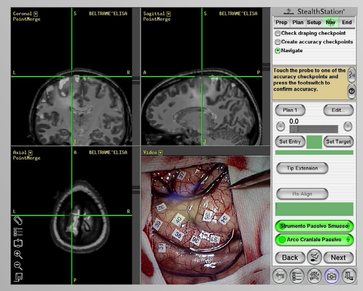
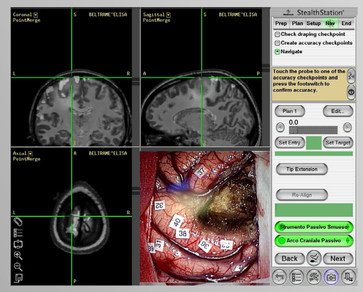


Image guided surgery

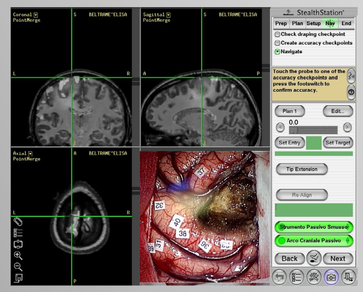
Neuronavigation



- Standard imaging
- Routine use

Image guided surgery

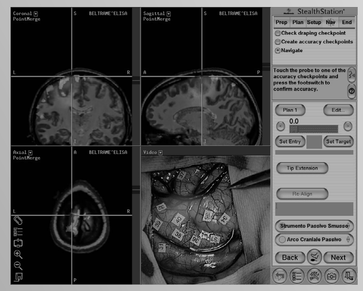
Neuronavigation



- Standard imaging
- Routine use
- Pre-op imaging
- Virtual / No real-time navigation
- Brain shift / brain deformation

Image guided surgery

Neuronavigation

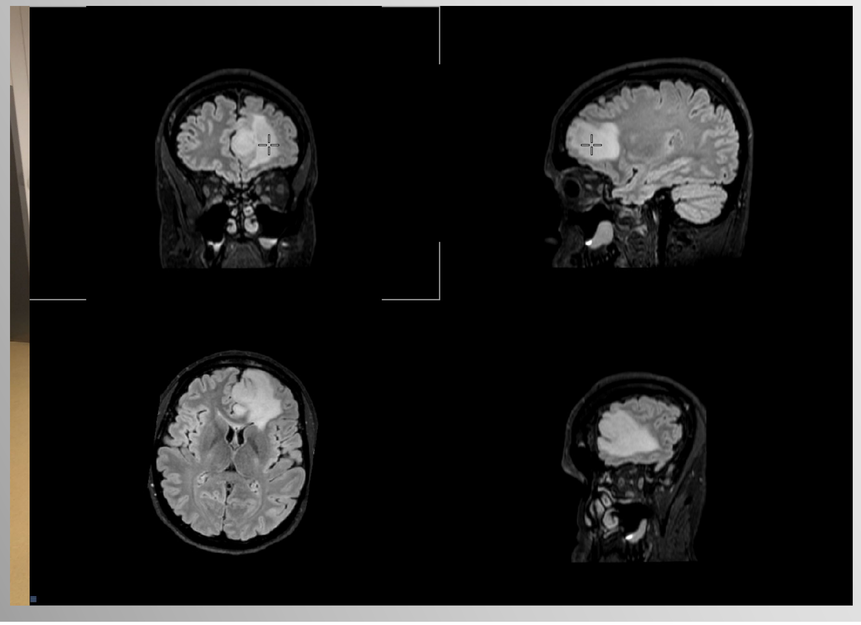


Intraoperative MRI

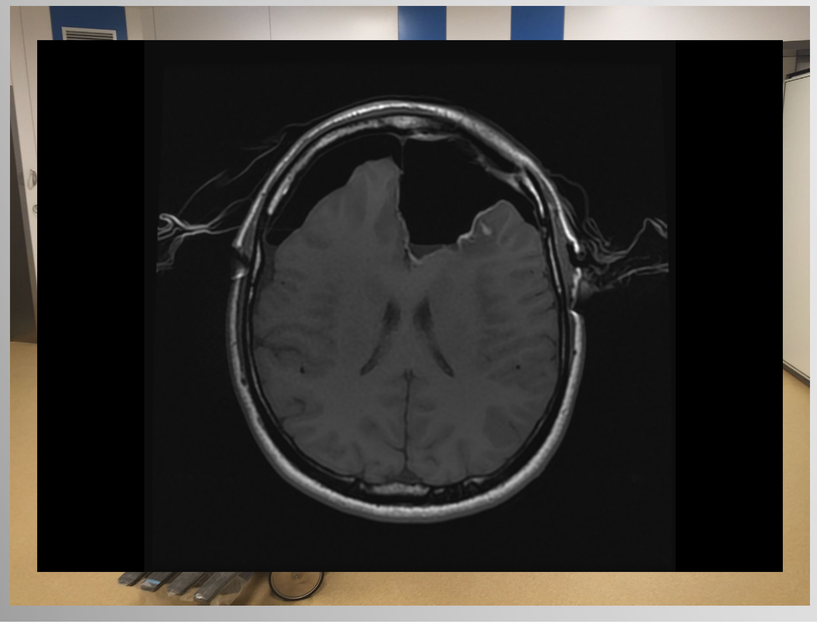
- Standard imaging
- Accurate

Intraoperative MRI

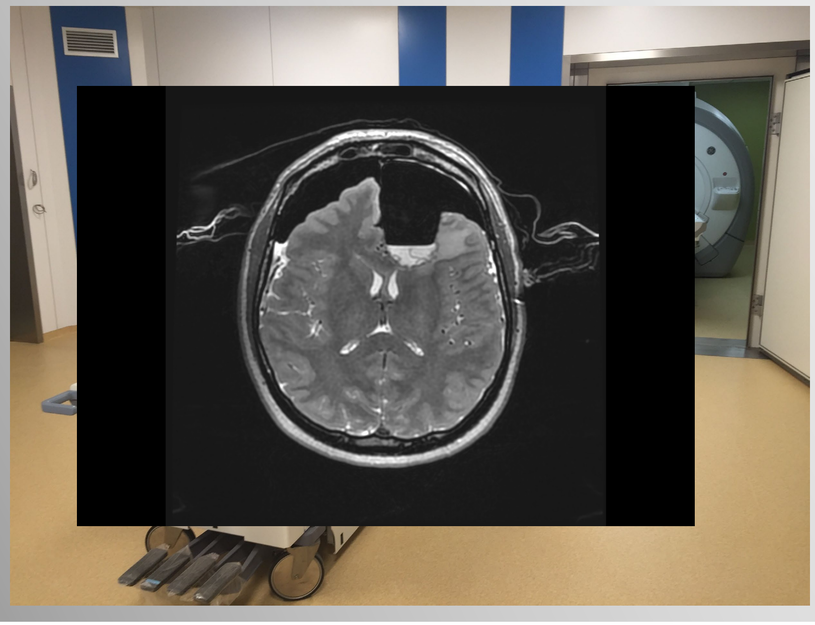
Intraoperative MRI



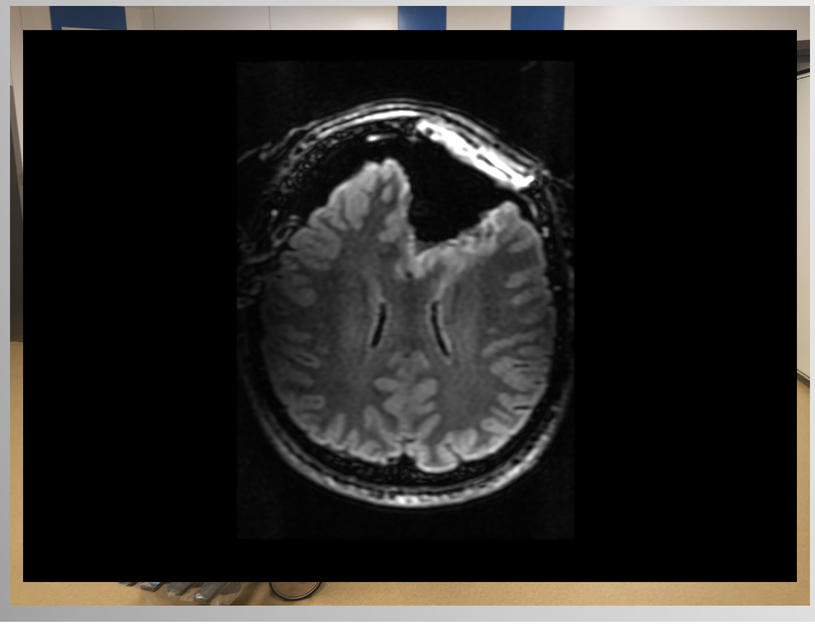
Intraoperative MRI



Intraoperative MRI



Intraoperative MRI



Intraoperative MRI

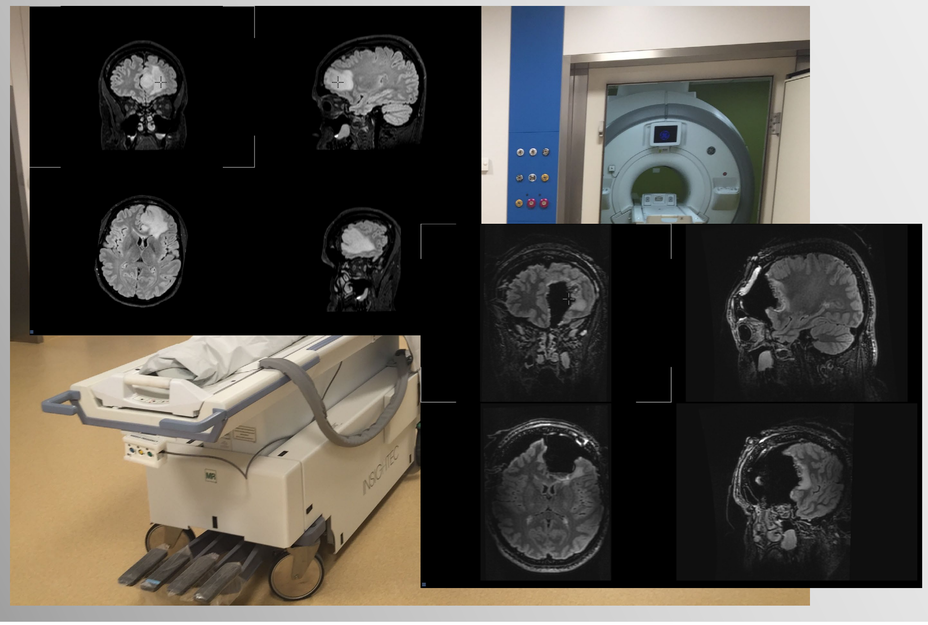
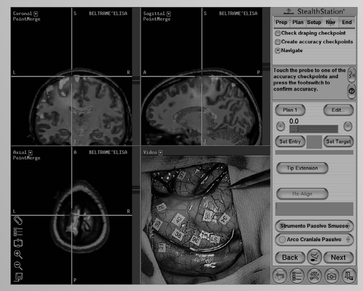


Image guided surgery

Neuronavigation

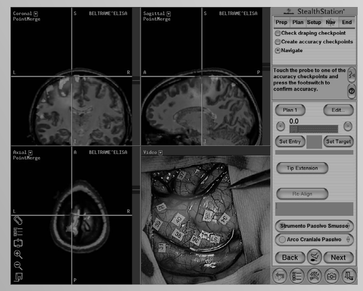


Intraoperative MRI

- Standard imaging
- Accurate
- Dedicated area/tools
- Time consuming
- Expensive
- Non dynamic - offline

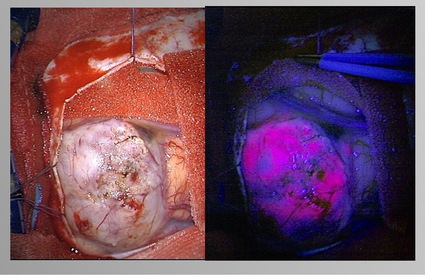
Image guided surgery

Neuronavigation



Intraoperative MRI

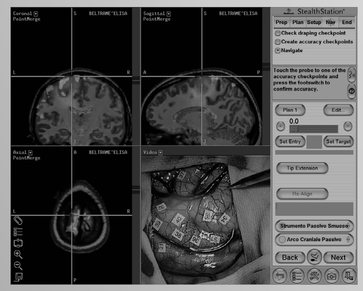
5-ALA



- Real time
- Marks tumor cells

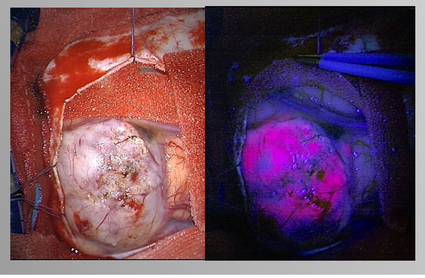
Image guided surgery

Neuronavigation



Intraoperative MRI

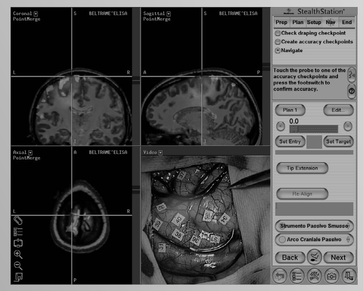
5-ALA



- Real time
- Marks tumor cells
- Works only on HG gliomas
- Visualized only on surface

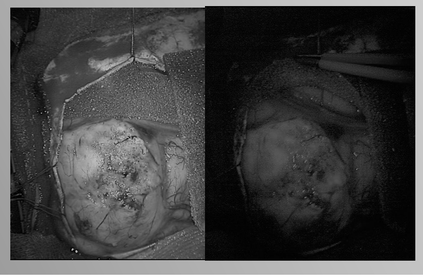
Image guided surgery

Neuronavigation

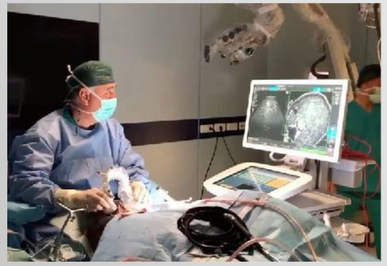


Intraoperative MRI

5-ALA

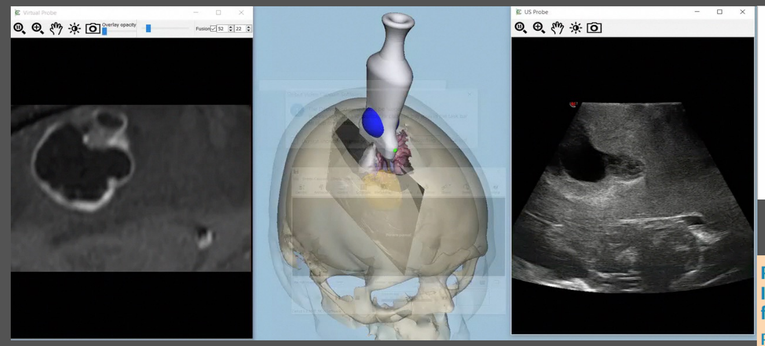


Intraoperative ultrasounds



Ecografia Intraoperatoria

Integrated Intra-operative MR/US neuronavigation: Virtual Navigator®



J Ultrasound
DOI 10.1007/s40477-014-0111-8

PICTORIAL ESSAY

Fusion imaging for intra-operative ultrasound-based navigation in neurosurgery

Francesco Prada · Massimiliano Del Bene · Luca Mattei · Cecilia Casali · Assunta Filippini · Federico Legnani · Antonella Mangraviti · Andrea Saladino · Alessandro Perin · Carla Richetta · Ignazio Vetrano · Alessandro Moiraghi · Marco Saini · Francesco DiMeco

Preoperative Magnetic Resonance and Intraoperative Ultrasound Fusion Imaging for Real-Time Neuronavigation in Brain Tumor Surgery

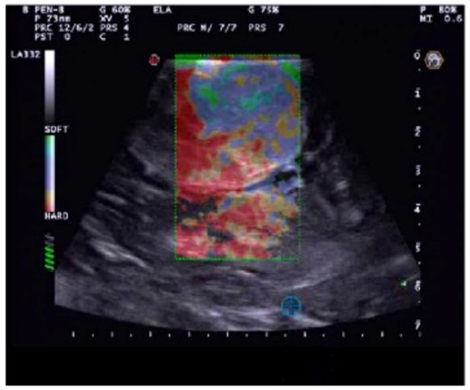
Präoperative MRI- und intraoperative Ultraschallfusion für Echtzeit-Neuronavigation in der Kopftumorenchirurgie

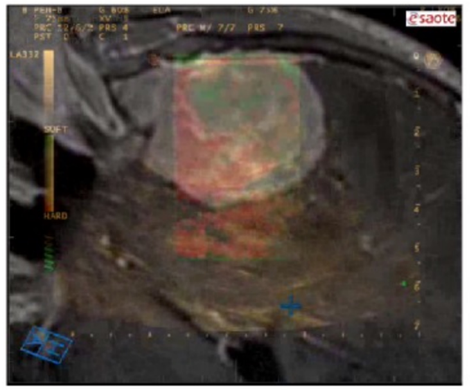
Authors F. Prada[1], M. Del Bene[2], L. Mattei[1], L. Lodigiani[1], S. DeBeni[3], V. Kolev[1], I. Vetrano[1], L. Solbiati[4], G. Sakas[3], F. DiMeco[1]

Affiliations
[1] Neurosurgery, Fondazione IRCCS Istituto Neurologico C. Besta, Milano
[2] Research and Development, Esaote S. p. a., Genova
[3] Research and Development, MedCom, Darmstadt
[4] Interventional Oncology, A. O. Circolo, Busto Arsizio
[5] Neurosurgery, The Johns Hopkins University, Baltimore

ioUS additional features:

Elastosonography





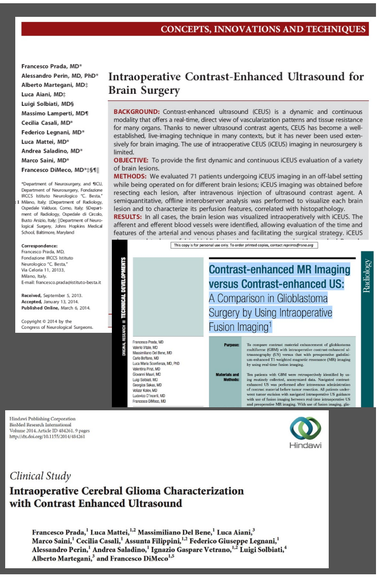
(a) (b)

Biomed Res Int. 2015;2015:925729. doi: 10.1155/2015/925729. Epub 2015 May 25.

From Grey Scale B-Mode to Elastosonography: Multimodal Ultrasound Imaging in Meningioma Surgery-Pictorial Essay and Literature Review.

Prada F[1], Del Bene M[1], Moiraghi A[2], Casali C[1], Legnani FG[1], Saladino A[1], Perin A[1], Vetrano IG[2], Mattei L[2], Richetta C[2], Saini M[1], DiMeco F[3].

ioUS additional features - iCEUS



CONCEPTS, INNOVATIONS AND TECHNIQUES

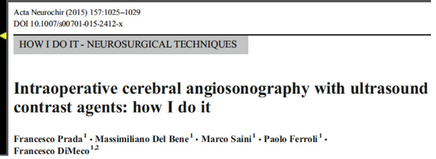
Intraoperative Contrast-Enhanced Ultrasound for Brain Surgery

Contrast-enhanced MR Imaging versus Contrast-enhanced US: A Comparison in Glioblastoma Surgery by Using Intraoperative Fusion Imaging

Hindawi

Clinical Study

Intraoperative Cerebral Glioma Characterization with Contrast Enhanced Ultrasound

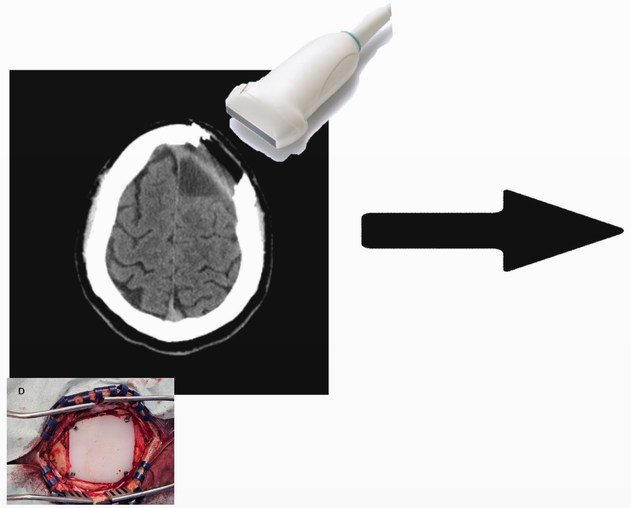


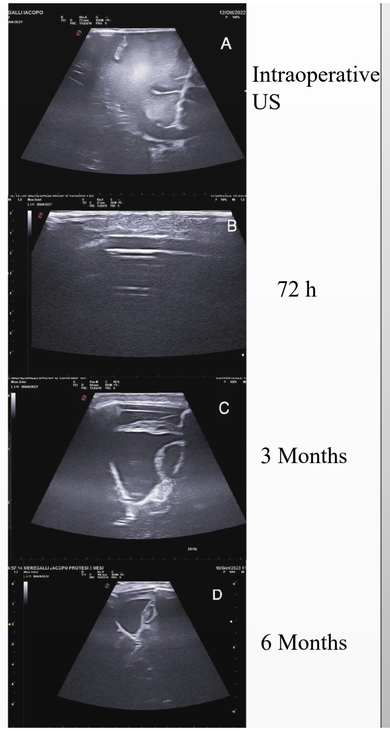
Acta Neurochir (2015) 157:1025–1029
DOI 10.1007/s00701-015-2412-x

HOW I DO IT - NEUROSURGICAL TECHNIQUES

Intraoperative cerebral angiosonography with ultrasound contrast agents: how I do it

Protesi US trasparente





Intraoperative US

72 h

3 Months

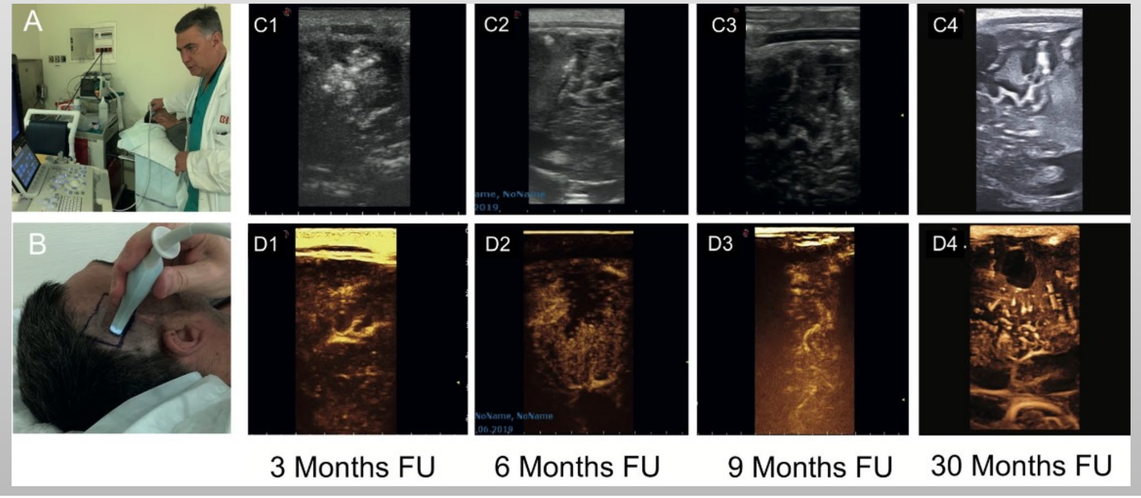
6 Months

Journal of Neuro-Oncology
https://doi.org/10.1007/s11060-021-03929-x

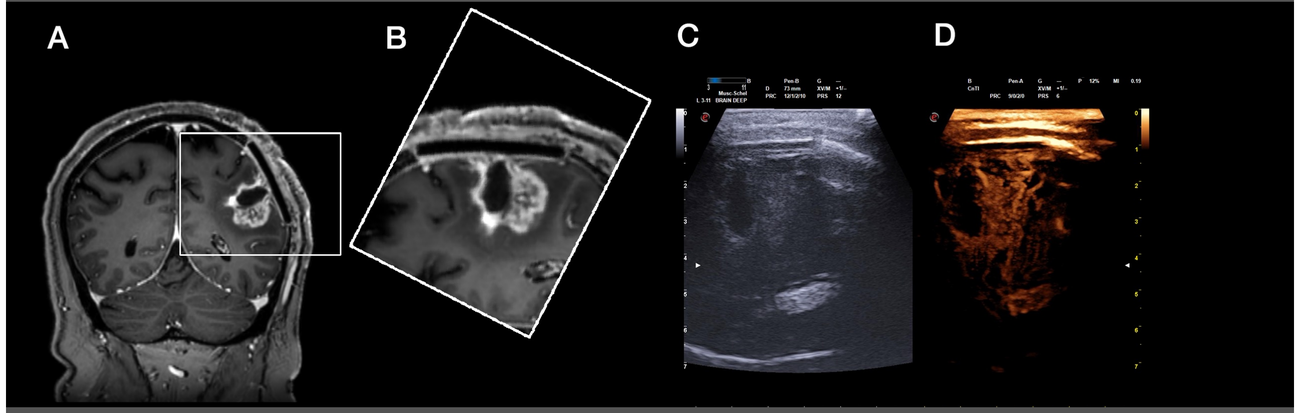
CLINICAL STUDY

Cranial sonolucent prosthesis: a window of opportunity for neuro-oncology (and neuro-surgery)

Massimiliano Del Bene[1,2] · Luca Raspagliesi[1] · Giovanni Carone[1] · Paola Gaviani[3] · Antonio Silvani[3] · Luigi Solbiati[4,5] · Francesco Prada[1,6,7] · Francesco DiMeco[1,8,9]

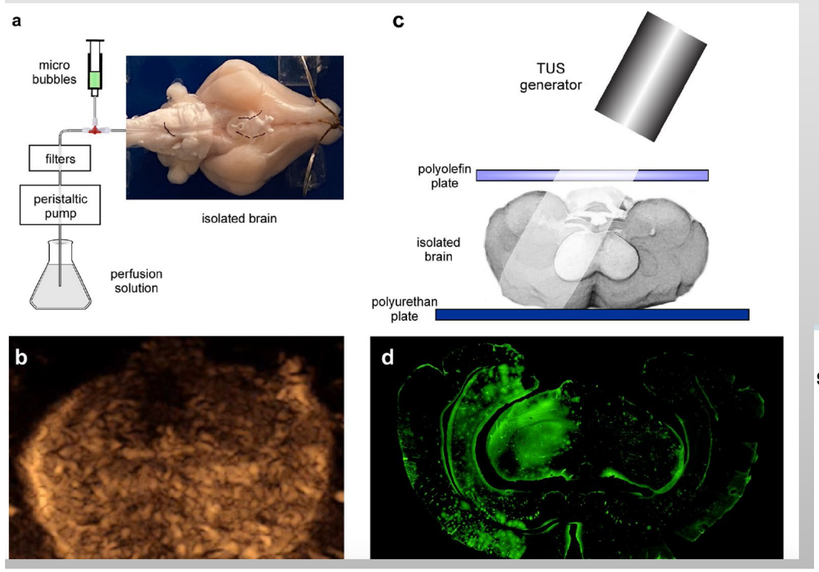


Utile per seguire i pazienti….



T. Galbiati

…ma utile anche anche come opportunita’ di trattamento




www.nature.com/scientificreports

scientific reports

OPEN

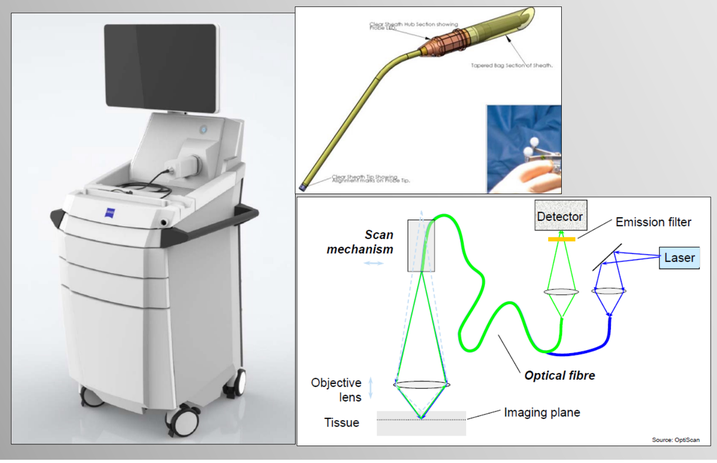
Ultrasounds induce blood–brain barrier opening across a sonolucent polyolefin plate in an in vitro isolated brain preparation

Laura Librizzi[1,11], Laura Uva[1,11], Luca Raspaglio[2,3,4], Matteo Gionso[3,4,5], Maria Cristina Regondi[1], Giovanni Durando[6], Francesco DiMeco[5,7,8], Marco de Curtis[1] & Francesco Prada[4,5,9,10]

Confocal Laser Endomicroscopy

Convivo system

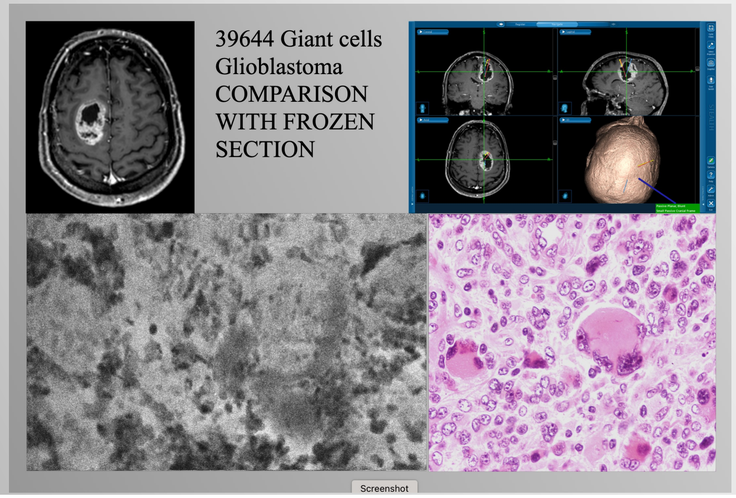
First system specifically studied for neurosurgery,
to bring real-time tissue information in the OR



Confocal Laser Endomicroscopy

Convivo system

Ex vivo



Confocal Laser Endomicroscopy

Convivo system

Ex vivo

frontiers in Oncology

Front Oncol. 2020; 10: 606574.
Published online 2020 Dec 23. doi: 10.3389/fonc.2020.606574
PMCID: PMC7787149
PMID: 33425764

Ex Vivo Fluorescein-Assisted Confocal Laser Endomicroscopy (CONVIVO® System) in Patients With Glioblastoma: Results From a Prospective Study

Francesco Acerbi,[1,*] Bianca Pollo,[2] Camilla De Laurentis,[1] Francesco Restelli,[1] Jacopo Falco,[1] Ignazio G. Vetrano,[1] Morgan Broggi,[1] Marco Schiariti,[1] Irene Tramacere,[3] Paolo Ferroli,[1] and Francesco DiMeco[1,4]

Front Oncol

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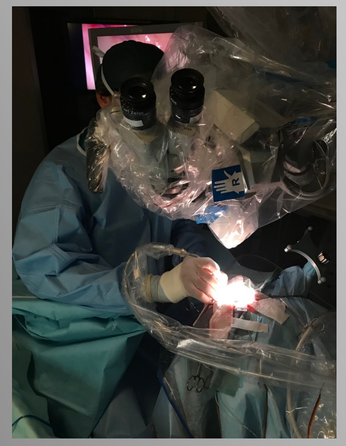
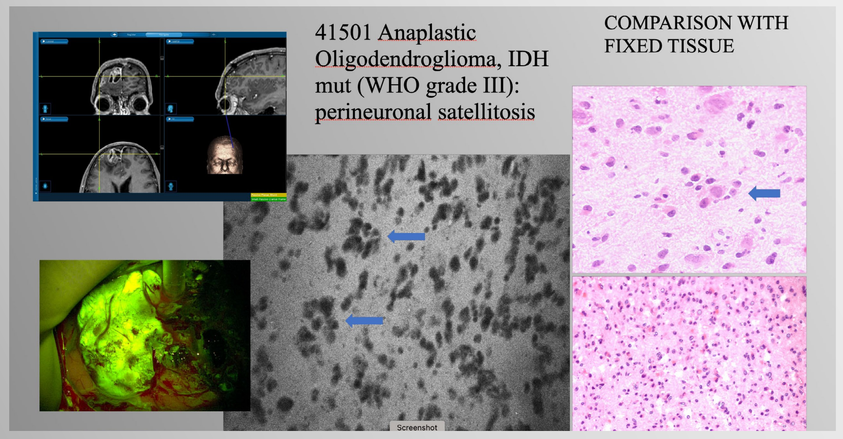
Confocal Laser Endomicroscopy

Convivo system

In vivo

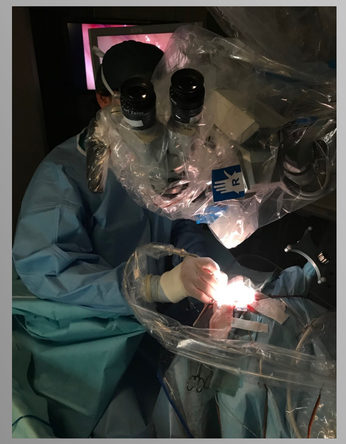




Confocal Laser Endomicroscopy

Convivo system

In vivo



ORIGINAL ARTICLE

Journal of Neurosurgical Sciences 2023 June;67(3):280-7

DOI: **10.23736/S0390-5616.22.05906-9**

lingua: Inglese

A new study protocol for in-vivo assessment of tumor diagnosis and microscopic tumor infiltration at the resection cavity in central nervous system tumors by a new miniature confocal endomicroscope (CONVIVO system)

Francesco RESTELLI [1], Elio MAZZAPICCHI [1], Bianca POLLO [2], Jacopo FALCO [1], Giulio BONOMO [1], Emanuele LA CORTE [1, 3], Morgan BROGGI [1], Marco SCHIARITI [1], Francesco DI MECO [1, 4], Paolo FERROLI [1], Irene TRAMACERE [5], Francesco ACERBI [1, 6] ✉

Innovation in Neurosurgery

Microsurgery, endoscopy, exoscopy

Imaging evolution, functional imaging and neuromonitoring

Loco-regional therapies

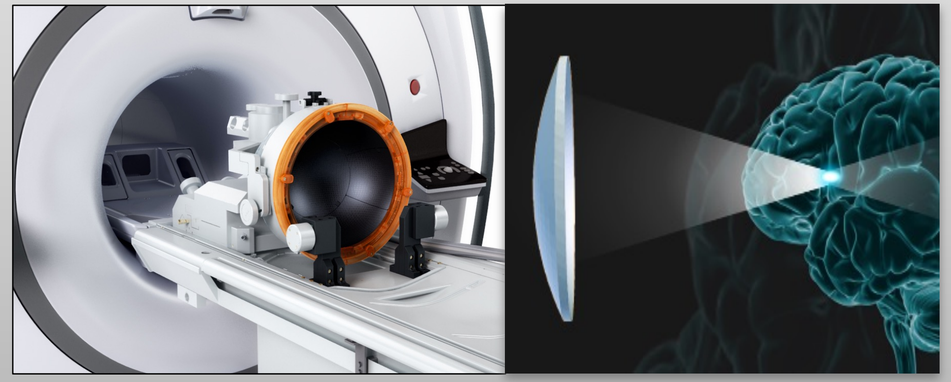
Image guided surgery

Focused Ultrasound

Virtual reality/augmented reality/ simulation

US in neurochirurgia: non solo imaging!
Focused Ultrasound (FUS)

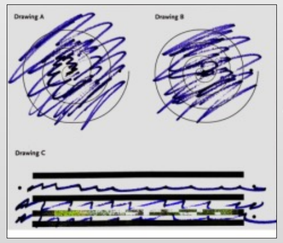
Non invasive technique with several therapeutic potential for many diseases exploiting US energy to reach deeply located CNS target with no surgical incision or radiation



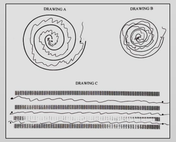
HI-FU per Tremore Essenziale

Before TX

ET: pre MRgFUS



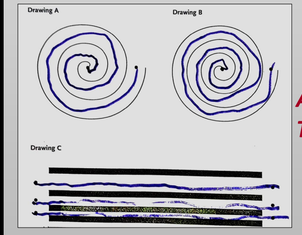
Before TX



During TX

After TX

ET: post MRgFUS



After TX

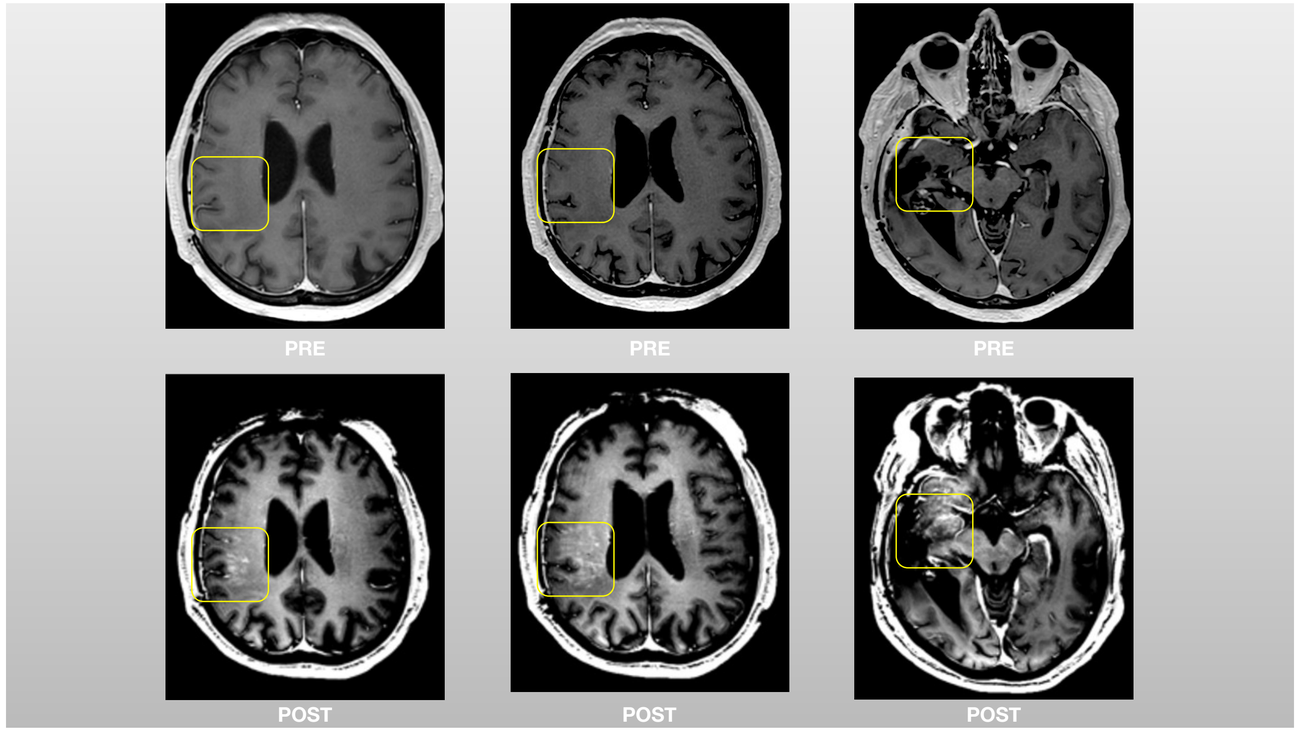
LI-FU per i Tumori Cerebrali

Apertura Barriera Emato-Cerebrale (BBB)

Terapia Sonodinamica

Apertura Barriera Emato-Cerebrale (BBB) con Exablate

Primo paziente in Europa, 21 Ottobre 2021


PRE
PRE
PRE
POST
POST
POST

Innovation in Neurosurgery

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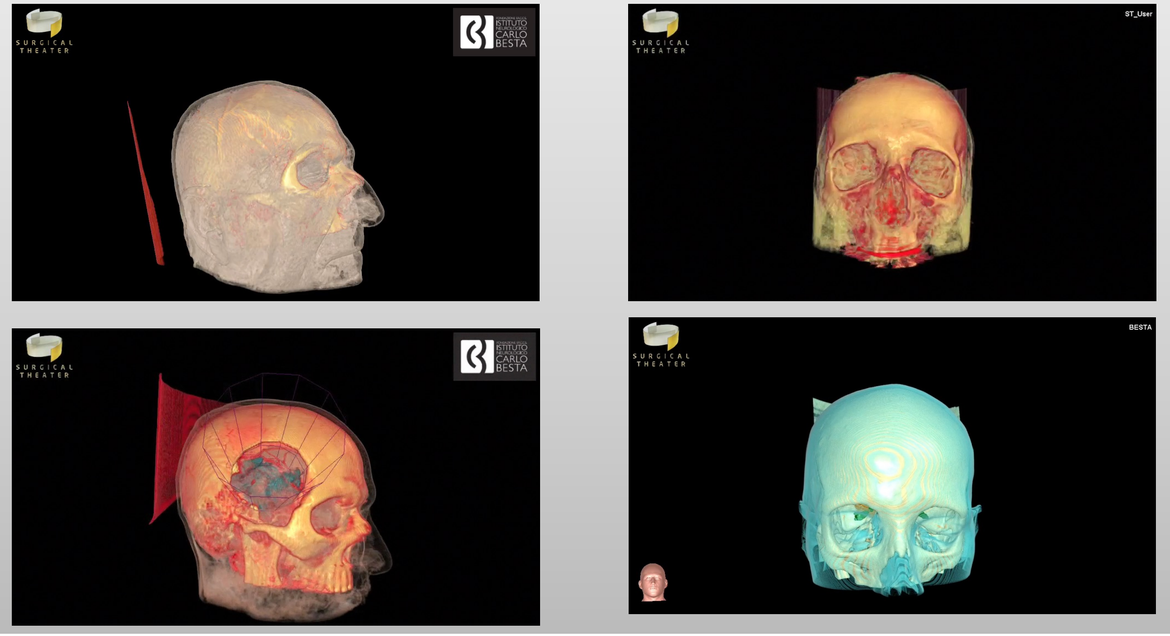
Loco-regional therapies

Image guided surgery

Focused Ultrasound

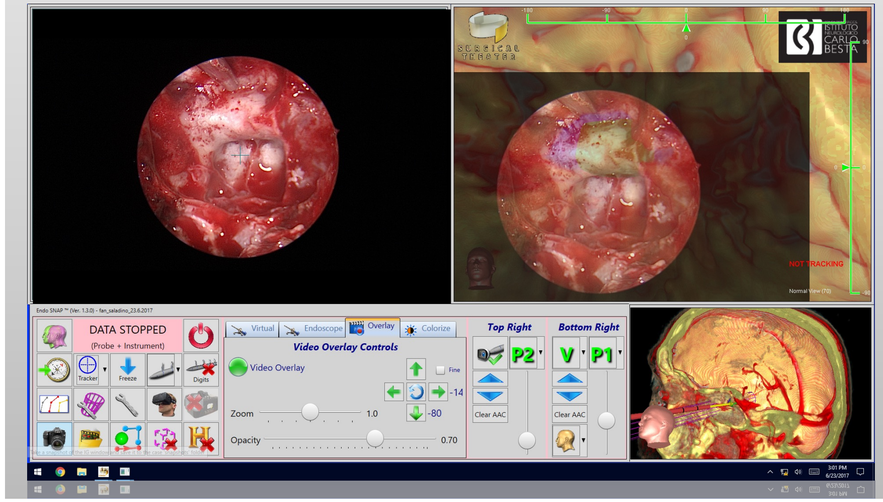
Virtual reality/augmented reality/ simulation

Imaging Avanzato: Realta’ Virtuale

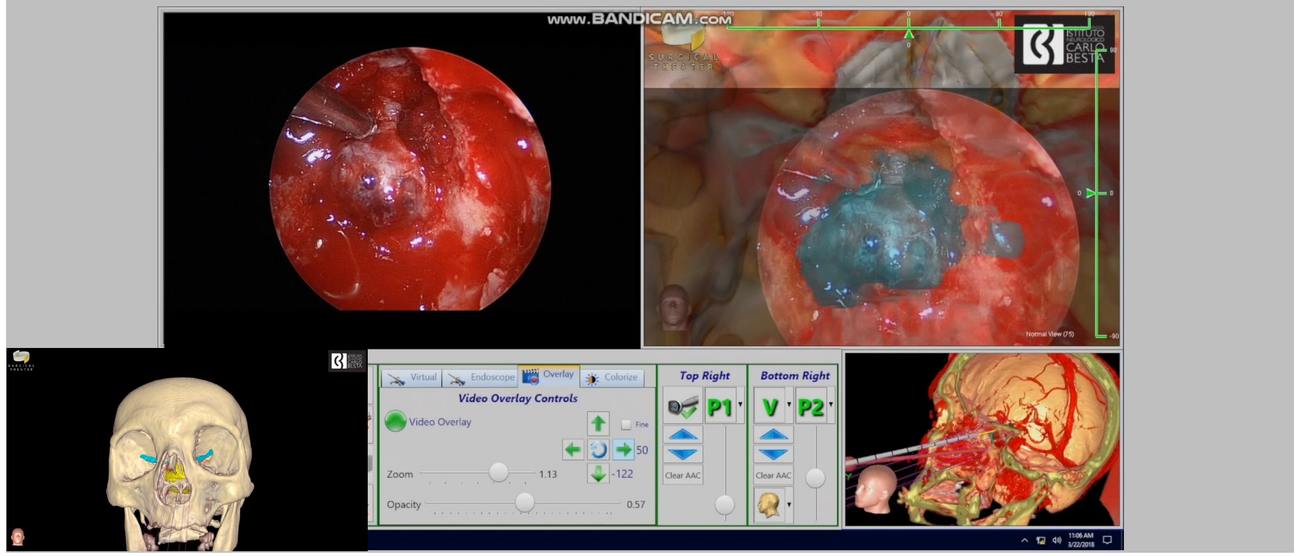


Imaging Avanzato: Realta' Aumentata

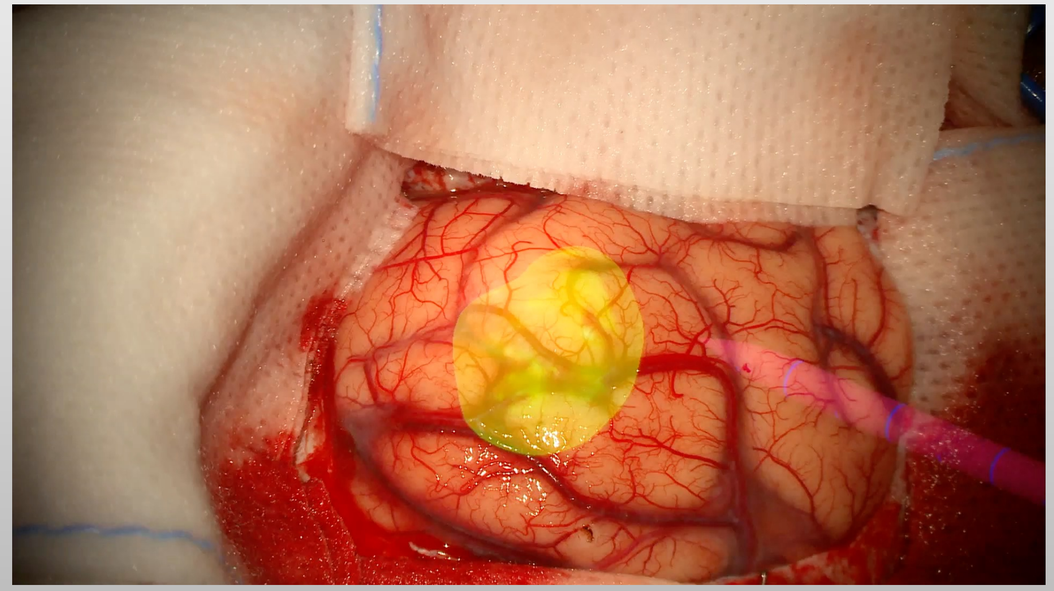
Workstation Surgical Theater®
EndoSNAP®



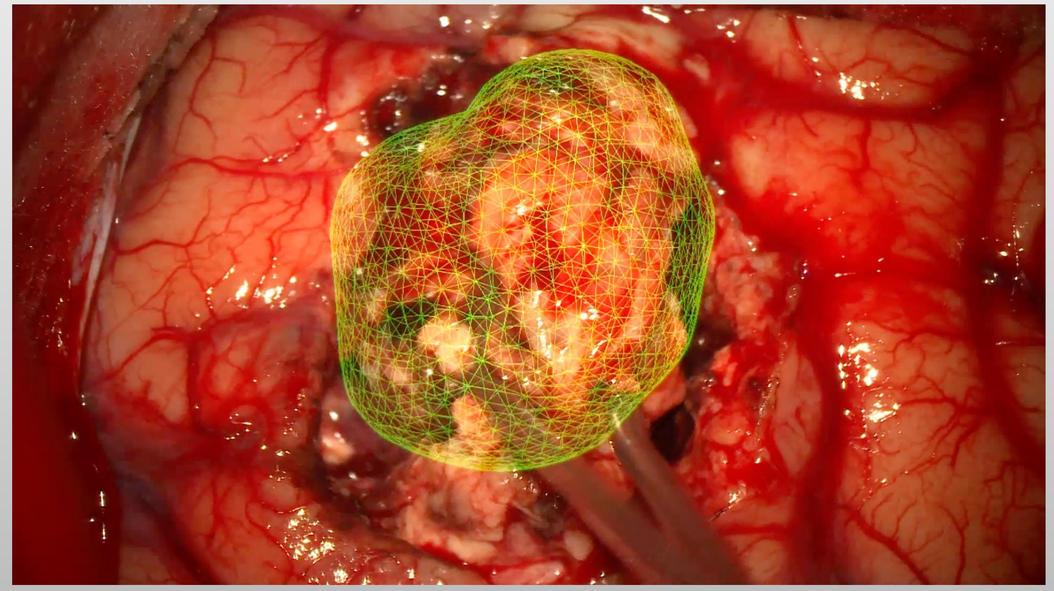
Imaging Avanzato: Realta’ Aumentata



Imaging Avanzato: Realta’ Aumentata



Imaging Avanzato: Realta' Aumentata



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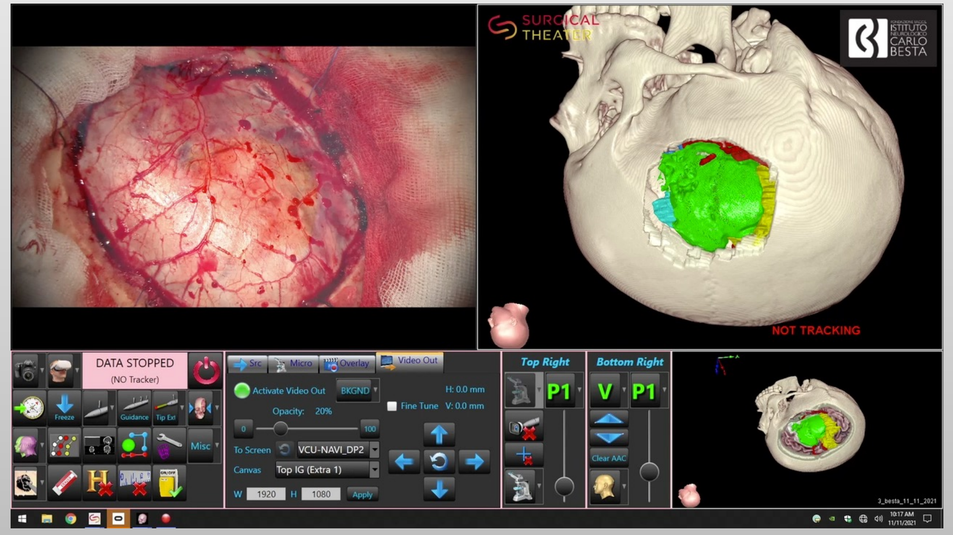
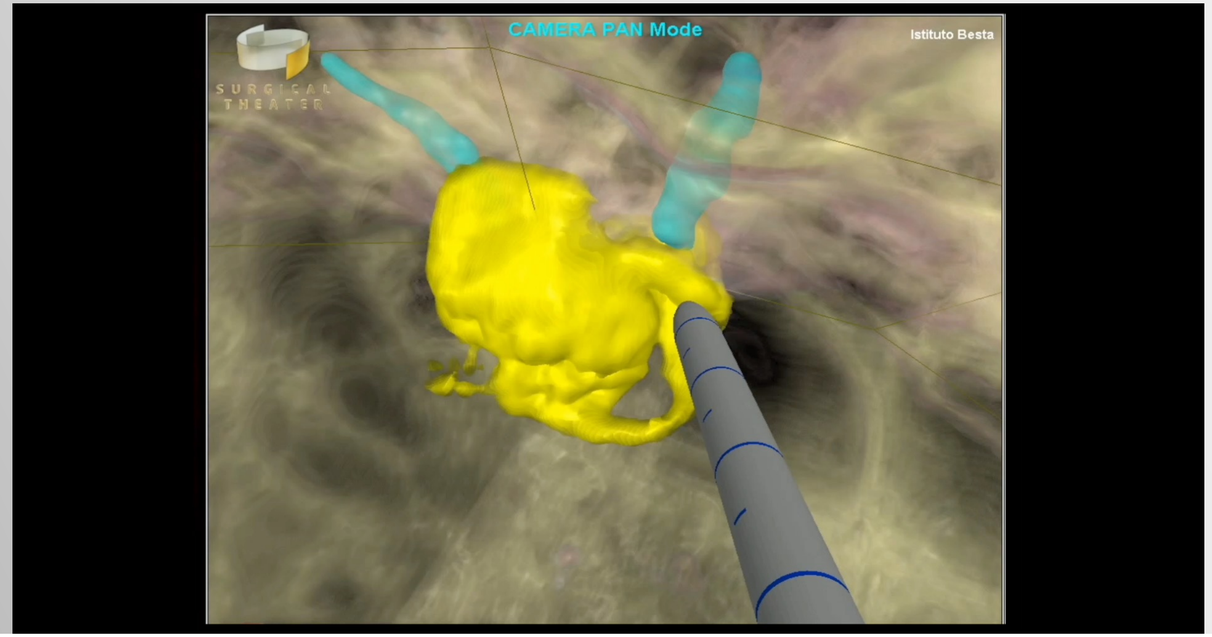


Imaging Avanzato: Realta' Aumentata



Neurosurgery of the III millennium

Virtual reality

Simulazione / training

BESTA NEUROSIM CENTER

First Neurosurgical Simulation Center in Europe


Virtual Proteins
Surgical Theater SNAP
Surgical Theater ENDO_SNAP
NeuroTouch
ImmersiveTouch
BESTA NEUROSIM CENTER
NeuroTouch
NeuroTouch Simulator
Actaeon BBZ
Multidisciplinary Team
USim®
Pre-operative MR
Intra-operative US

Physical Simulation

BESTA NEUROSIM CENTER

Physical Simulation

BESTA NEUROSIM CENTER

HUVANT
Human Haptic and Virtual Phantoms


HUVANT
Medical Simulation Platform
CONTACT US

Classic Learning Model

Classic Learning Model

See one

Classic Learning Model

See one

Do one

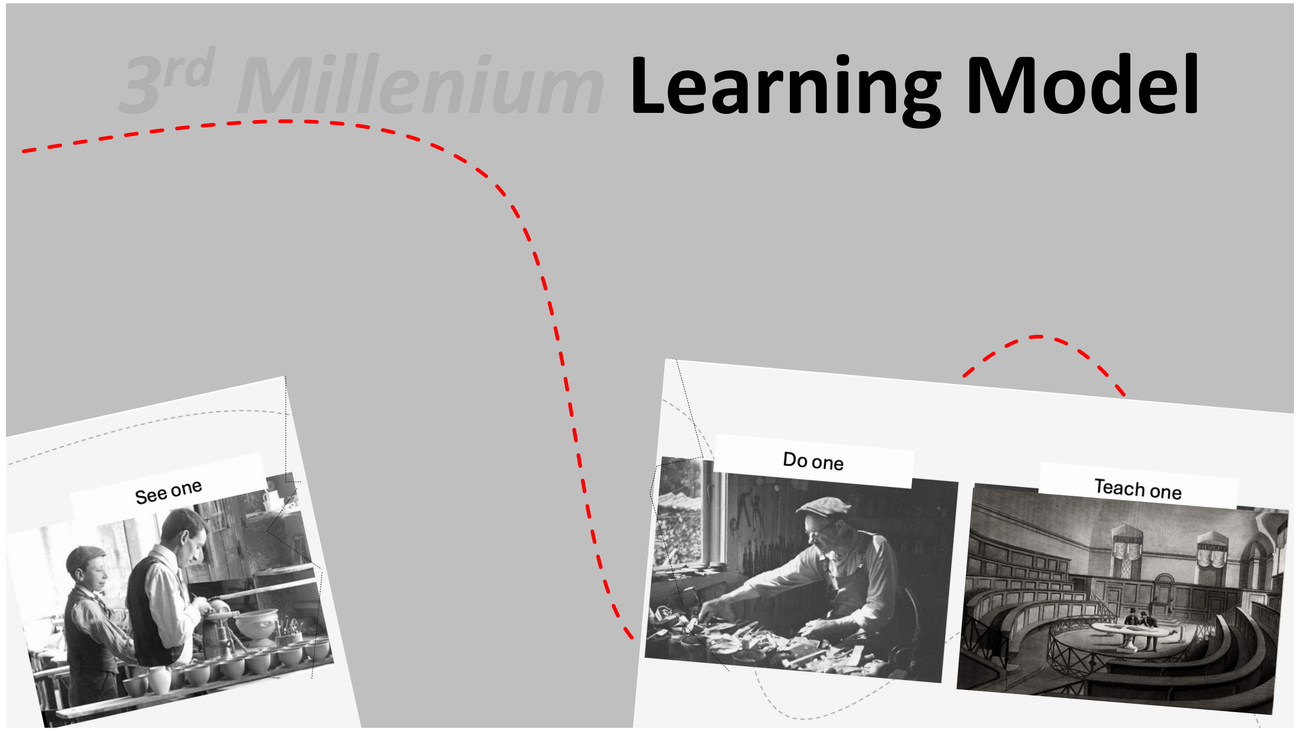
Classic Learning Model

See one

Do one

Teach one

3rd Millenium Learning Model




3rd Millenium Learning Model
Sim one!
See one
Do one
Teach one

Fondazione I.R.C.C.S. Istituto Neurologico Carlo Besta
Sistema Socio Sanitario Regione Lombardia
UNIVERSITÀ DEGLI STUDI DI MILANO
deepblue
HEAL FONDAZIONE

Progetto ASTRO-NETS - Conferenza stampa

23 Gennaio 2024

neurochirurghi addestrati come astronauti: il progetto ASTRO-NETS

Al Besta le nuove frontiere per l'addestramento dei neurochirurghi con il progetto ASTRO-NETS

Redazione

Se il chirurgo va a scuola dagli astronauti

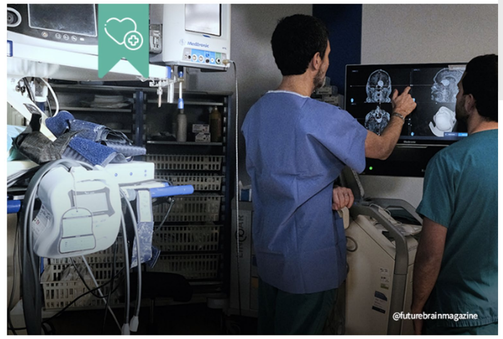
di Letizia Gabaglio

Evitare gli errori in sala operatoria. Imparando a gestire le emergenze e a contare sul gruppo. Proprio come si deve f sulla Stazione spaziale. Perché lo stress può diventare un punto di forza

Written by Sara Giovannoni • 25 January 2024 • 10:38 • Health , Home

A big step towards the future of neurosurgery with ASTRO-NETS

Astronaut training to deal with every possible situation



la NEUROLOGIA italiana
AGGIORNAMENTO E INFORMAZIONE PER LO SPECIALISTA NEUROLOGO

CEFALEE DEMENZE EPILESSIA ICTUS MALATTIE RARE PARKINSONISMI RICERCA SCL

Neurochirurghi nello spazio: presentato al Besta di Milano il progetto ASTRO-NETS

3 Febbraio 2024 Ricerca

Neurochirurghi addestrati come astronauti, nasce il progetto Astro-Nets

Un approccio innovativo con un preciso programma di preparazione per allenare le *soft skills* necessarie a reagire in situazioni di forte stress

Neurochirurghi Addestrati come gli Astronauti

FORMAZIONE
sulle **SOFT-SKILLS**

- COMUNICAZIONE
- CONSAPEVOLEZZA SITUAZIONALE
- STRESS MANAGEMENT
- ERRORE UMANO

Mettendosi nei panni degli **astronauti** con l'utilizzo del **Simulatore InterLAB**

Modello di competenze

MODELLO di COMPETENZE | Panoramica

ASTRO-NETS
Astronauts for Neurosurgery Training Scheme

Autonomia - Pianificazione - Briefing - Debriefing - Clima lavorativo - Orientamento agli obiettivi - Senso di responsabilità - Coaching - Visibilità esterna

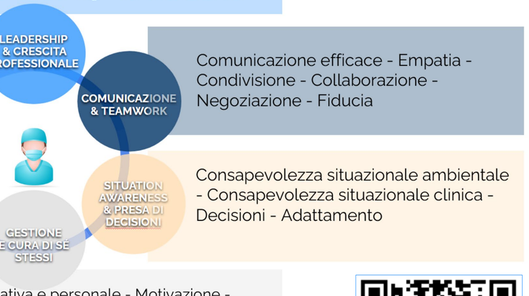
Interazione con gli strumenti: Settaggio, Utilizzo, Troubleshooting - Interazione con i ferri: Scelta, Utilizzo

Conoscenza teorica - Modellizzazione 3D - Procedure chirurgiche - Procedure ospedaliere - Codice deontologico - Ricerca

Comunicazione efficace - Empatia - Condivisione - Collaborazione - Negoziazione - Fiducia

Consapevolezza situazionale ambientale - Consapevolezza situazionale clinica - Decisioni - Adattamento

Equilibrio tra vita lavorativa e personale - Motivazione - Sicurezza di sé - Gestione dei propri limiti - Distacco emotivo - Gestione dello stress - Gestione della stanchezza



Outdoor training

allenare le competenze trasversali in un **ambiente ostile**, **diverso** dall'ambiente lavorativo ma molto **simile** dal punto di vista di **sfide e dinamiche di teamwork**!

GIORNO 1
Rocca Pendice (PD)

GIORNO 2
Lumignano (VI)

GIORNO 3
Agriturismo Valverde Villaga (VI)

Outdoor training | Giorno 1

OBIETTIVI

- Familiarizzare con strumenti e territorio
- Allenare la **comunicazione efficace**, il **teamwork**, la **situational awareness** e la **presa di decisione**

1 **Formazione sul decision-making e tecnica sui ruoli**

2 **1° ATTIVITÀ OUTDOOR:**
1 squadra, 2 team - 11 indizi da risolvere

Outdoor training | Giorno 2

OBIETTIVI

- Applicare **competenze mediche** in ambiente ostile e esplorare le pratiche di soccorso in montagna
- Continuare ad allenare le competenza del gg 1 + **leadership/coordinamento**, capacità di **pianificazione** e **ripianificazione**, **gestione pazienti e familiari** e **comunicazione empatica**

1 Formazione su comunicazione empatica

2 2° ATTIVITÀ OUTDOOR: 1 squadra - Soccorso a 3 feriti

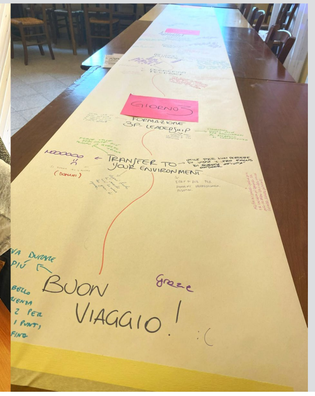
Outdoor training | Giorno 3

OBIETTIVI

- Focus su **gestione della stanchezza** ed impatto dell'**affaticamento** sulle **performance**
- "**Transfer to your environment**"

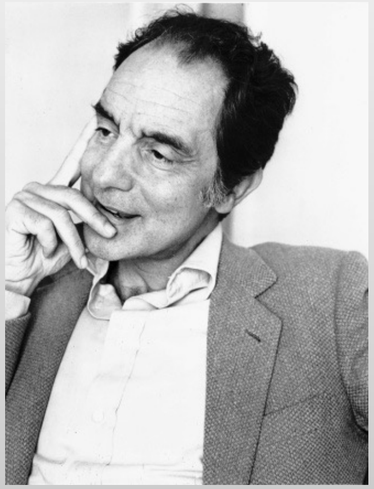
1 Attività serale
(focus su fatigue)

2 CONSOLIDAMENTO & FEEDBACK



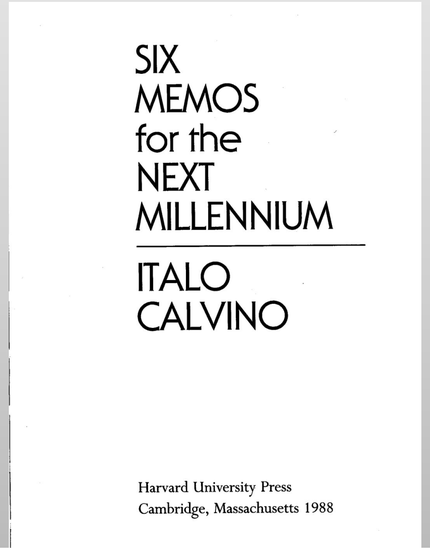
Conclusioni

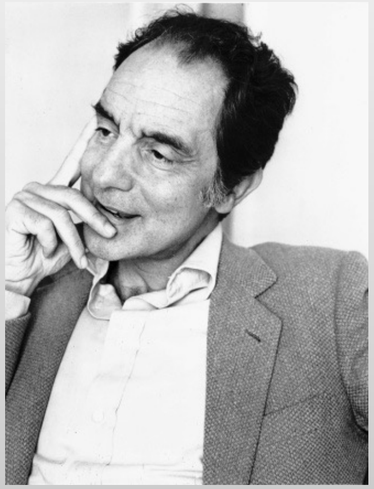
- **L'innovazione tecnologica** ha giocato un ruolo cruciale nel migliorare le procedure neurochirurgiche e soprattutto **l'outcome dei pazienti**
- Per propria natura **la neurochirurgia stimola l'innovazione** con evoluzioni estremamente rapide dello scenario chirurgico
- La realta' virtuale/aumentata e la simulazione stanno creando **nuovi paradigmi di formazione** per le prossime generazioni di neurochirurghi
- La sfida e' identificare le **tecnologie piu' promettenti** ed allo stesso tempo superare la nostra **costituzionale resilienza**



Italo Calvino
(1923-1985)

Harvard "Charles Eliot Norton Lectures"
1985-1986

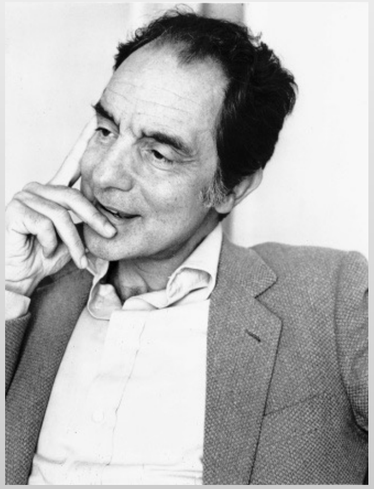




Italo Calvino
(1923-1985)

Circa la creativita'…

*"**La fantasia e' come la marmellata**, ha bisogno di essere spalmata su di una **solida fetta di pane**. Altrimenti rimane qualcosa di informe su cui non puoi costruire nulla….."*



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*c'e' bisogno di **esattezza, tecnica, concretezza e senso di realta'***

Ringraziamenti


WORLD'S BEST SPECIALIZED HOSPITALS
2024
Newsweek
POWERED BY
statista
THE WORLD'S
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SPECIALIZED
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2024
BY NEWSWEEK

WBSPH 2024 - Neurosurgery

Search

Rank	Medical Field	Hospital	City	Country	PROMs
1	Neurosurgery	Mayo Clinic - Rochester	Rochester, MN	United States	
2	Neurosurgery	Cleveland Clinic	Cleveland, OH	United States	
3	Neurosurgery	Charité - Universitätsmedizin Berlin	Berlin	Germany	
4	Neurosurgery	New York-Presbyterian Hospital-Columbia and Cornell	New York, NY	United States	
5	Neurosurgery	Massachusetts General Hospital	Boston, MA	United States	
6	Neurosurgery	National Hospital For Neurology and Neurosurgery	London	United Kingdom	
7	Neurosurgery	The Johns Hopkins Hospital	Baltimore, MD	United States	
8	Neurosurgery	The Mount Sinai Hospital	New York, NY	United States	
9	Neurosurgery	UCSF Medical Center	San Francisco, CA	United States	
10	Neurosurgery	AP-HP - Hôpital Universitaire Pitié Salpêtrière	Paris	France	
11	Neurosurgery	Stanford Health Care - Stanford Hospital	Stanford, CA	United States	
12	Neurosurgery	Memorial Sloan Kettering Cancer Center	New York, NY	United States	
13	Neurosurgery	Barrow Neurological Institute at St. Joseph's Hospital & Medical Center	Phoenix, AZ	United States	
14	Neurosurgery	The University of Tokyo Hospital	Tokyo	Japan	
15	Neurosurgery	Brigham And Women's Hospital	Boston, MA	United States	
16	Neurosurgery	Universitätsklinikum Heidelberg	Heidelberg	Germany	
17	Neurosurgery	Johns Hopkins Bayview Medical Center	Baltimore, MD	United States	
18	Neurosurgery	Fondazione I.R.C.C.S. Istituto Neurologico Carlo Besta	Milan	Italy	
19	Neurosurgery	Karolinska Universitetssjukhuset	Solna	Sweden	✓
20	Neurosurgery	NYU Langone Hospitals	New York, NY	United States	
21	Neurosurgery	MD Anderson Cancer Center	Houston, TX	United States	
22	Neurosurgery	Duke University Hospital	Durham, NC	United States	
23	Neurosurgery	Severance Hospital - Yonsei University	Seoul	South Korea	
24	Neurosurgery	Mayo Clinic - Phoenix	Phoenix, AZ	United States	
25	Neurosurgery	MUHC Montreal General Hospital	Montréal	Canada	
26	Neurosurgery	Maastricht UMC+	Maastricht	The	

Screenshot

WBSPH 2024 - Neurosurgery

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22	Neurosurgery	Duke University Hospital	Durham, NC	United States	
23	Neurosurgery	Severance Hospital - Yonsei University	Seoul	South Korea	
24	Neurosurgery	Mayo Clinic - Phoenix	Phoenix, AZ	United States	
25	Neurosurgery	MUHC Montreal General Hospital	Montréal	Canada	
26	Neurosurgery	Maastricht UMC+	Maastricht	The	

Screenshot

Top 4 European Centers