THE SOCIETY OF UNIVERSITY NEUROSURGEONS

Dubrovnik, Croatia

2019 ANNUAL MEETING

June 26-30, 2019

THE SOCIETY OF UNIVERSITY NEUROSURGEONS

American Association of Neurological Surgeons

Jointly Provided by the AANS

Dubrovnik, Croatia 2019

Dear Colleagues, dear Friends,

The Department of neurosurgery, University Clinical Centre Zagreb, is honored and delighted to host the 2019 SUN meeting in the Dubrovnik Palace Hotel, Dubrovnik, Croatia, from 26th to 30th June 2019.

The Department of neurosurgery, University Clinical Centre Zagreb is the oldest neurosurgical department, connected with the undergraduate and postgraduate neurosurgical programs in University of Zagreb School of Medicine which celebrates 100 years of existence.

The Neurosurgery Department was established after the Second World War, and was organized like most of European neurosurgery departments, with first stereotactic procedure taking place in 1965 and first micro-surgical procedure performed in 1970, only a few years after Yasargil and Donaghy.

The City of Dubrovnik, declared a World Heritage Site by UNESCO in 1979, is the jewel of Croatian tourism, sitting in the southernmost part of Croatia. It harbors centuries of heritage created by the noble skills and finest builders and artists, and became most prominent touristic destination in the Mediterranean Sea. The prosperity of the city was historically based on maritime trade, as the capital of the maritime Republic of Ragusa. During the 15th and 16th Century it became notable for its wealth and skilled diplomacy, and used to be an independent merchant republic for 700 years until Napoleon conquer the region. Dubrovnik has high education tradition which dates back to the 17th Century when Collegium Ragusinum, as a first public institution of higher education, was established.

The City itself is completed in the 13th Century and its walls remained virtually unchanged to the present days. Apart from some earthquakes that demolished its beauty, the last attacks to its Beauty were held in 1990 during the armed conflict.

The City is surrounded by the 1940m long defensive walls with only two main entrances to the old town. The most famous promenade which is called "Stradun" is surrounded with fountains, Gothic and Renaissance facades of the Sponza palace and Ducal palace, and Baroque church of St. Blasius, Jesuit College and lot of different other buildings. To enjoy in its beauty, the Croatian Neurosurgical Society has organized the joint meeting with the AANS in 2008 with great impact on the professional development and strengthening ties in neurosurgical community.

The Department of neurosurgery University Clinical Centre Zagreb would like to invite colleagues whose life is dedicated to neurosurgery to share the ideas, experiences and knowledge, and enjoy the remarkable City of Dubrovnik and its surroundings, and taste the local food with astonishing view of the Adriatic sea, to enjoy music in lovely Palaces and streets, and to feel tranquility of this divine place.

We hope that Dubrovnik, with its remarkable history and astonishing beauty, will leave everybody moved and delighted, in words of Bernard Shaw: "Those who seek paradise on Earth should come to Dubrovnik".

Warm regards!

Ass. Prof. Goran Mrak M.D., Ph.D.
Local Host, SUN 2019
Head of the Department for Neurosurgery
University of Zagreb, Medical School
Clinical Hospital Centre Zagreb

Professor Miroslav Vukic, M.D., Ph.D.
Scientific Program Co-Chair, SUN 2019
President of the Croatian Neurosurgical Society

Present Officers

President
Richard Ellenbogen, MD

Vice President
Felipe Albuquerque, MD

President-Elect
Erol Veznedaroglu, MD

Secretary/Treasurer
Richard Anderson, MD

Historian
Ken Smith, MD

Member-at-Large
Ian McCutcheon, MD

Membership Committee
Kadir Erkmen, MD
Daniel Hoh, MD
Ian McCutcheon, MD
Christina Notarianni, MD

Future Sites Committee
Ruth Bristol, MD
Daniel Yoshor, MD
Jeff Sorenson, MD
Anthony Sin, MD

CME
Carlos David, MD

Past Presidents

~~~~~~1965~~~~~~
James T. Robertson, MD

~~~~~~1966~~~~~~
George T. Tindall, MD

~~~~~~1967~~~~~~
Robert G. Ojemann, MD

~~~~~~1968~~~~~~
Charles L. Branch, MD

~~~~~~1969~~~~~~
Jim Story, MD

~~~~~~1970~~~~~~
Herbert Lourie, MD

~~~~~~1971~~~~~~
Byron Pevehouse, MD

~~~~~~1972~~~~~~
Kenneth Shulmann, MD

~~~~~~1973~~~~~~
Darton Brown, MD

~~~~~~1974~~~~~~
Ellis Keener, MD

~~~~~~1975~~~~~~
Robert Hardy, MD

~~~~~~1976~~~~~~
Phanor Perot, MD

~~~~~~1977~~~~~~
Gordon Thompson, MD

~~~~~~1978~~~~~~
Lucien R. Hodges, MD

~~~~~~1979~~~~~~
Robert White, MD

~~~~~~1980~~~~~~
Robert Grossman, MD

~~~~~~1981~~~~~~
Stewart Dunsker, MD

~~~~~~1982~~~~~~
Marshall Allen, MD

~~~~~~1983~~~~~~
Ian Turnbull, MD

~~~~~~1984~~~~~~
Henry Garretson, MD

~~~~~~1985~~~~~~
Harold F. Young, MD

~~~~~~1986~~~~~~
Robert Smith, MD

~~~~~~1987~~~~~~
Kenneth R. Smith, Jr. MD

~~~~~~1988~~~~~~
Willis Brown, MD

~~~~~~1989~~~~~~
Glenn W. Kindt, MD

~~~~~~1990~~~~~~
Salvador Gonzales-Cornejo, MD

~~~~~~1991~~~~~~
Michael L.J. Apuzzo, MD

~~~~~~1992~~~~~~
William A. Buchheit, MD

~~~~~~1993~~~~~~
Alan R. Hudson, MD

~~~~~~1994~~~~~~
Robert Maxwell, MD

~~~~~~1995~~~~~~
Peter L. Black, MD

~~~~~~1996~~~~~~
William Shucart, MD

~~~~~~1997~~~~~~
Ronald F. Young, MD

~~~~~~1998~~~~~~
David W. Roberts, MD

~~~~~~1999~~~~~~
Charles S. Hodge, Jr. MD

~~~~~~2000~~~~~~
John E. McGillicuddy, MD

~~~~~~2001~~~~~~
H. Hunt Batjer, MD

~~~~~~2002~~~~~~
Philip Stieg, PhD, MD

~~~~~~2003~~~~~~
Robert Rosenwasser, MD

~~~~~~2004~~~~~~
Robert Breeze, MD

~~~~~~2005~~~~~~
Kim Burchiel, MD

~~~~~~2006~~~~~~
Jon Robertson, MD

~~~~~~2007~~~~~~
Carl Heilman, MD

~~~~~~2008~~~~~~
Robert Solomon, MD

~~~~~~2009~~~~~~
Jeffrey Bruce, MD

~~~~~~2010~~~~~~
John Wilson, MD

~~~~~~2011~~~~~~
Anil Nanda, MD

~~~~~~2012~~~~~~
Thomas Origitano, MD

~~~~~~2013~~~~~~
Neil Kitchen, MD

~~~~~~2014~~~~~~
Sander Connolly, MD

~~~~~~2015~~~~~~
Jacques Morcos, MD

~~~~~~2016~~~~~~
Michael Levy, MD

~~~~~~2017~~~~~~
Nelson Oyesiku, MD

~~~~~~2018~~~~~~
Michael Wang, MD

Previous Meetings

~~~~~~1965~~~~~~
Montreal Neurological Institute
Montreal, QUE
~~~~~~1966~~~~~~
Duke University
Durham, NC
~~~~~~1967~~~~~~
University of Minnesota
Minneapolis, MN
~~~~~~1968~~~~~~
Upstate Medical Center
Syracuse, NY
~~~~~~1969~~~~~~
Massachusetts General Hospital
Boston, MA
~~~~~~1970~~~~~~
Baptist Memorial Hospital
Memphis, TN
~~~~~~1971~~~~~~
Albert Einstein College of Medicine
Bronx, NY
~~~~~~1972~~~~~~
University of British Columbia
Vancouver, BC
~~~~~~1973~~~~~~
Emory University
Atlanta, GA
~~~~~~1974~~~~~~
University of Texas Medical School
San Antonio, TX
~~~~~~1975~~~~~~
Mayo Clinic
Rochester, MN
~~~~~~1976~~~~~~
Jefferson Medical College
Philadelphia, PA
~~~~~~1977~~~~~~
Mayfield Neurological Institute
Cincinnati, OH
~~~~~~1975~~~~~~
Mayo Clinic
Rochester, MN
~~~~~~1976~~~~~~
Jefferson Medical College
Philadelphia, PA
~~~~~~1977~~~~~~
Mayfield Neurological Institute
Cincinnati, OH
~~~~~~1978~~~~~~
Medical College of Georgia
Augusta, GA
~~~~~~1979~~~~~~
University of Guadalajara
Guadalajara, MX
~~~~~~1980~~~~~~
University of Florida
Gainesville, FL
~~~~~~1981~~~~~~
University of Western Ontario
London, ONT
~~~~~~1982~~~~~~
University of Mississippi
Jackson, MS
~~~~~~1983~~~~~~
Duke University/University of NC
Durham/Chapel Hill, NC
~~~~~~1984~~~~~~
University of Washington
Seattle, WA

~~~~~~1985~~~~~~
University of Colorado
Denver/Vail, CO
~~~~~~1986~~~~~~
University of Louisville
Louisville, KY
~~~~~~1987~~~~~~
Medical College of Virginia
Richmond, VA
~~~~~~1988~~~~~~
University of Tubingen
Tubingen, FRG
~~~~~~1989~~~~~~
University of Toronto
Toronto, ONT
~~~~~~1990~~~~~~
Louisiana State Univ. Medical Center
New Orleans, LA
~~~~~~1991~~~~~~
Tufts New England Medical School
Boston, MA
~~~~~~1992~~~~~~
Dartmouth Medical School
Woodstock, VT
~~~~~~1993~~~~~~
St. Louis University Medical School
St. Louis, MO
~~~~~~1994~~~~~~
University of Lyon
Lyon, France
~~~~~~1995~~~~~~
Thomas Jefferson Medical School
Philadelphia, PA
~~~~~~1996~~~~~~
University of Southern California
Los Angeles, CA
~~~~~~1997~~~~~~
University of Michigan
Ann Arbor, MI
~~~~~~1998~~~~~~
University of Tennessee
Memphis, TN
~~~~~~1999~~~~~~
University of Melbourne
Melbourne, Australia
~~~~~~2000~~~~~~
Havard Medical School/
Brigham & Women's
Boston, MA
~~~~~~2001~~~~~~
Oregon Health Sciences University
Portland, OR
~~~~~~2002~~~~~~
Northwestern University/ Chicago
Evanston, IL
~~~~~~2003~~~~~~
Columbia Presby. Med Center/
NY Presby. Hospital
New York, NY
~~~~~~2004~~~~~~
Karolinska Institute
Stockholm, Sweden
~~~~~~2005~~~~~~
Wake Forest University
School of Medicine
Winston-Salem, NC
~~~~~~2006~~~~~~
University of California – San Diego
Del Mar, CA

~~~~~~2007~~~~~~
National Hospital for Neurology
and Neurosurgery
London, England
~~~~~~2008~~~~~~
University of California
San Francisco, CA
~~~~~~2009~~~~~~
Sapienza University
Rome, Naples & Capri, Italy
~~~~~~2010~~~~~~
University of Miami
Miami, Florida
~~~~~~2011~~~~~~
Istanbul, Turkey
~~~~~~2012~~~~~~
Emory University
Atlanta, Georgia
~~~~~~2013~~~~~~
Carlos Haya University
Malaga, Spain
~~~~~~2014~~~~~~
University of Washington
Seattle, WA
~~~~~~2015~~~~~~
Huashan Hospital Fudan University
Shanghai, China
~~~~~~2016~~~~~~
Barrow Neurological Institute
Phoenix, AZ
~~~~~~2017~~~~~~
University of Cape Town
Cape Town, South Africa
~~~~~~2018~~~~~~
MD Anderson Cancer Center
Houston, TX
~~~~~~

2019 Meeting Attendees

SUN Members

Acar, Feridun, MD
Albuquerque, Felipe, MD
Amin-Hanjani, Sepideh, MD
Anderson, Richard, MD
Binning, Mandy, MD
Bristol, Ruth, MD
Boulis, Nicholas, MD
Brau, Ricardo, MD
Bruce, Jeffrey, MD
Burchiel, Kim, MD
Camarata, Paul, MD
Charbel, Fady, MD
Chin, Lawrence, MD
Cockroft, Kevin, MD
Connolly, Sander, MD
David, Carlos, MD
Ecklund, James, MD
Ellenbogen, Richard, MD
Goumnerova, Liliana, MD
Heilman, Carl, MD
Kaiser, Michael, MD
Kitchen, Neil, MD
Krishnamurthy, Satish, MD
Kurpad, Shekar, MD
Lavine, Sean, MD
Levi, Allan, MD
Levy, Michael, MD
Liebman, Kenneth, MD
Liu, James, MD
Liu, Charles, MD
Lonser, Russell, MD
Mrak, Goran, MD
Markert, James, MD
McCutcheon, Ian, MD
McKhann, Guy, MD
McCormick, Paul, MD
Michael, Madison, MD
Morcos, Jacques, MD
Nanda, Anil, MD
Ogden, Alfred, MD
Prabhu, Sujit, MD
Preul, Mark, MD
Sagher, Oren, MD
Sheth, Sameer, MD
Sin, Anthony, MD
Sisti, Michale, MD
Smith, Kenneth, MD
Solomon, Robert, MD
Tibbs, Phillip, MD
Tronnier, Volker, MD
Veznedaroglu, Erol, MD
Wang, Michael, MD
Yoshor, Daniel, MD
Zadeh, Gelareh, MD

Members' Guests

Bergsneider, Marvin, MD
Goldstein, Ira, MD
(Nanda, Anil, MD)

Britz, Gavin, MD
Tjoumakaris, Stav, MD
(Lavine, Sean, MD)

Camins, Martin, MD
(Connolly, Sander, MD)

Chamoun, Roukoz, MD
(Camarata, Paul, MD)

Nemir, Jacob, MD
(Mrak, Goran, MD)

Lang, Frederick, MD
(McCutcheon, Ian, MD)

Mendez Rosito, Diego, MD
(Liu, James, MD)

Abou-Hamden, Amal, MD
Midha, Rajiv, MD
Sames, Martin, MD
(Morcos, Jacques, MD)

Quest, Donald, MD
(Solomon, Robert, MD)

Friehs, Gerhard, MD
Riesenburger, Ron, MD
Zerris, Vasilios, MD
(Heilman, Carl, MD)

Vukic, Miroslav, MD
(Scientific Program Co-Chair, MD)

Vyas, Nilesh, MD
(Ecklund, James, MD)

Walters, Beverly, MD
(Ellenbogen, Richard, MD)

Yoon, Jang, MD
(Wang, Michael, MD)

Youssef, Samy, MD
(Liu, James, MD)

Zager, Eric, MD
(Levy, Allan, MD)

Jabbour, Pascal, MD
(Veznedaroglu, Erol, MD)

Distinguished Service Award

Michael Y. Wang, MD FACS
Professor with Tenure, Departments of Neurosurgery and Rehab Medicine

Dr. Wang was born in Scottsdale, Arizona and spent his childhood in Atlanta, Georgia. He then attended Stanford University in Palo Alto, California where received both his B.S. and M.D. degrees. He completed his residency at the University of Southern California/LA County general Hospital and went on to become the Spine Program Director and Spine Fellowship Director at the USC. In 2007 he moved to South Florida and currently serves as a Professor in the Departments of Neurological Surgery and Rehabilitation Medicine at the University of Miami, Miller School of Medicine.

Dr. Wang has been an advocate for neurosurgeons and spinal surgeons. He was elected to the AANS Young Neurosurgeons Executive Committee in 2003, and in the AANS he has served as Local Host for the 2010 Annual Meeting, on the Member Benefits Committee, the Joint Sponsorship Committee, the AANS Development Committee, and the International Committee. In the AANS/CNS Joint Section on Disorders of the Spine & Peripheral Nerves he has served as Chair of the Publications, Education, Fellowship, and Exhibits Committees and is the current Scientific Program Chair. He is also the Membership Chair and Public Relations Chair of the Congress of Neurosurgeons. Dr. Wang serves on several editorial review boards, including Neurosurgery, *The Journal of Spinal Disorders & Techniques, World Neurosurgery, Acta Neurochirurgica, Spinal Cord, the Journal of Spinal Cord Medicine, and the Journal of Neurosurgery: Spine.*

Dr. Wang's research and clinical interests include minimally invasive spinal surgery, intradural spinal surgery, spinal deformity, clinical outcomes and trials, and spinal cord injury. He has edited 5 medical textbooks and authored over 100 peer-reviewed publications in the medical literature.

THE SOCIETY OF UNIVERSITY NEUROSURGEONS

Special Speaker

Kate Bagoje, B.A.

I am an Art Historian, born on the 23rd January 1952 in Dunave, Dubrovnik, Croatia.

Education:

I completed eight-year elementary school and four-year Grammar school in Dubrovnik. I spent one school-year in England studying English language, and after that I enrolled the Faculty of Arts in Zadar and graduated the English language and Art History lasting eight semesters. I received my B.A. (University degree) in the English language and Art History in 1975.

I also attended Italian lessons during that period and have some knowledge of the Italian language, too.

Additional Training:

Two-months' International Stone Conservation Course in Venice, organized and sponsored by UNESCO, ICCROM and Samuel Cress Fondation, spring 1989.

A week Course on the monuments' protection at the Institute for Conservation and Restoration, Postgraduate Dept. of St.Lukes Institute for Art and Architecture in Gent, Belgium, September 1995.

Presently completing my final Masters' thesis on the late Renaissance stone altars in the region of Dubrovnik at the Postgraduate Studies after passing all required exams (University of Zagreb) for my M.A.

Working experience:

From 1981 I was actively engaged on the protection of historic monuments in Dubrovnik.

In 1986 I was appointed the Coordinator of the exhibition "Golden Age of Dubrovnik", a two-year's project that was displayed in Zagreb and Dubrovnik in 1987, presenting several hundreds of the best artefacts created in the Renaissance period of the 15th and the 16th centuries in the Dubrovnik Republic.

After the war aggression on Croatia 1991/92 I was particularly engaged on the restoration of stone monuments damaged during the bombardment of Dubrovnik. First I worked on detailed documentation of the damaged monuments and from 1993 I was the Head of Restoration Dept. in the Institute for Restoration of Dubrovnik till November 1996. In that period I supervised the restoration of the most damaged stone monuments inside the old City of Dubrovnik upon the requirement of UNESCO experts who officially visited Dubrovnik listed on the UNESCO Heritage List.

From 1996 I was employed full-time as a Secretary-Conservator in the Association of Friends of Dubrovnik Antiquities, an institution that has in charge and takes maintenance of the ancient city walls and fortification' complex of the whole Dubrovnik region.

Since 1998 I am an adjunct lecturer of Art History at the American College of Management and Technology (ACMT) in Dubrovnik.

Participation at International Symposiums:

During last twelve years I have attended numerous symposiums in Croatia and Europe (Belgium, France, Italy, Great Britain, Wales, Switzerland, Portugal) that were concerned with problems on protection of historic heritage and I took an active part on the sessions giving lectures and presenting the works on monuments. These works were published in various professional publications.

I was the editor-in-chief and the author of several texts in two Monographies of the Dubrovnik Airport (two editions in 2008 and in 2012) and the translator of complete texts in both books to the English language.

I permanently participate in different promotion Tourist Board brochures in Dubrovnik writing about the monuments of Dubrovnik and the surrounding area ('Welcome to Dubrovnik' - 5 issues, 'Freedom and Beauty' etc.).

Frequently I write art critics on contemporary exhibitions of local artists.

I also give temporary lectures on Dubrovnik history and its cultural heritage with CD presentation at the International University Centre in Dubrovnik for various institutions and participants on different occasions.

Welcome to Montana for SUN 2020

It is my distinct privilege and pleasure to invite you to the beautiful Flathead Valley, in Northwest Montana, United States for the 2020 Society of University Neurosurgeons Annual Meeting, being held August 2nd through the 5th. This will be a meeting of high science and exceptional natural beauty. The Flathead Valley is nestled on three sides by the Rocky Mountains, and to the south lays Flathead Lake, North America's largest fresh water lake west of the Mississippi. The meeting will take place at the Lodge at Whitefish Lake, a four-star resort and spa. Whitefish, Montana is the gateway to Glacier National Park one of the world's most iconic environmental reserves and home to some of the last surviving glaciers in North America.

Members and guest participants will provide the rich scientific and clinical material to the annual assembly. Northwest Montana will provide a backdrop of inspirational beauty and endless outdoor experiences. You and your family will be immersed in opportunities to experience the exquisiteness and wonder of THE LAST BEST PLACE. Life here in Montana is laid back. Montana formal usually means a clean pair of blue jeans, a button down shirt, perhaps a vest, cowboy hat, and dancing boots (with leather soles to glide across the dance floor).

While seemingly remote, access to Whitefish, Montana in the summer is exceptional with direct flights to Glacier Park International Airport (FCA) from Seattle, Portland, San Francisco, Oakland, Los Angeles, Las Vegas, Salt Lake, Denver, Chicago, Minneapolis, and Atlanta. Book your flights early as more than 2.5 million people come through the valley every summer.

The summer weather in Northwest Montana is idyllic with long dry days (with over 15 hours a day of sun light). Temperatures are in the mid 80 degrees during the day with cooler nights in the low 70s. Bring multiple thin layers of clothes and a backpack. We will also teach you how to use bear spray (which by the way you cannot take it on the plane).

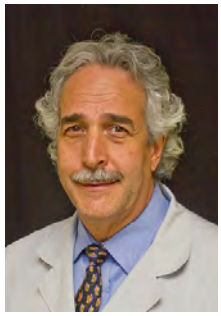
Outside of the scientific sessions there will be opportunities to hike in Glacier Park, scenic float and raft, hot air balloon sightseeing, fly fishing, mountain biking, watersports, unique golfing experiences, and a restorative spa. Please, come early, stay late, and enjoy all the summer in the Flathead Valley can offer. Please bring your family, as it will be an experience that they will never forget and will want to repeat. People here are friendly and practical. If you have questions, from bug spray to accommodations, please feel free to contact Willie Deering (wdeering@krmc.org) or Jamie Mack (jmack@krmc.org) at the Neuroscience and Spine Institute, Department of Neurological Surgery, Kalispell Regional Healthcare.

John Steinbeck said it best: "I'm in love with Montana. For other states I have admiration, respect, recognition, even some affection. But with Montana it is love. And it's difficult to analyze love when you're in it."

Come, with an open heart and an open mind to learn, to exchange ideas, perhaps even to fall in love.

I wish you all peace, good health and hope see you in my beloved Montana.

Respectfully,



TC Origitano MD PhD FACS FAANS
Medical Director
Neuroscience & Spine Institute
Department of Neurological Surgery
Kalispell Regional Medical Center

THE SOCIETY OF UNIVERSITY NEUROSURGEONS

Meeting Schedule

Wednesday, June 26, 2019

6:30-9:30 pm:	Welcome Reception	Dubrovnik Palace Hotel Roof Top Terrace

Thursday, June 27, 2019

6:30-8:30 am:	Breakfast Buffet	Elafiti Restaurant
8:00-12:00 pm:	**Joint Meeting between SUN and Croatian Neurosurgical Society Dubrovnik**	**Mare 1**
	Moderator:	Miroslav Vukic, MD
8:00-8:10 am:	Welcome address	Miroslav Vukić, MD Richard Ellenbogen, MD (SUN President)
8:10-8:25 am:	History of Neurosurgery in Croatia	Darko Ledić, MD
8:25-8:40 am:	Neuroimaging: Spine Degeneration vs Inflammation vs Infection	Zoran Rumboldt, MD
8:40-8:55 am:	Deep Brain Stimulation In Patients With Impaired Consciousness	Darko Chudy, MD
8:55-9:10 am:	CSF Circulation – Does It Really Exist?	Miroslav Vukić, MD
9:10-9:40 am:	Subathmospheric Intracranial Pressure Is A Long Lasting Phenomenon	Marijan Klarica, MD
9:40-10:00 am:	Discussion	
10:00-10:30 am:	**Break with exhibitors**	
10:30-10:45 am:	Neuroimaging Modalities for Mechanical Thrombolysis in Patients with Acute Stroke	Marko Radoš, MD
10:45-11:00 am:	Intraventricular Thrombolysis In Patients With Aneurysmal Subarachnoid Haemorrhage	Zdravka Poljaković, MD
11:15-11:15 am:	Radiosurgery of AVM – Our First Fifteen Years' Experienc	Zdravko Heinrich, MD
11:15-11:30 am:	Surgical Treatment Of Brain Ischaemia	Goran Mrak, MD

11:30-12:00 pm:	GUEST LECTURE: Ivica Kostović, Professor of Neuroscience and Anatomy, Academician of the Croatian Academy of Science and Arts, Former Vice-President of Croatian Government, Former Vice-President of Croatian Parliament, and Former Minister of Science: A Politician's Brain	
12:00-12:15 pm:	Discussion	

Activities:

12:30-1:30 pm:	Lunch (attendees and family)	Elafiti Restaurant
1:30-5:45 pm:	Free Time	
6:00-6:15 pm:	**Leave hotel for TIRENA galleon sunset cruise (Bus Transport to port)**	**Front Lobby**
6:15-8:00 pm:	Coctails Onboard (Open bar)	Buffet dinner on board during sunset cruise
8:00-8:45 pm:	Disembark in the Old Town for Guided Tour	
9:00-9:30 pm:	Classical music concert	
9:45 pm:	Transfer back to Palace Hotel	

Friday, June 28, 2019

6:30-8:30 am:	Breakfast Buffet	Elafiti Restaurant
7:00-8:00 am:	**Executive Committee Meeting (Executive only)**	**Kokpit**
8:01-10:10 am:	Scientific Session 1: Vascular neurosurgery.	Mare 1
	Moderators:	Felipe Albuquerque, MD Sean Lavine, MD
8:01-8:10 am:	Introduction	Goran Mrak, MD
8:11-8:20 am:	Transradial approach for neuro-endovascular procedures: clinical outcomes and patient satisfaction measures	Pascal Jabbour, MD
8:21-8:30 am:	Management of posterior inferior cerebellar artery aneurysms	Martin Sames, MD
8:31-8:40 am:	Feasibility of robotic-assisted neurovascular interventions: Inital experience in flow model and pig model	Gavin Britz, MD
8:42-8:50 am:	Outcomes of Surgically Managed Ruptured and Unruptured Brain Arteriovenous Malformations	Amal Abou-Hamden, MD
8:51-9:00 am:	The Cut Flow Index—Revisited: Utility of Intraoperative Blood Flow Measurements During Extracranial-Intracranial Bypass for Ischemic Cerebrovascular Disease	Fady Charbel, MD
9:01-9:10 am:	Antiplatelet agents in the 24-hour TPA window	Mandy Binning, MD
9:11-9:20 am:	Direct STA-MCA bypass for Moyamoya and Atherosclerotic disease: A single surgeon series - Indications, Results and Intraoperative Blood Flow data	Jacques Morcos, MD
9:21-9:30 am:	Impact of current generation anticonvulsant prophylaxis on seizure incidence after ICH	Kevin Cockroft, MD
9:31-9:40 am:	Technology: Friend or Foe?	Jang Yoon, MD
9:41-9:43 am:	Introduction of SUN President	James Ecklund, MD
9:43-10:10 am:	Presidential Address	Richard Ellenbogen, MD
10:10-10:30 am:	**Break with exhibitors**	**Foyer / terrace**

10:30-12:00 pm:	Scientific Session 2: Peripheral nerve/Functional neurosurgery.	Mare 1
	Moderators:	Kim Burchiel, MD Sameer Sheth, MD
10:30-10:40 am:	Functional Neurosurgery	Volker Tronnier, MD
10:41-10:50 am:	Current Evidence on Image-Guided Implantation of Deep Brain Stimulation Electrodes Under General Anesthesia	Kim Burchiel, MD
10:51-11:00 am:	Nerve transfers to restore motor function in patients with cervical spinal cord injury	Rajiv Midha, MD
11:01-11:10 am:	CT-Guided, Ethanol Sympatholysis for Primary Axillary-Palmar Hyperhidrosis	Vasilios A Zerris, MD
11:11-11:20 am:	Peripheral nerve/tumor	Eric Zager, MD
11:21-11:40 am:	Extent of subdural grid implantation correlates with delay in seizure occurrence	Oren Sagher, MD
11:41-11:50 am:	Mechanisms Supporting Optimal Decision-Making in Human Prefrontal Cortex	Sameer Sheth, MD
11:51-12:00 pm:	Intraosseous Cannulation During Brain Herniation in Place of Central Venous Line Placement	Nilesh Vyas, MD
12:01-12:10 pm:	Recurrence patterns in Skull Base Meningioma	Anil Nanda, MD

Activities:

12:30-1:30 pm:	Lunch (attendees and family)	Elafiti Restaurant
1:30-5:30 pm:	Free Time	
5:45-6:15 pm:	**Departure to the Village of Cavtat for Dinner by the Sea. Bus transfer to CAVTAT**	**Front Lobby**
7:30-9:15 pm:	Dinner at Spinnaker	
9:30-10:00 pm:	Bus transfer Cavtat - Hotel	

Saturday, June 29, 2019

6:30-8:30 am:	Breakfast Buffet	Elafiti Restaurant
7:00-8:00 am:	**SUN Business Meeting (members only)**	**Mare 2+3**
8:01-9:10 am:	Scientific Session 3: Spine and Pediatrics.	Mare 1
	Moderators:	Mike Kaiser, MD Richard Anderson, MD
8:01-8:10 am:	Can a laminectomy save a life? Amyloidosis, the ligamentum flavum, and the heart	Ron Riesenburger, MD
8:11-8:20 am:	Advantages of the Endoscopic Endonasal approach versus the Transoral approach for Odontoid resection	Carl Heilman, MD
8:21-8:40 am:	Minimally-invasive Direct Pars Repair with Cannulated Screws and Recombinant Human Bone Morphogenetic Protein in the Young Athlete	Allan Levi, MD
8:41-8:50 am:	Preoperative 3D Modeling in Infants and Children with Complex Cerebral Aneurysmal Malformations	Michael L. Levy, MD
8:51-9:00 am:	Hydrocephalus	Ruth Bristol, MD
9:01-9:10 am:	Spine - Pediatric Deformity	Anthony Sin, MD
9:11-10:50 am:	Scientific Session 4: Tumor/skull base.	Mare 1
	Moderators:	Anil Nanda , MD Madison Michael , MD
9:11-9:20 am:	The ultimate skull base maneuver does not involve removing bone: quantifying the benefits of the interfascial dissection	Madison Michael, MD
9:21-9:30 am:	Skull Base Surgeon: The Law of Nature	A Samy Youssef, MD
9:31-9:40 am:	Brain Tumors and endovascular treatments with stem cells	Frederick F. Lang, MD
9:41-9:50 am:	Use of intraoperative ultrasound in transsphenoidal surgery for pituitary adenomas	Roukoz Chamoun, MD

9:51-10:00 am:	Impact of Surgical Resection of a Single Dominant Tumor in Patients with Multiple Brain Metastases	Ian McCutcheon, MD
10:01-10:10 am:	Skull base	Marvin Bergsneider, MD
10:11-10:20 am:	Lessons learned in jugular paraganglioma surgery	Diego Mendez Rosito, MD
10:21-10:30 am:	Predicting brain tumor recurrence: development and validation of a DNA-methylation based nomogram in meningioma	Gelareh Zadeh, MD
10:31-10:40 am:	Efflux transporter function determines hydrocephalus following intraventricular hemorrhage in an experimental model.	Satish Krishnamurthy, MD
10:41-10:50 am:	A Comparison of General Anesthesia Versus Conscious Sedation In Mechanical Thrombectomy Patients For Surgical and Functional Outcomes	Stavropoula Tjoumakaris, MD
10:51-11:10 am:	**Break with exhibitors**	**Foyer / terrace**
11:11-12:10 pm:	Scientific Session 5: General interest.	Mare 1
	Moderators:	Erol Veznederoglu, MD Ian McCutcheon, MD
11:11-11:20 am:	Confocal Laser Endomicroscopy for Optical Biopsies of Brain Tumors: 10-Years of Research and Clinical Investigations for Precise Real-Time Neurosurgical Intraoperative Microimaging	Mark Preul, MD
11:21-11:30 am:	Impact on Extent of Resection and Facial Nerve Outcomes Using Subperineural Dissection Technique for Surgical Resection of Acoustic Neuromas	James Liu, MD
11:31-11:40 am:	Validation of Preoperative Language Mapping Modalities: A Comparison of fMRI, nTMS, and DCS	Sujit Prabhu, MD
11:41-11:50 am:	A Novel Low Profile Shunting System	Kenneth Liebman, MD
11:51-12:00 pm:	Forever Young: A Program to Enhance Brain Health and Vitality	James Ecklund, MD
12:01-12:10 pm:	The Role of Evidence Based Medicine in Neurosurgical Education: A survey of United States Residency Training Programs	Beverly C Walters, MD

Activities:

1:00 pm:	**Bus transfer to the Old Town**	**Front Lobby**
1:30- 1:45 pm:	Boat and entrance at Lokrum with guide	
2:00-5:00 pm:	Lunch (attendees and family)	Lokrum Island Escape with Lunch
5:00 pm:	Disembark and Bus transfer back to the hotel	
6:30-7:30 pm:	Cocktail Hour at the hotel	
7:30-10:30 pm:	Gala Dinner on VALA beach /hotel Palace	

Learning Objectives

Upon completion of this CME activity, the participant should be able to:

- Discuss current practice patterns with regards to the symptomatology, diagnosis, treatment methods and complication avoidance with respect to the entire spectrum of neurosurgical conditions and allied specialties in the clinical and basic neurosciences.
- Review real clinical cases and specific treatment methods that are justified and explained by recognized world leaders in the field.
- Describe the most recent and future trends in neurosurgery around the world.
- Identify effective program innovations and models from experts around the world.

Accreditation/ Continuing Medical Education (CME)

This activity has been planned and implemented in accordance with the accreditation requirements and policies of the Accreditation Council for Continuing Medical Education (ACCME) through the joint providership of the AANS and the Society of University Neurosurgeons. The AANS is accredited by the ACCME to provide continuing medical education for physicians.

The AANS designates this live activity for a maximum of 11.75 AMA PRA Category 1 Credits™. Physicians should claim only the credit commensurate with the extent of their participation in the activity.

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Educational Format

Didactic lectures, case presentations/discussions, panel discussions, and oral paper presentations

Disclosure Information

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Name	Disclosure	Type of Relationship*
Allan Levi, MD	NIH/NINDS	Department of Defense
Carl Heilman, MD	Cerevasc LLC Cerevasc LLC	Consultant Fee Stocks or Shareholder
Charles Liu, MD	NIH, NSF, DARPA, DOD	University Grants/Research Support
Eric L. Zager, MD	Teaching in the David Kline Legacy course at LSU in New Orleans, LA - Feb. 2019	Honorarium
Erol Veznedaroglu, MD	Stryker, Trice, Penumbra	Consultant Fee
Fady Charbel, MD	VasSol, Inc. Transonic, Inc	Consultant Fee
Frederick Lang, MD	National Cancer Institute Grant DNAtrix, Inc. (patent holder for Delta-24-RGD, receive royalties from this patent; MD Anderson has licensed Delta-24-RGD to DNAtrix, Inc.)	University Grants/Research Support Other Financial or Material Support
Gavin Britz, MD	Houston Methodist Research Institute TIRR, "Neuroprotective device"	CO PI: Gavin Wayne Britz MD; CO PI; Phillip Honer; 12/01/17-12/01/20; $1,0000,00.00
Gelareh Zadeh, MD	CIHR Brain Tumor Charity UK	
Ivica Kostovic, MD	Croatian Science Foudation - project	Humansubplate
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Mark Preul, MD	Barrow Neurological Foundation	University Grants/Research Support
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Richard Ellenbogen, MD	NIH Nanotechnology Platform for Cancer, Investigator NIH R-25 (PI) Neuroscience Training for the under-represented diversity	University Grants/Research Support
Ruth Bristol, MD	Phoenix Children's Hospital Research Awards committe RAC Award Date: 12/04/2014- 12/4/2015 $14,373	Other Financial or Material Support
Sameer Sheth, MD	U01 NS108923	Other Financial or Material Support
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	R01 MH106700	
	Dana Foundation Neuroscience Research Program	Consultant Fee
	Koh Young	
Satish Krishnaurthy, MD	Research grant from Reach foundation and Pediatric hydrocephalus foundation	Other Financial or Material Support
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	Medtronic, Abbott	Industry Grant Support

Zdravka Poljakovic, MD	University Grant for Scientitic project: Gene polymorphism in patients with intracranial aneurysms (2016)	University Grants/Research Support
	Sponsored lectures at Home Congresses on behalf of: Boehringer Ingelheim Croatia Pfizer Croatia Sanofi Croatia Pliva Croatia	Honorarium
Zoran Rumboldt, MD	TMC Acaderny	Honorarium

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Abstracts

Transradial approach for neuro-endovascular procedures: clinical outcomes and patient satisfaction measures

Pascal Jabbour, MD

Radial artery catheterization serves as an alternative means of achieving vascular access than femoral artery punctures for a wide range of neuro-endovascular procedures, including diagnostic angiograms, treatment procedures, and thrombectomies for acute stroke. Here, we report our institution's case series of 272 consecutive neuro-endovascular procedures performed via radial artery catheterization, sub-categorized as follows: 182 angiograms; 26 thrombectomies for stroke intervention; 47 stent / stent-coil /flow diverter for aneurysm treatments; and 9 embolizations of cranial and spinal vascular malformations. There were 2 cases converted to transfemoral one because of the inability to catheterize the radial artery and the second because of tortuosity of the vasculature. There were no instances of major but one minor procedural complications which was a radial artery thrombosis but asymptomatic. For same day procedures, patients spent shorter duration recovering in PACU before being discharged home. A patient satisfaction questionnaire was sent to patients who have undergone both radial and previously femoral artery punctures, and all responders preferred radial artery access compared to groin puncture. Taken together, our findings lend credence to the use of radial artery access, which has shown to be safe and effective for performing a wide range of neuro-endovascular procedures, with excellent patient satisfaction outcomes.

Management of posterior inferior cerebellar artery aneurysms

Martin Sames, MD
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Ondra Petr 3, Miriam Mulino 3, Aleš Hejčl 1, Claudius Thomé 3 and Giuseppe Lanzino 2

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Background: Posterior inferior cerebellar artery (PICA) aneurysms are an uncommon, heterogeneous group of aneurysms with poorer clinical outcomes compared to other intracranial aneurysms. We performed a multicenter retrospective study to analyze the outcome in a large series of patients treated with modern microsurgical and endovascular techniques.

Methods: Records of 94 patients treated for PICA aneurysms between 2001 and 2016 at three large tertiary referral centers were retrospectively reviewed.

Results: Eighty-three patients met inclusion criteria and of these, two died before treatment, leaving 81 treated patients (43 underwent endovascular and 38 surgical treatment). Among patients treated endovascularly, procedure-related complications occurred in four cases (11.8%). Six patients (19.4%) suffered from complications directly associated with surgery. Recurrences occurred in 0% of surgical and in 16.3% of endovascularly treated patients, requiring treatment. Patients with unruptured asymptomatic aneurysms had good outcomes. In the group of 67 ruptured aneurysms, 16 endovascularly (47.1%) and 15 surgically (48.4%) treated patients had modified Rankin scale (mRS) scores of 3–6. Of patients in poor neurological condition (Hunt & Hess (H&H) IV–V at admission), 84.6% suffered a poor clinical outcome. Fifty percent of patients with distal and 31.9% patients with proximal ruptured PICA aneurysms suffered a poor neurological outcome.

Conclusions: This study of PICA aneurysms demonstrates that results of both treatment modalities are comparable. However, endovascular treatment is associated with higher risks of recurrence, requiring additional treatment. Outcomes were mostly impacted by clinical state at admission.

Feasibility of robotic-assisted neurovascular interventions: Initial experience in flow model and pig model

Gavin Britz, MD

Background: Despite advances in robotic-assisted technology for cardiac and peripheral vascular interventions, a robotic-assisted platform for

neurovascular intervention is not yet available. Objective: The goal of this preclinical study was to evaluate the feasibility of the CorPath® GRX robotic-assisted platform (Corindus Inc., Waltham, MA, USA) for neurovascular interventions.

Methods: The robotic system was tested for its ability to accurately navigate a variety of common neurovascular instruments in an in vitro flow model and in a live, anesthetized pig, under conditions and following procedures appropriate for clinical intervention. An access catheter was introduced manually at the equivalent of the common carotid artery in both models. Endovascular wires and catheters were navigated through the external and internal carotid artery and posterior cerebral vasculature under robotic assistance using 0.014 in guidewires, 2.4F/1.7F microcatheters, bare-metal stents, and embolic coils.

Results: All procedures in both the flow and pig models, including navigation, wiring, and deployment of the stent, and coils, were performed successfully with no technical complications. There was no evidence of extravasation, dissection, thrombosis, or other vascular injury when angiography was compared before and after the live-animal procedure.

Conclusion: This is the first study to demonstrate that use of a robotic-assisted platform that is feasible for intracranial neurovascular intervention. The robotic system was successful at navigating and deploying the small-gauge instruments specific to neurovascular procedures. Given the potential benefits of robotic-assisted surgery for the patient and the surgeon, further investigation is warranted for this indication.

Outcomes of Surgically Managed Ruptured and Unruptured Brain Arteriovenous Malformations

Amal Abou-Hamden, MD

Purpose: The controversial ARUBA (A randomised trial of unruptured brain arteriovenous malformations (bAVM) study recommended conservative management in unruptured bAVMs.
Several institutions have since published data suggesting microsurgery is a safe and effective treatment, especially in patients with lower Spetzler Martin (SM) grades. In this study we present our experience with the surgical treatment of bAVMs, including a subset of ARUBA eligible patients.

Methodology: Our prospectively collected vascular database was retrospectively reviewed for patients with bAVMs surgically treated between the period of January 2011 and December 2016. The variables recorded were demographic, clinical presentation, radiological (SM grade and presence of associated aneurysms), treatment (use of embolisation or radiotherapy) and outcomes (complications, obliteration rates, mortality, neurological deficits and modified Rankin Score (mRS) pre-operatively and at latest follow up). Follow up was usually at 2 months and 1 year. ARUBA eligibility was determined for all cases.

Results: 48 patients were included, with mean age of 42 (range 19-75 years). 52% presented following hemorrhage. 23 were ARUBA eligible. SM grade was 1 in 37%, 2 in 41%, 3 in 15%, 4 in 7%. 25% had pre-treatment embolisation. Post-operative obliteration rates were 96%. Mean mRS scores were 0.5 at latest follow up in the unruptured group, compared with mRS 1 in the ruptured group. Rates of new transient neurological disability were 11% and 4%. No ARUBA eligible patients suffered permanent neurological disability.

Conclusions: Microsurgery was a safe and effective treatment for bAVMs, in particular those of low SM grade. Further prospective studies may more clearly delineate the appropriate management of this heterogenous disease.

The Cut Flow Index—Revisited: Utility of Intraoperative Blood Flow Measurements During Extracranial-Intracranial Bypass for Ischemic Cerebrovascular Disease

Fady Charbel, MD
Christopher J. Stapleton MD, Sepideh Amin-Hanjani MD, and Fady T. Charbel MD

Background and Purpose: In extracranial-intracranial (EC-IC) bypass surgery, the cut flow refers to the free flow (ml/min) of the donor vessel prior to bypass and is an indicator of the flow available to the recipient bed. The cut flow index (CFI) is the ratio of bypass flow (ml/min) to cut flow (ml/min), and a CFI ≥ 0.5 has been shown to correlate with bypass patency. We sought to validate this observation in a large cohort of EC-IC bypasses for ischemic cerebrovascular disease.

Methods: All intracranial bypass procedures performed between 2001 and 2018 were reviewed. Demographic, clinical, operative, and angiographic data were recorded then analyzed according to bypass

patency with univariate and multivariate statistical analyses.

Results: A total of 308 consecutive intracranial bypasses were performed during the study period, of which 187 (60.7%) were EC-IC bypasses for ischemic cerebrovascular disease (moyamoya disease/syndrome [n=91] or atherosclerotic disease [n=96]). Intraoperative blood flow measurements were available in 160 patients and angiographic follow-up was available at 2.0 ± 2.6 years (mean ± SD, range 0-11.2 years) after bypass. The mean CFI was significantly higher in patients with patent bypasses (0.92 vs. 0.68; p=0.002). Using a CFI of 0.5 as a threshold, the bypass patency rate was 80.1% in cases with a CFI ≥ 0.5 compared with 44.8% in cases with a CFI < 0.5 (p=0.0002). Adjusting for age, sex, diagnosis, and single vs. double-barrel bypass, the CFI remained a significant predictor of bypass patency (p=0.0003; OR 5.0, 95% CI: 2.1-12.1). Of the 41 bypasses not patent at last follow-up, 29 (65.9%) were patent on immediate post-operative angiography. There was no association between CFI and time to bypass non-patency (p=0.16).

Conclusions: A poor CFI predicts eventual bypass non-patency, and may indicate problems with the donor vessel, anastomosis, or recipient bed during surgery.

Antiplatelets agents in the 24 hour tpa window

Mandy Binning, MD
Mandy J. Binning, Kenneth M. Liebman, Hirad Hedayat, Zakaria Hakma, Erol Veznedaroglu

Introduction: Multiple randomized control trials have shown that alteplase in addition to thrombectomy for select patients with acute ischemic stroke (AIS) and large vessel occlusion is superior to alteplase alone. As thrombectomy has become the standard of care in specific patients, some post-tpa protocols regarding the administration of antiplatelet agents or anticoagulants in the first 24 hours following tpa administration seem outdated. This is especially true when acute intracranial or extracranial stenting is required as part of an acute stroke intervention.

Methods: The authors present a retrospective series in which acute stenting is required following tpa administration. Bleeding complications including hemorrhagic conversion of stroke, access site hematomas and other bleeding complications were compiled.

Results: Of patients receiving a loading dose of dual antiplatelet agents for emergent stenting following alteplase administration, no hemorrhagic complications were encountered.
Introduction: Dual-antiplatelet agents were found to be safe when loaded via NG tube in patients receiving alteplase for AIS.

Direct STA-MCA bypass for Moyamoya and Atherosclerotic disease: A single surgeon series - Indications, Results and Intraoperative Blood Flow data

Jacques Morcos, MD

Introduction: The COSS trial has concluded that bypass surgery for atherosclerotic ischemia (ATH) is not beneficial, in spite of several non-randomized series demonstrating the contrary. In the setting of adult Moyamoya disease/syndrome (MMD), direct bypass is well-established. Additionally, little has been published on the use and interpretation of intraoperative blood flow measurements in either set of patients. We assessed our recent surgical series to address outcomes and blood flow results in both groups.

Methods: A retrospective chart review was performed to identify all patients undergoing EC-IC bypass at our institution, 2005-2016, (single surgeon, JJM). We included patients with evidence of hypoperfusion undergoing STA-MCA bypass for MMD or ATH, and excluded aneurysms and tumors. We analyzed: intraoperative blood flow data; bypass patency (traditional angiography, CTA, or MRA) prior to discharge and at 12 months; complications; patient symptoms (worsened/stable/mild improvement/major improvement/resolved); and Modified Rankin scale (mRS) (pre- and post-operatively).

Results: During the study period, 129 EC-IC bypass operations were performed; 91 of which met inclusion criteria. There were 71 patients/105 anastomoses. Patients presented primarily with ischemia (1 day – 5 years), mean mRS 2.2 (MMD 2.0; ATH 2.7). Perioperative infarcts occurred in < 10% of patients – 5 MMD (9%) and 2 ATH (6%) patients. Graft occlusion rates were: MMD 10.3% (1/4 asymptomatic, mean time-to-occlusion 189 days); ATH 10.8% (all asymptomatic, mean time-to-occlusion 45 days). 91.2 % of patients showed clinical improvement/no change, mean follow-up 335 days (MMD: 93.1%, ATH: 87.9%). mRS at final follow-up was: MMD 1.2; ATH 1.4. The majority of patients are mRS 0-2 (94% ATH; 80% MMD). Cut Flow Index (CFI) (MMD 95.3%; ATH 106.5%) was not significantly different between occluded and patent grafts (p=0.7354). Flow in the STA post-bypass was higher in occluded vs patent grafts in ATH (p=0.0493)

and combined datasets (p=0.0219).

Conclusions: We can reasonably conclude that STA-MCA bypass remains highly beneficial in most Moyamoya patients, and a select group of atherosclerotic carotid occlusion patients, with respect to clinical outcomes and graft patency rates. We were unable to replicate the reported correlation between CFI and graft occlusion rates, details of which will be discussed during the presentation.

Impact of current generation anticonvulsant prophylaxis on seizure incidence after ICH

Kevin Cockroft, MD

Introduction: The role of prophylactic anticonvulsants after intracerebral hemorrhage (ICH) remains controversial. Current guidelines recommend against prophylaxis. However, these are based on older studies primarily utilizing phenytoin as the anticonvulsant of choice. Newer medications, such as levetiracetam, have not been extensively studied.

Methods: We performed a retrospective review of our clinical database from 2010 to 2015. All patients with diagnosis of ICH were included, patients with mortality within 5 days, hemorrhagic conversion, prehospital seizures, and infratentorial ICH were excluded. Patients were divided into those who received prophylactic anticonvulsants and those who did not. Patient demographics, as well as seizure data and outcomes were collected. Results were analyzed using descriptive statistics and binary logistic regression, each analysis was corrected for age, gender, and initial NIHSS score. The primary outcome was seizure incidence.

Results: A total of 365 patients were included in the study. Average age was 69 and 54.8% were male. Median initial NIHSS was 7 (IQR, 2-16), prophylaxis group 8 (IQR, 2-17), and no prophylaxis group 4 (IQR, 1-12), p=0.005). Of the 265 patients (72.6%) that received prophylactic anticonvulsants, 258 (97%) received levetiracetam and 17 (6.8%) had seizure events compared with 16 (19.0%) of those without prophylaxis. Patients treated with anticonvulsant prophylaxis had significantly lower odds of a seizure (adjusted OR, 0.29; 95%CI, 0.12-0.69).

Conclusions: Administration of predominantly levetiracetam for anticonvulsant prophylaxis after ICH significantly reduced the odds of seizure independent of age, sex, initial NIHSS score, and hematoma volume.

Technology: Friend or Foe?

Jang Yoon, MD

Technology has been an integral part of modern neurosurgical procedures. From the development of surgical microscope, x-rays, spine instrumentation to navigation system, technological advancement continually disrupts the "status quo," and change the way the surgeries are performed. The field of minimally invasive spine surgery (MISS) has rapidly evolved over the past three decades. Its rapid evolution, in part, is rooted in technological progress. Then, what will the future of spine surgery look like? In this talk, we will retrace the history and evolution of MISS, and attempt to highlight the major breakthroughs in the field. In addition, we will review new technology such as augmented reality, artificial intelligence and robotics, and focus on its potential to impact MISS of the future.

Functional Neurosurgery

Volker Tronnier, MD
Volker Tronnier, MD, Ph.D, Department of Neurosurgery
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X-linked recessive dystonia-parkinsonism (XDP), also referred to as DYT3 dystonia, is a rare progressive neurodegenerative disorder, which is considered a monogenic form of combined dystonia. The disease is highly prevalent in a specific region in the Philippines (Panay Island). The genetics of XDP is complex and the causative mutation among a number of genetic variants has not yet been determined.
XDP usually starts in early adulthood with focal dystonia and subsequently generalizes within a few years. In most patients, dystonia is severe and results in a markedly reduced quality of life. After a plateau phase of variable length, most patients develop Parkinsonian signs, whereas dystonia often eases off. Sixteen male XDP patients (mean age 40.9 y, disease duration 1-6 y) from the Philippines with predominant dystonia underwent GPi DBS in Luebeck, Germany. Clinical assessment included the motor parts of the Burke-Fahn-Marsden scale (BFMDRS-M) and the Unified Parkinson's Disease Rating Scale (UPDRS-III). Microelectrode recordings and T1-based basal ganglia volumetry were correlated with postoperative outcome.
Blinded video rating revealed significant improvements of dystonia severity one week (-55%, p<0.01) and 6 months (-59%, p<0.001) after surgery. The UDPRS-III score improved to a lesser extent (-19% and -27%)). Unblinded long-term follow-up

confirmed efficacy of GPi DBS up to 46 months after surgery. Mean GPi firing rates were between those in isolated dystonias and Parkinson's disease. Caudate atrophy and high intraoperative GPi firing rates were predictors of a less beneficial outcome. Internal globus pallidus DBS had a positive association in XDP with predominant dystonia and contributed to an improved quality of life). The response to DBS occurred within 1 week. Given the inverse correlation of postoperative benefit and caudate atrophy, GPi-DBS should be considered early during the disease course.

Current Evidence on Image-Guided Implantation of Deep Brain Stimulation Electrodes Under General Anesthesia

Kim Burchiel, MD

Implantation of deep brain stimulation (DBS) electrodes has traditionally been accomplished in awake patients, under local anesthesia (LA), using microelectrode recording (MER) to physiologically verify target acquisition. Evidence is now mounting that image-guided implantation of DBS electrodes can be accomplished under general anesthesia (GA) in patients with Parkinson's disease (PD), and that post-operative outcomes can be achieved under GA which are equivalent to those achieved using physiologic MER guidance, including motor (UPDRS II-III) levodopa equivalent daily dose (LEDD), complications and adverse events, target accuracy, inpatient length of stay (LOS) and 30-day readmission rates. There is also evidence that image-guided DBS electrode placement under GA may produce superior results with respect to verbal performance, communication, and on-time without dyskinesia, when compared to DBS implantation under LA using MER mapping. Early results with essential tremor (ET) indicate that there is no difference in the percentage of improvement in tremor when "asleep" DBS is compared to "awake" DBS. Considerable work has already been accomplished using intraoperative MRI and CT guidance for DBS surgery. It is likely that one of these imaging systems will emerge as the dominant technology for image-guided DBS surgery. MRI has the advantages of no radiation, and the potential for "live" updates of electrode position. Cost, accessibility, and a compromised surgical environment are disadvantages of MRI. CT has the advantage of being a less expensive, and more accessible intraoperative imaging technology, without the concerns of ferromagnetic instrumentation in the surgical field. Its disadvantage is that it requires a radiation dose to the patient, which would only be increased by successive "live" updates, requiring repeated imaging. We have now demonstrated that verification of DBS electrode position can be achieved using intra-operative electromagnetic localization using an existing system, which may obviate the need for repeated CT imaging. The current state of the evidence on "asleep" DBS will be reviewed, as will the issue of intraoperative imaging and navigation guidance during these procedures.

Nerve transfers to restore motor function in patients with cervical spinal cord injury

Rajiv Midha, MD

Objective: Patients with cervical spinal cord injury (SCI) / tetraplegia consistently rank hand function as the most desirable to improve quality of life. Motor nerve transfers traditionally used to treat peripheral nerve injuries, are increasingly being used to treat patients with cervical SCIs. In this study, we performed a systematic review summarizing the literature where nerve transfers were used to restore upper extremity function in tetraplegia.

Methods: A systematic literature search was conducted to identify relevant literature published through October 2018. We included original research studies and extracted information on patient characteristics, operative details, and strength outcomes.

Results: Our literature search yielded 248 results. Citation review for eligibility criteria produced 22 unique studies, reporting on 154 nerve transfers in 118 upper limbs of 92 patients (94.5% males). Mean duration from SCI to surgery was 18.1 months (range 4 months–13 years) and mean postoperative follow-up was 16.3 months (1 month–4 years). The main goals of reinnervation were restoration of finger flexion, elbow extension, and wrist/finger extension. All but one case report demonstrated recovery of at least Medical Research Council (MRC) strength 3/5 in recipient muscles. There was greater variability in the results of case series. Illustrative cases will highlight the surgical approach to restore finger flexion, using the brachialis branch of the musculocutaneous nerve transferred to the anterior interosseous (AIN) and flexor digitorum superficialis (FDS) branches of the median nerve; and for restoration of wrist/finger extension, the use of supinator branch of the radial nerve transferred to the posterior interosseous nerve (PIN).

Conclusion: Nerve transfers are a promising treatment option to restore upper extremity functions after SCI.

Flexor reinnervation strategies show variable effect sizes, however, extensor reinnervation provides more consistent meaningful recovery.

CT-Guided, Ethanol Sympatholysis for Primary Axillary-Palmar Hyperhidrosis.

Vasilios A Zerris, MD
Zerris V, Friehs G, Tsiskari M, Georgiadis

Purpose: Primary hyperhidrosis is an excessive sweating due to an overactive sympathetic system. Conventional treatments frequently are invasive, requiring hospitalization and associated with significant risks. Our goal was to test the safety and efficacy of CT-guided sympatholysis, for primary hyperhidrosis.

Materials and Methods: A total of nine consecutive patients with axillary-palmar hyperhidrosis were treated between 2013 and 2015. CT-guided sympatholysis was performed at T-2, T-3, and T-4, bilaterally using alcohol under local anesthesia. Immediate postprocedure CT was obtained. Technical success and clinical success were recorded. Primary and secondary efficacy was assessed. Mean follow-up was 12 months (6-26 months). Descriptive statistics was used to report the outcomes.

Results: One procedure was aborted due to eyelid ptosis after test lidocaine injection. All other eight patients (5:3, F:M) (median age 32) had immediate cessation of sweating. Two complications (pneumothorax, one requiring a chest tube) occurred. Two patients recurred with unilateral and one patient with bilateral symptoms. One of the unilateral recurrence and the bilateral recurrence patients was retreated successfully. Median follow-up was 1 year. No cases of Horner's or compensatory hyperhidrosis were observed.

Conclusions: CT-guided ETOH sympatholysis for axillary/palmar primary hyperhidrosis is both safe and efficacious. Technical failure rate was 11 %. Primary efficacy was 75% and secondary efficacy 94 %, with a median follow-up of 1 year. Risk profile appears favorable.

Peripheral Nerve/Tumor

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Title: Giant Neurofibromas of the Brachial Plexus Region

Background: Plexiform neurofibromas in patients with type 1 neurofibromatosis (von Recklinghausen's disease or NF-1) traditionally have not been considered to be optimal lesions for surgical intervention. When these lesions reach giant proportions, they may present formidable problems for patients in terms of progressive cosmetic and/or functional decline.

Objective: Eight patients with NF-1 who were treated at 2 academic centers were retrospectively reviewed. These patients presented with giant neurofibromas of the brachial plexus region which prompted surgical intervention because of intractable pain (local and/or radiating upper extremity), neurological decline (both motor and sensory), cosmetic deformity, and concern for possible malignancy.

Methods: Retrospective chart review with emphasis on radiological studies, operative reports, pathology reports and clinical outcomes.

Results: The patients were 6 males and 2 females, of median age 17 (range 5 to 48), with the most common presentations of local and regional pain/tenderness, tumor growth, mechanical complaints (e.g., swallowing difficulty), cosmetic deformity, and concern for malignant transformation. Preoperative biopsy was performed in 1 case. Surgical intervention was comprised of the supraclavicular approach alone in 2 cases, infraclavicular approach alone in 0 cases, a combined approach in 5 cases and a thoracotomy combined with infraclavicular approach in 1 case. Neurophysiological monitoring of nerve function was performed in all cases. Surgical goals included debulking of tumor, ruling out malignancy, pain relief and preservation of brachial plexus function. Subtotal resection was the rule, as plexiform tumors could not be completely resected without incurring a serious neurological deficit. Surgical goals in all 8 patients

were reached (i.e., complete pain relief, no mechanical or cosmetic complaints without neurological deterioration). Two malignant peripheral nerve sheath tumors were completely resected from the same patient in separate operations (9 years apart), one in each brachial plexus, with acceptable neurological outcomes (stable hand intrinsic deficit on one side; no deficit on the other side). Both malignant tumors were treated with postoperative radiation therapy, with survival out to 14 years and no sign of recurrence to date. All other tumors were nodular and plexiform neurofibromas that required no adjuvant treatment.

Conclusion: Giant symptomatic neurofibromas of the brachial plexus region can be managed with aggressive but cautious surgical intervention, with the goals of subtotal resection, while preserving neurological function and achieving improvements in quality of life via improved cosmesis and reduction of local and regional pain. Ideally, however, careful monitoring of growth of neurofibromas in the brachial plexus region should be performed from early age onwards by specialized teams including nerve surgeons in order to optimize timing of surgical intervention prior to the development of these giant dimensions.

Extent of subdural grid implantation correlates with delay in seizure occurrence

Oren Sagher, MD

Introduction: Patients with medically refractory, localization-related epilepsy frequently undergo invasive monitoring using intracranial electrodes in order to identify the epileptogenic zone. Implantation of subdural, cortical arrays and intraparenchymal depth electrodes provides clinicians with an opportunity both to localize the seizure onset zone and to map local, neuronal function. While subdural grids afford the ability to accomplish both tasks, we have observed that some patients will experience a seizure "holiday" once implanted despite tapering antiepileptic drugs (AEDs). As the mass effect of these grids has the potential of altering local neuronal network behavior, the present study examined the relationship between the time until first seizure and the degree of cortical displacement produced by implantation.

Methods: We analyzed a series of 110 patients monitored with subdural grid implants, and 38 patients monitored with intraparenchymal depth electrodes, in which there is little to no mass effect exerted by the implant. The average number of contacts in the grid patients was 73 (range 20-162). We divided the implantations into large implants (>80 contacts) and small implants (<=80 contacts). AEDs were tapered in all patients according to a protocol but individualized to the pre-operative seizure frequency. We recorded the first day seizures were recorded after implantation, specifically examining the correlation between the extent of the implantation with the delay in recording seizures.

Results: Eighteen out of the 110 patients in the series had a >1-week delay to their first post-implant seizure. Patients with small implantations had a >1-week delay in 8 out of 65 cases (12%) whereas those with a large implantation were delayed in 10 out of 55 cases (22%). Three of the patients with large grids failed to seize for the entire two-week implantation, while no patient in the small grid group failed to seize in that timeframe. This trend persisted upon subgroup analysis of patients with frequent versus infrequent baseline seizures. Only 2/38 (5%) patients with depth electrode placement failed to seize within the first week, and all depth electrode patients seized within 2 weeks of implantation. Volumetric analysis of a separate group of 13 patients implanted with grids showed that the brain displacement correlated with the overall seizure delay. The actual volumetric displacement correlated more tightly with seizure delay than did the size of the grid implanted ($r = .667$, $p = .0129$ vs. $r = .499$, $p = .0828$).

Conclusions: These data demonstrate a significant relationship between seizure delay and cortical displacement in two separate patient groups. We speculate that this relationship is explained by the mass of the electrodes and consequent brain deformation leading to suppressed neural function either locally or at the network level.

Mechanisms Supporting Optimal Decision-Making in Human Prefrontal Cortex

Sameer Sheth, MD

In our day-to-day lives, we are constantly faced with decisions. For example, when approaching an intersection in which the traffic light turns yellow, we must make an optimal decision about whether to hit the brake or accelerator. Our brain's decision-making circuitry must incorporate relevant information (speed, distance to the intersection, presence of police, etc.), ignore irrelevant information (children arguing in the back seat), factor in long-term goals (avoid a traffic violation), and modify future behavior based

on previous outcomes. The neurocognitive processes that permit such controlled decision-making can be subsumed under the term "cognitive control," which refers to the allocation of mental resources to optimize the performance of goal-driven behavior. Deficiencies in these processes are thought to underlie a host of neuropsychiatric disorders. The prefrontal cortex (PFC) is known to play an important role in cognitive control. We have studied these processes in the human brain using the opportunities afforded by neurosurgical procedures requiring intracranial neurophysiological recordings, such as deep brain stimulation or epilepsy surgery. Consenting patients can then engage in behavioral tasks that allow us to study components of the decision-making process. Using this paradigm, we have recorded from two critical regions in the cognitive control network, the dorsal anterior cingulate cortex (dACC) and dorsolateral PFC (dlPFC). We find that individual dACC neurons encode specific aspects of stimulus parameters that are relevant for the decision. These neurons' firing rate also encodes an estimate of the amount of cognitive effort required to perform the task. Analysis of population activity (local field potentials, LFP) reveals that this information is transmitted from dACC to dlPFC using a "carrier signal" in the form of oscillatory activity in the theta (4-7 Hz) range. dACC neurons conveying relevant information synchronize their firing to theta oscillations, which carry the information over the relatively large expanse to dlPFC. A large fraction of dlPFC neurons, in turn, synchronize their firing to the theta signal. This spike-LFP coherence is a likely mechanism for coordinating information transfer between individual neurons and larger neural populations across brain regions. Precise temporal coordination of these signals between these structures allows the decision-making circuitry to optimize the selection and timing of our responses, enabling us to seamlessly execute well-controlled behaviors.

Intraosseous Cannulation During Brain Herniation in Place of Central Venous Line Placement:

Nilesh Vyas, MD

Background: The intraosseous (IO) access is a rapid, alternative route for vascular access during cardiac arrest. Successful management of intracranial hypertension includes immediate initiation of hyperosmolar therapy with 23.4% NaCl or mannitol. 23.4% is caustic to peripheral veins and must be administered via central access. Compared to IO's role in cardiac arrest resuscitation, little data exists regarding safety or effectiveness of administering of 23.4% NaCl via IO in this patient population. IO placement, as compared to central line placement, is fast, efficient (Paxton et al. 2009), and does not require correction of coagulopathy or validation of placement, and may be a more suitable means of administering 23.4% in an emergent situation.

Methods: Retrospective chart review of patients with acute neurologic injury requiring 23.4% and IO placement. Demographics, diagnosis, GCS, sodium (Na+), and pupillary reactivity were obtained to evaluate the safety of 23.4% NaCl via IO and evaluate treatment effectiveness as reflected by a rise in Na+ level, ICP normalization, and reversal of brain herniation.

Results: 8 patients included: 4 males, age range 33-84 yo. Diagnosis include intracerebral hemorrhage (ICH, n=7) and extra-axial hematoma (n=1). GCS range 3 to 8. All patients were intubated and briefly hyperventilated. IO was placed in tibia (1) or humerus (7), with 100% correct placement first attempt. Comparing 1 hr post-23.4% NaCl treatment to pre-treatmentpretreatment: Na+ level increased (6/8)(Koenig et al. 2008). We could not assess the improvement of ICP since all these patients were treated emergently before ICP monitors could be placed. Indirect measures such as GCS improvement (3/8) and returned pupillary reactivity (3/6) were assessed but confounded by sedation. No adverse events reported. In addition to 23.4% saline, mannitol (Manninen et al. 1987) and/or 8.4% sodium bicarbonate were also used. Coadministration of mannitol (3/8) →

Conclusion: Preliminary data suggest that during ICP crisis, IO access has a great potential as a means to rapidly and safely administer hypertonics in patients without central access. Successful placement with minimal training is possible.

THE SOCIETY OF UNIVERSITY NEUROSURGEONS

Recurrence patterns in Skull Base Meningioma and role of Simpson Grading

Anil Nanda, MD

Introduction: The authors assessed the surgical outcome and predictors of recurrence after resection of skull-base (SBM) and non-skull base (NSBM) meningioma.

Methods: Clinical, radiological and surgical procedural information of 441 patients with SBM and 200 patients with NSBM, who underwent surgery over the past 22 years, were reviewed. The extent of resection [EOR] was evaluated by Simpson grading scale. Kaplan-Meier curves and Cox proportional-hazards regression were used to investigate the survival and predictors of survival respectively.

Results: In the SBM cohort, overall tumor recurrence rates for Simpson grades I,II,III and IV of resection were 10%,20%,31% and 40% respectively. The median RFS for Simpson grades I,II,III and IV of resection were 247,114, 68, and 64 months respectively. Patients undergoing Simpson grade I and II resection (gross total) showed significant improvement in RFS compared to patients undergoing grades III and IV (subtotal) resection (116 months vs.64 months, p=0.004). In Cox regression analysis GTR (Simpson grade I/II, p=0.018) was revealed as a significant predictor of RFS. The recurrence rate of SBM was higher (28%; n=106); than NSBM (19.7%; n=35). The median RFS for SBM was significantly lower than that for NSBM at 5 years (36 months vs. 50 months, p<0.0001), at 10 years (69 months vs. 97 months, p=0.001) and in the overall period (109 months vs. 134 months, p=0.005). SBM had a higher rate of recurrence in the initial 5 years. Interestingly, there was no difference in the median PFS after 10 years of follow up (SBM 210 months vs NSBM 212 months, p=0.93).

Conclusion: We observed an association between the EOR and RFS. A common idea is that GTR is the goal for SBM, however, it should be tailored to each patient depending on the risks and surgical morbidity. Furthermore, SBM behave differently as compared to NSBM tumors.

Can a laminectomy save a life? Amyloidosis, the ligamentum flavum, and the heart

Ron Riesenburger, MD

Amyloid in the ligamentum flavum was described over 25 years ago. At that time, the medical community did not know that the misfolding of many different proteins could lead to amyloid deposition. Since this early description, over thirty types of amyloidosis have been discovered, and treatments are available for some of the amyloidosis subtypes.
Recent studies show that ligamentum flavum amyloid typically results from wild type transthyretin amyloid (ATTRwt). In this condition, the transthyretin tetramer, made in the liver, mistakenly dissociates into monomers. This 127 amino acid monomer misfolds and deposits in extracellular tissues throughout the body, most commonly in the ligamentum flavum, the flexor tenosynovium of the carpal tunnel, and the heart. Cardiomyopathy from amyloid deposition (ATTR-CM) can be fatal and may require lifesaving heart transplantation.
Recent medications have been discovered that may be able to slow or halt the progression of ATTR-CM. Making the diagnosis of ATTR-CM is difficult, however, and is often not done until late stage cardiac involvement, when medications may not be of benefit. Therefore, it is imperative to make an early diagnosis of ATTR prior to severe cardiac involvement. An early diagnosis could potentially be made by pathological evaluation of ligamentum flavum that is removed during laminectomy surgery.
During this talk, I will discuss the likelihood of finding ATTRwt on pathological evaluation of the ligamentum flavum in patients undergoing laminectomy surgery. I will discuss how often these patients have evidence of ATTR elsewhere in the body, including cardiac involvement. I will discuss a theory that diagnosing ATTR in the ligamentum flavum could lead to initiation of lifesaving medical treatment that halts or slows the progression of cardiac amyloidosis.

Advantages of the Endoscopic Endonasal Approach Versus the Transoral Approach for Odontoid Resection

Carl Heilman, MD

Background: The transoral approach has been the predominant technique for odontoid resection over the past three decades. This approach passes through the posterior oral pharynx and typically requires temporary restriction of oral intake requiring a

nasogastric feeding tube. The endoscopic endonasal approach allows resection of the odontoid through the posterior nasopharynx. This approach may allow sooner resumption of oral feeding postop, simplify airway management, and decrease ICU stay.
Objective: To compare the transoral versus the endoscopic endonasal approach for odontoid resection.

Methods: A retrospective chart review of all patients undergoing odontoid resection followed by posterior spinal fusion between 1997 and 2018 by the senior author was conducted. Sixteen patients were identified: 7 had an endoscopic endonasal resection and 9 a transoral resection. All but one patient underwent posterior fusion surgery the same day as the odontoid resection. The medical record was reviewed for clinical and radiographic outcomes. Statistical significance was $P<0.05$.

Results: The median age of patients at surgery was 44.5 years. Chiari I malformation with a retroflexed odontoid (31%) and basilar invagination (31%) were the most common diagnoses. Gait instability/quadriparesis (44%) and numbness/tingling in extremities (44%) were the most common presenting symptoms. A dobhoff feeding tube was placed on 8 patients (89%) who underwent a transoral resection and 1 patient (14%) who underwent an endoscopic resection. The dobhoff was replaced by a PEG feeding tube 16 days postop on 1 patient who underwent a transoral resection. Complications occurred in 4 patients (44%) who underwent a transoral resection. They included infection surrounding the odontoid resection cavity, postop pneumonia with pulmonary embolism, one revision of the posterior fusion hardware, and one reintubation with replacement of the dobhoff feeding tube. One complication occurred in 1 patient (14%) who underwent endoscopic surgery, which was the requirement of two additional anterior surgeries on the residual C2 vertebrae due to cranial settling 8 years after the first surgery.
Post-operative patients who underwent endoscopic surgery spent significantly less time in the ICU compared to patients who underwent transoral surgery (2.2 vs. 4.2 days; $p=0.02$). Patients who underwent endoscopic vs. transoral surgery tended to spend less time intubated [median 1 (1-1.75 vs. 3 (2-5) days] and tended to have a shorter LOS [median 6 (5-6) vs. 8 (7.5-14) days], though this did not reach statistical significance. Neurological outcome was classified as improved, unchanged, or worse. Of the patients who underwent a transoral approach, 3 patients (33%) were improved, 4 patients (44%) were unchanged, 1 patient (11%) was worse, and 1 was lost to follow-up. Of the patients who underwent an endoscopic approach, 6 patients (86%) were improved, and 1 patient (14%) was unchanged.

Conclusions: Endoscopic endonasal odontoid resection through the nasopharynx warrants further investigation but may help reduce length of stay, intubation time, length of ICU stay, the need for a feeding tube, complication rates and improve patient outcomes.

Minimally-invasive Direct Pars Repair with Cannulated Screws and Recombinant Human Bone Morphogenetic Protein in the Young Athlete

Allan Levi, MD

Objective: To describe the use of a minimally-invasive surgical treatment of lumbar spondylolysis in young athletes by a fluoroscopically-guided direct pars screw with recombinant-human bone morphogenetic protein-2, with clinical and radiographic follow-up.

Methods: A retrospective review was conducted of young atheletes treated surgically for lumbar spondylolysis without lysthesis via a minimally-invasive approach. Summary demographic information, clinical features of presentation, perioperative and intraoperative radiographic imaging, and postoperative data were collected. A 1cm midline incision was performed for the placement of bilateral pars screws utilizing biplanar fluoroscopy, followed by insertion of a Universal Cannulated Screw System (UCSS, Medtronic, Memphis, TN, USA) Guide with cannulated trocar and then docked on the inferior entry point of the lamina. A 24" disposable threaded guidewire was advanced through the cannulated trocar and into the lamina, pars fracture, terminating in the pedicle. An intraoperative CT scan is performed to confirm the desired location of the guidewire within the lamina (O-arm, Medtronic). A cannulated drill bit is advanced over the guidewire and the process repeated, followed by the cannulated tap. A fully-threaded 4.0 mm diameter titanium cannulated lag screw is placed (Medtronic). A METRx tubular table-mounted retractor is placed using sequential dilators to a final working channel of 18 mm (Medtronic). The now visualized pars fracture can then be decorticated or curettage with care not to damage the titanium screw when using a high-speed drill. Local bone obtained from the curettage is then placed in the defect with 1.05 mg recombinant human bone morphogenetic protein-2 (rhBMP-2, Infuse, Medtronic) divided equally between the bilateral pars defects.

Results: Thirteen (13) patients were identified (mean age 18.9 ± 3.42 years, range 14-25) 6 of which were female (46%). All patients presented with bilateral pars fractures (L2 to L5) with the majority present (92%) located at the L4 or L5 levels. The mean duration of preoperative symptoms was 17.22 ± 13.2 months (range 9-48). The mean operative duration was 189 ± 29 minutes (range 151-228 minutes). The mean intraoperative blood loss was 17.5 ± 10 mL (range 10-30). The average clinical follow-up was 25.4 months and long term radiographic follow-up was available in the majority of patients. The mean hospital length of stay was 1.13 ± 0.35 days (range 1-2 days). There were no intraoperative complications.

Conclusion: Lumbar spondylolysis treatment with a minimally invasive direct pars repair is a safe and technically feasible option whereby minimizing muscle and soft tissue dissection particularly benefits the adolescent population with a desire to return to a high level of physical activity.

Preoperative 3D Modeling in Infants and Children with Complex Cerebral Aneurysmal Malformations

Michael L. Levy, MD

There are numerous pitfalls that can result in an excessive morbidity /mortality in treating infants with complex cerebral aneurysmal malformations. Variables including Blood Volume and Estimated Blood Loss, Operative Duration, and Time to Proximal Control/ Aneurysmal Securing are primary concerns. Duration of the operative invention is a significant variable in children as is the anatomic variation and vascularity of the skull, pericranium, and dura.

We reviewed our series of children less than 36 months of age who presented with complex aneurysmal vascular malformations over the past 20 years. There were 23 patient's identified (16 males, 7 females) with a mean age of 12.2 Months (+ 13.3 months). Presentations were the result of cranial nerve abnormalities in 6, hydrocephalus in 2, intracerebral hemorrhage in 2, and SAH in 8. 20 aneurysms were spontaneous, 2 traumatic, and 1 infectious in nature. 10 aneurysms were defined as giant including 1 bihemispheric lesion. 7 involved the posterior circulation whereas 14 involved the anterior circulation. With regard to treatment, 3 underwent coiling and/or embolization alone, 3 underwent embolization with resection, 7 underwent trapping with excision, 5 underwent classic clip ligation, 2 underwent clip ligation in the setting of cardiac arrest, and 2 underwent classic clipping in combination with wrapping. 1 patient with a bihemispheric lesion was not treated.

Six patients additionally had pre-operative virtual imaging in addition to stereolithographic modeling. Both modalities were used in the treatment of these patients. non operatively. Despite the paucity of patients and lack of a control population, it was our opinion that pre-operative modeling contributed to a better understanding of the vascular anatomy specific

to the lesion and maximized our determination of approach and the time until the aneurysm was secured in all 6 cases. There were no morbidities or mortality in these 6 patients.

We found that preoperative planning diminished surgical duration in all of our cases. It additionally increased the anatomic recognition and decreased the time until proximal control was obtained.

Hydrocephalus

Ruth Bristol, MD

Title: MEMS (Micro-Electro-Mechanical-System) based Passive Hydrogel Valve for Hydrocephalus Treatment

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Introduction: Existing shunts suffer from complications including mechanical malfunctions, obstructions, infections, blockage, breakage, overdrainage, and/or underdrainage. Some of these complications may be attributed to the shunts' physically large and lengthy course making them susceptible to external forces, siphoning effects, and risks of infection. Additionally, intracranial catheters traverse the brain and drain the ventricle rather than the subarachnoid space.

Methods: A MEMS (Micro-Electro-Mechanical-System) based hydrogel check valve offers an alternative treatment approach targeting restoration of near natural CSF dynamics. Reconstruction of this route may potentially offer greater reliability and safety to current failure-prone shunts. The valve, being made of hydrogel, was manufactured via MEMS technology, which aims to regulate the CSF flow between the sub-arachnoid space and the superior sagittal sinus, in essence substituting for the obstructed arachnoid granulations.

Results: The benchtop measurements demonstrate the realization of targeted cracking pressures of 20–200mmH2O without observable degradation or reverse flow leakage, <-10 micro-L/min. Hydrodynamic measurements and over-time tests under physically relevant conditions further demonstrate the valve's operationally-reproducible properties.

Conclusions: The MEMS-based valve has been shown to operate with targeted hydro-static and dynamic specifications as a stand-alone passive unit for hydrocephalus treatment. Results of this work indicate the valve's potential application in treating hydrocephalus in a safer and more robust manner than current treatment methods. Future work to ensure its reliability and ability to drain CSF in sentient brains will entail further in-vitro testing as well as in-vivo testing in animal models.

Spine - Pediatric Deformity

Anthony Sin, MD

Introduction: Pediatric deformity cases present different challenges than adults for spine surgeons. The infection rate is traditionally lower among pediatric population.

Method: Retrospective review of cases performed over January 2012 to January 2019 at Shriners Hospital for Children - Shreveport was done. Basic demographic information, type of deformity, and prevalence of infection were determined

Results: 338 cases were done over 7 years of study period. Four cases of de novo post-operative infection cases were identified. Three out of 37 (8.1%) neuromuscular patients had infections. One case was immediate drainage of serous fluid within one week, and she was taken back for washout and revision of wound without further sequelae. The other case was almost one year after his index fusion due to chronic urinary tract infection in cerebral palsy boy with suprapubic catheter. There was one infection (1 out of 3 patients = 33%) after growth modulation implant lengthening for early onset scoliosis. She was the only one out of three patients who underwent growth modulation implants during the study period. Only one patient out of 162 (0.6%) AIS cases had perioperative infection that required washout in two weeks after his fusion. He unfortunately developed delayed infection and subsequent implant removal approximately one year after his index surgery. There were no infections among 18 Scheuermann's kyphosis cases even after revision cases.

Conclusion: The overall incidence of infection among pediatric deformity case was low. NM scoliosis cases had significantly higher incidence compared to AIS cases.

The ultimate skull base maneuver does not involve removing bone: quantifying the benefits of the interfascial dissection

L. Madison Michael II, MD

Introduction: Several adjunctive osteal skull base maneuvers have been proposed to increase surgical exposure of the anterolateral approach. However, one of the easiest methods does not involve bone: the interfascial temporalis muscle dissection.

Methods: Sequential dissections were performed bilaterally on 5 fixed silicone-injected cadaver heads. The amount of sphenoid drilling, scalp retraction, and brain retraction were standardized in all specimens. For each approach, surgical angles were measured for 4 deep targets: the tip of the anterior clinoid process, the internal carotid artery terminus, the origin of the posterior communicating artery, and the anterior communicating artery. Five surgical angles were measured for each target.

Results: There were increases on the order of 20% in the anterior- posterior (AP)-mid, AP-lateral, and medial-lateral (ML)-anterior angles for all deep targets with interfascial approach vs. a myocutaneous flap. Orbitozygomatic osteotomy additionally increased almost all the angles, but incrementally less so.

Conclusion: An interfascial dissection increases the surgical exposure to a larger degree over a myocutaneous approach for several surgically relevant working angles. The addition of an orbitozygomatic osteotomy affords a smaller additional benefit. Increased adoption of this easily performed and low-risk approach during anterolateral craniotomies may obviate the need for more involved skull base drilling.

Skull Base Surgeon: The Law of Nature

A Samy Youssef, MD

The significant advances in endoscopic skull base surgery added a new set of intricate less invasive approaches to the neurosurgical armamentarium. The new generations of neurosurgeons face the challenge of adopting the ever-changing technology and quickly learning modern surgical techniques beyond the traditional neurosurgery comfort zone. The future skull base surgeon must be well trained and knowledgeable in all surgical portals to the skull base in order to select the safest, least invasive, most direct approach that offers the optimum exposure to handle a complex skull base pathology. The multi-portal/corridor philosophy is often adopted in order to achieve superior surgical and clinical outcomes. Neurosurgeons need to consider such an approach when appropriate as it may offer a superior outcome while minimizing the morbidity associated with large exposures.

Brain Tumors and endovascular treatments with stem cells

Frederick F. Lang, MD

Authors: Frederick F. Lang, MD and Peter Kan, MDl

The universally fatal outcomes of patients with malignant gliomas is due largely to the inability to deliver therapeutic agents to the tumor cells. To address this delivery problem we propose that endovascular super-selective intra-arterial (ESSIA) approaches, typically applied to cerebrovascular problems (e.g., AVMs), may be used to effectively deliver novel therapeutics to malignant brain tumors. Specifically, we have shown that intra-arterially delivered bone marrow mesenchymal stem cells loaded with the oncolytic virus Delta-24-RGD (MSCs-D24) are capable of homing to brain tumors, releasing the virus, and eradicating GBM xenografts in mouse models of human gliomas. In an effort to translate this approach to the clinic, we sought to determine the extent to which MSCs-D24 can be safely delivered using clinically applicable EAIA approaches. We first assessed the compatibility of MSCs-D24 with three clinical-grade microcatheters (Marathon™, Echelon-14™, and Marksman™), which are commonly used in human neuro-endovascular procedures. In a series of ex vivo studies in which we infused MSCs-D24 though these catheters, we showed there was no significant differences between the number of viable cells before and after infusion, regardless of which catheter was tested. Rapid injections did not result in rupture of the cells compared with slow injections, and infusion through highly tortuous catheter patterns (to mimic the carotid siphon) did not alter cell viability. Co-infusing MSC-D24 with heparin, omnipaque, and/or verapamil did not alter the viability of MSCs-D24 or the ability of MSCs-D24 to kill gliomas. In a series of preclinical in vivo studies in canines (N=10) infusion of up to 1x10^8 GMP grade MSCs-D24 in 10 ml (1x10^7 cell/ml) using the Eschelon™ microcatheter positioned in the distal carotid artery via transfemoral endovascular approaches identical to those used in humans did not result in any MSC-D24-induce stroke or hemorrhage based on pre-and post-injection angiography, MRI and histological examination of brains. Taken together these studies indicate that ESSIA infusions using clinically available microcatheters will

be feasible in clinical trials of MSC-D24 and support the development of the new field of Endovascular Neurosurgical Oncology.

Use of intraoperative ultrasound in transsphenoidal surgery for pituitary adenomas

Roukoz Chamoun, MD

Despite major advances in endoscopic surgery, transsphenoidal resection of pituitary adenomas remain challenging in certain cases.
Several adjuncts have been used to maximize resection and improve safety. Intraoperative ultrasound is a simple tool that can be used to this end.
we report the use of intraoperative ultrasound in 20 consecutive cases of pituitary adenomas with knosp grade 2 and 3.
we report outcome, complications and compare the intraoperative ultrasound results to postop MRIs performed routinely at 3 months follow-up.
we discuss these results and review the literature relevant to the topic

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Impact of Surgical Resection of a Single Dominant Tumor in Patients with Multiple Brain Metastases

Ian McCutcheon, MD

Objective: Brain metastases present a significant therapeutic challenge. Although the effect on survival of surgery for solitary metastasis is established, its impact in the setting of multiple brain metastases is less defined.

Methods: An IRB-approved, retrospective review was conducted of patients (n=274) with previously untreated multiple brain metastases who underwent resection of a single dominant brain lesion at M D Anderson Cancer Center between 1/1998 and 2/2016 to determine predictors of survival. Volumetric analysis of pre-operative and post-operative total tumor burden (cumulative volume) was performed. Post-operative percentage volume reduction was calculated. Univariate and multivariate analysis were done to test associations between clinical factors and survival.

Results: Median patient age and pre-operative Karnofsky Performance Scale (KPS) score were 59 years and 90, respectively. The most common histologies were lung (32%), melanoma (23%) and breast (14%). At surgery, synchronous systemic disease was present in 64% of patients. Median number of brain metastases was 2.5 (range, 2-10), with a median pre-operative cumulative tumor volume of 18.8 cm3. Median volume of the resected dominant single metastases was 15.7 cm3, and 94% of patients had a complete resection. Median total volume reduction with surgery was 92.4%. Median follow-up among alive patients was 36 months (range, 0.4-165). Postoperative mortality was 4% at 30 days. The majority of patients (72%) underwent post-operative radiation within 6 weeks of resection. The median Kaplan-Meier postoperative survival estimate was 7.7 months. Multivariate analyses (multivariable Cox proportional hazard model) detected lower KPS, GI or melanoma primary, evidence of primary disease, and larger pre-operative cumulative tumor volumes as negative predictors of survival. Postoperative radiotherapy and increased surgical reduction of total tumor volume were predictors of improved patient survival (all $p < 0.05$).

Conclusion: In addition to known prognostic factors (KPS, primary disease status, postoperative radiotherapy), cumulative pre-operative tumor burden and surgical reduction of overall tumor volume significantly impacted survival of patients with multiple brain metastases.

Skull base

Marvin Bergsneider, MD

Introduction: Conceptually, en bloc pseudocapsular should improve cure rates given that the pseudocapule can be infiltrated by tumor. We investigated the remission rate, endocrine and surgical outcomes following en bloc pseudocapsule resection of functional pituitary adenomas resected via endoscopic endonasal surgery (EES).

Methods: We retrospectively reviewed 91 patients with endocrine active pituitary adenomas who underwent EES (2010 – 2016) for whom en bloc resection was considered possible. These included 29 growth hormone (GH) secreting tumors, 23 adrenocorticotrophic hormone (ACTH) secreting tumors and 39 prolactinomas (Prl). Endocrine functional outcomes were assessed immediately postoperatively: POD 1 GH < 1.0, post-op cortisol nadir < 1.0, POD 1 Prl < 5, respectively. Patients were grouped by whether en bloc pseudocapsule resection was achieved (Group 1) or not (Group 2).

Results: En bloc pseudocapsule resection (Group 1) was achieved in 9 (31%) GH tumors, 11 (48%) ACTH tumors and 18 (46%) prolactinomas. Immediate

surgical remission rate for Group 1 patients were 78% for acromegaly, 100% for CD, and 100% for prolactinomas, as compared to Group 2 where 65% for acromegaly ($p = 0.5$), 67% for CD ($p = 0.04$), and 81% for prolactinomas ($p = 0.04$). The intra-operative CSF leak rate was higher in Group 2 patients (9 vs 2 patients, $p = 0.04$). There were no statistical differences in post-op complications.

Conclusion: En bloc pseudocapsule resection of pituitary adenomas may offer superior early remission rates compared to traditional intracapsular resection methods. Long-term follow-up will be required to assess remission permanence.

Lessons learned in jugular paraganglioma surgery

Diego Mendez Rosito, MD

Objective: The anatomy of the jugular foramen (JF) is complex. It contains the lower cranial nerves and major vascular structures. Jugular paragangliomas (JPs) are the most common primary neoplasms of the JF, arising from the paraganglion cells within the adventitia of the jugular bulb. They are slow-growing, highly vascularized tumors. Although considered histologically benign, the management of jugular paragangliomas is challenging because of their infiltrative nature and proximity to the facial and lower cranial nerves (CN), carotid canal, posterior fossa meninges, and otic capsule. Although radiosurgery has shown an important role in the treatment of JPs, surgery is the main treatment strategy in a selected group of young and symptomatic patients. In this lecture, we present the experiences learned in a single surgeon series, which have led to the formation of an institutional protocol.

Methods: The authors retrospectively reviewed the operative notes of a consecutive database of procedures in which a surgical treatment of JPs was performed. The preoperative MRI, angio CT, angiogram as well as the surgical notes and videos were reviewed and analyzed. Special consideration was done in the postoperative complications to establish an institutional protocol for the management of JPs.

Result: Between January 2014 and August 2018, 12 patients (3M, 9F) aged 19-62 years underwent a total of 12 surgeries for JPs by the primary author (DMR). All cases were staged, where the first surgery included a cervical vascular control and a posterior petrosal approach tailored for each case. All the tumors were preoperatively embolized prior to surgery (24-96 hrs). CSF leak presented in 25% of the cases requiring a lumbar drainage. Multiple full HD videos are collected to analyze the surgical technique.

Conclusion: Surgical management of JPs is challenging and requires a thorough knowledge of the surgical anatomy of the JF and craniocervical areas. A selected group of patients require surgery due to progressive neurological deficit. Preoperative embolization and retrofacial infralabynrinthine approach provide a wide exposure for the removal of JPs. An adequate selection of the patients is crucial to avoid complications.

Predicting brain tumor recurrence: development and validation of a DNA-methylation based nomogram in meningioma

Gelareh Zadeh, MD
Gelareh Zadeh for the MacFeeters-Hamilton Neuro-oncology Program, Princess Margaret Cancer Centre, University Health Network, Toronto

Background: Standard-of-care classifications are challenged in predicting early tumor recurrence at the individual patient level in meningioma which limits the appropriate selection of patients who would benefit from adjuvant radiation to delay recurrence. We aimed to develop an individualized prediction model of early recurrence risk combining clinical and molecular factors in meningioma.

Methods: DNA methylation profiles from training cohort of clinically-annotated tumor samples across multiple institutions (N=228 patients) were used to develop a methylome-model of 5-year recurrence-free-survival (RFS). Model performance was evaluated and compared to a standard-of-care model using three independent cohorts (N=54; N=140; N=64 patients). Subsequently, a 5-year meningioma recurrence score was generated using a nomogram that integrated the methylome-model with established prognostic clinical factors in a training cohort (N=368 patients) and performance was evaluated and compared to a clinical-factory only nomogram using two independent validation cohorts (N=54; N=64 patients).

Results: The methylome-based predictor of 5-year RFS performed favorably compared to a

grade-based predictor when tested using the three validation cohorts (ΔAUC =0.10, 95%CI 0.03–0.018) and was independently associated with RFS after adjusting for tumor grade, extent of resection and burden of copy number alterations (HR 3.6, 95%CI 1.8–7.2, P < 0.001). A nomogram combining the methylome-predictor with clinical factors demonstrated greater accuracy than a nomogram using clinical factors alone in two independent validation cohorts (ΔAUC =0.25, 95%CI 0.22 – 0.27) and resulted in two different risk groups with distinct recurrence patterns (HR 7.7, 95%CI 5.3–11.1, P<0.001) and clinical implications.

Conclusions: The models developed and validated in this study provide important prognostic information not captured by previously established clinical and molecular factors that could be used to individualize decisions regarding post-operative therapeutic interventions, in particular, whether to treat patients with adjuvant radiation therapy versus observation alone.

Efflux transporter function determines hydrocephalus following intraventricular hemorrhage in an experimental model.

Satish Krishnamurthy, MD

Introduction: Intraventricular hemorrhage is a common cause of hydrocephalus. However, it is difficult to predict who is likely to develop hydrocephalus based on the amount of hemorrhage whether it is in infants or in adults. Efflux transporters, such as p-glycoprotein (PGP), clear a wide variety of macromolecules from the brain and are expressed on the blood brain barrier. Decreased function of PGP has been noted in HTX rat which presents with hydrocephalus. This study was conducted to determine whether efflux transporters have any influence on the presence and degree of hydrocephalus following experimental intraventricular hemorrhage. Our hypothesis was that knockout of PGP should result in severe hydrocephalus whereas overexpression should protect the rat from hydrocephalus.

Methods: Groups of 9 Mdr1a knockout (PGP inhibited) and Mrp2 knockout (PGP overexpressed) rats were compared to normal rats. Hydrocephalus was induced by intraventricular injection of autologous blood (130 ul). Ventricular volumes were calculated from 7T MRI scans that were performed prior to the surgical procedure, at 5 days, 10 days and at 15 days following inducing hydrocephalus. Macromolecule clearance half time for each group was determined by injecting 20 ul(1 ug/ul) red fluorescent dextran labeled with iron to the right lateral ventricle on the 15th day.

Results: Mdr1a rats (pgp knockout) had a mean increase in volume (5.37ul) which was more than double the mean increase in volume on the normal rats (2.52 ul). However, Mrp2 rats (pgp overexpressed) had a mean increase of less than half that of normal rats (1.15ul). The difference between the groups were statistically significant (p=0.036). The macromolecular clearance times (t half) from the ventricles were 50% in the Mrp2 rats compared to the Mdr1a rats or normal rats.

Conclusions: P-glycoprotein knockout aggravates hydrocephalus whereas overexpression decreases the chance of hydrocephalus in this intraventricular hemorrhage model. This suggests that p-glycoprotein is one of the key regulators in removal of excess macromolecules from intraventricular hemorrhage. Drugs that enhance p-glycoprotein function can be used to treat hydrocephalus in the future.

A Comparison of General Anesthesia Versus Conscious Sedation In Mechanical Thrombectomy Patients For Surgical and Functional Outcomes

Stavropoula Tjoumakaris, MD

Objective: Mechanical thrombectomy procedure impressively altered functional outcomes following acute ischemic stroke. Significant effort has been made aiming to optimize outcomes by rapid procedure performance, more advanced equipment, and fine selection criteria. Anesthesia technique, whether general or sedation, has been a matter of debate in terms effect on clinical outcomes. General anesthesia opponents prefer this method due to a perception of safety, while, on the other hand, sedation allows minimal delay and improved hemodynamic stability.

Methods: A retrospective review of a prospectively maintained database for patients presenting with acute ischemic stroke undergoing mechanical thrombectomy. Outcomes including technique used, length of hospital stay, hemorrhage, pneumonia, and mortality were reviewed.

Results: Among 419, 189 (45%) underwent general anesthesia, and 231 (55%) underwent conscious sedation. The length of hospital stay, duration of the procedure and the time-to-revascularization from symptom onset were significantly longer in the GA group. GA group developed more frequent delayed extubation (54.2% vs 6.8%; P < .001), and pneumonia (11.4% vs 2.1%; P = .03). However, rates of both sICH and functional outcome defined as mRS < 2 did not significantly differ between the two groups

Conclusions: A retrospective analysis of thrombectomy patients showed that CS patients had shorter in-hospital stay and less postoperative complications; such as delayed extubation and pneumonia. However, that did not alter the functional outcome and rates were similar between the two groups.

Confocal Laser Endomicroscopy for Optical Biopsies of Brain Tumors: 10-Years of Research and Clinical Investigations for Precise Real-Time Neurosurgical Intraoperative Microimaging

Mark Preul, MD

Background: Confocal laser endomicroscopy (CLE) is designed as a fluorescence imaging technique for intraoperative real-time visualization of histopathological and cytoarchitectural features. Initial studies showed that images of brain tumors acquired by a first generation (Gen1) CLE system using fluorescein sodium (FNa) as a contrast yielded a diagnostic accuracy similar to surgical frozen-section and permanent histological analysis. The Gen1 system was used as an exploratory model for neurosurgery, whereas a second generation (Gen2) system was aimed for U.S. FDA approval and specifically for neurosurgery. We investigated performance of a Gen2 CLE system with analysis of improvements and comparison of the two CLE systems in imaging acquisition capability and application for neurosurgery. By using the fluorescein sodium (FNa) as a contrast, handheld confocal laser endomicroscopy (CLE) allows for intraoperative real-time "optical biopsy" at a cellular level. We present performance assessment of this technology and present results of 10 years clinical and experimental experience with CLE for diagnosis and visualization of various brain pathologies and tissues.

Methods: CLE (488nm) optical biopsies were performed in patients (nearly 200) and experimentally in animals. Animal feasibility studies included rodents injected with GL261, C6 glioma and human-derived GBM, swine and rodent brain injury and vascular models. Confocal probe was also positioned on blood vessels and brain tissue with continuous images and Z-stacks acquired after FNa injections (IV/IA). Fluorophores included FNa, acridine orange, acriflavine, sulforhodamine-101, 5-aminolevulinic acid, cresyl violet, and indocyanine green (ICG). Selected experimental gliomas had specific antibody labeling. For brain tumor imaging with the Gen2 CLE using FNa, we assessed various imaging parameters (gain, laser power, brightness, scanning speed, imaging depth, and Z-stack-3D block imaging). Our clinical experience with CLE includes patients examined ex-vivo and in-vivo using a Gen1 device and patients examined ex-vivo using a Gen2 CLE. CLE optical biopsies were analyzed and compared with matched H&E stained sections.

Results: CLE imaging in patients produces on average 77.7±46.2 images per optical biopsy location. A first diagnostic image was identified within seconds of CLE use clinically (within 7-14 images). CLE specificity/sensitivity during FNa-guided surgery was equal or better than frozen section (94%/91% for gliomas, 93%/97% for meningiomas). In experimental model gliomas and brain injuries with visible FNa extravasation were distinguished in over 90% of CLE locations imaged (Sensitivity=0.86, Specificity=0.96, PPV=0.97, NPV=0.78). Gen2 CLE showed improved resolution and more convenient interface comparing with Gen1. Animal and human CLE,

including specific antibody labeling, provided clear identification of tumor cells, tumor border, and invading cells (even around and into blood vessels). FNa injection with both CLEs, showed cells as dark objects on a background of FNa fluorescence: in vivo imaging showed fast movements of erythrocytes and stationary abnormal pleomorphic glioma cells. CLE imaging with FNa allowed for identification of nuclear and cytoplasmic contours in some tumor cells. Injection of higher dosages of FNa (20, 40 mg/kg) resulted in a subjectively better quality images than lower FNa doses (0.1-8 mg/kg). CLE was able to detect individual cells labeled with 5-ALA (PpIX) in the experimental tumors, but overall fluorescence intensity of tumor images was higher ($p<0.01$) than from the control brain. Blood flow was visualized in cerebral vessels of various sizes ranging from 7.2um-1mm diameter. Arteries and veins were discriminated based on the tortuosity and speed and pattern of flow. Various intravascular events such as thrombosis, agglutination of erythrocytes, rolling of cells, redistribution/reconstitution of flow in a microvascular bed were visualized. Red blood cell movements and flow changes were readily visible after vessel compression or proximal clip application. Overall, CLE angiography was possible for more than 40 minutes after a single 2mg/ml FNa administration, compared to about 6 min with the operating microscope. Multiple FNa reinjections (IA/IV) and co-administration of ICG did not decrease confocal image quality.

Conclusions: CLE is a novel technique that is capable of exquisite precision cellular-level imaging and blood flow assessment in cerebral vasculature on-the-fly during surgery, allowing for optical histoarchitectural interrogation prior to tissue removal. Confocal laser endomicroscopy extends effective imaging time compared to the wide field operative microscopy with FNa and provides additional details of intravascular cell movements. Clinical studies are ongoing to assess diagnostic accuracy and clinical value of the novel Gen2 CLE, including its effect on the surgery-pathology workflow. Future avenues regarding precision-based surgical management of tumors may involve microscopic imaging with specific targeted fluorescent markers as well as dye-less reflectance optical imaging that relies on intrinsic tissue properties.

Impact on Extent of Resection and Facial Nerve Outcomes Using Subperineural Dissection Technique for Surgical Resection of Acoustic Neuromas

James Liu, MD
James K. Liu, MD, Jorge Naranjo, BS, Gurkhirat Kohli, BS, Naveed Kamal, MD, Yu-Lan Mary Ying, MD, Robert W. Jyung, MD

Object: There has been recent interest in advocating intracapsular subtotal resection of acoustic neuromas followed by stereotactic radiosurgery for the goals of better facial nerve outcomes. However, the risk of recurrence is proportional to the volume of residual tumor. The authors report their experience adapting a philosophy of attempt at maximal resection of while preserving facial nerve function using a facial nerve-sparing strategy and subperineural dissection technique.

Methods: A retrospective study was performed on 74 consecutive patients who underwent surgical resection of acoustic neuroma using a subperineural dissection technique. The perineurium of the superior and inferior vestibular nerve are identified and dissected away from the tumor capsule. Extracapular dissection is performed while maintaining the subperineural plane of dissection, which serves as an anatomic buffer to protect the facial nerve. Attempt at maximal resection is performed. If, however, there is adherent tumor to the facial nerve, the volume of residual tumor is reduced as safely possible. Patients were evaluated for tumor size, extent of resection, facial nerve outcomes based on House-Brackmann (HB) scale, and tumor recurrence.

Results: The mean patient age at surgery was 52.3 years with a mean follow-up of 14.4 months. The retrosigmoid approach was used in 79.7% of cases while the translabyrinthine approach was used in 20.3%. Majority of the tumors were Koos grade III-IV (64.9%) while 35.1% had Koos grade I-II tumors. GTR and NTR (>95% resection) was achieved in 94.6% of patients. There was a decrease in gross

total resection (GTR) rate and increase in near total resection (NTR) with increased Koos grade I to IV (GTR: 100%, 93.3%, 75%, 42.5%; NTR: 0%, 6.7%, 25%, 50%, respectively). Favorable facial nerve outcomes (HB 1-2) were achieved in 94.6%, overall (100% in Koos I-II, 87.5% in Koos III, 92.5% in Koos IV). HB III outcomes were seen in none of the Koos I-II, 12.5% in Koos III, and 7.5% in Koos IV. The extent of resection did not appear to affect final facial nerve outcome. There was one recurrence that was treated with radiosurgery.

Conclusion: The subperineural dissection technique appears to be useful for preserving facial nerve function when attempting maximal resection of acoustic neuromas. The perineurium of the vestibular nerves provides an anatomic buffer to avoid direct dissection on the facial nerve. The technique will be demonstrated in the presentation via case examples.

Validation of Preoperative Language Mapping Modalities: A Comparison of fMRI, nTMS, and DCS

Sujit Prabhu, MD

Navigated transcranial magnetic stimulation (nTMS) is a presurgical mapping tool for identification of eloquent motor and speech areas. nTMS has an excellent correlation with direct cortical stimulation (DCS) in motor eloquent brain, however its correlation with speech areas lacks specificity. In this cohort of 23 patients who had an awake procedure for tumor resection we wanted to compare DCS to nTMS and sentence completion task based functional MRI (fMRI) to DCS. We chose the sentence completion task as it has been very predictable (in our hands) in identifying posterior speech areas of cortical activation. Using the distance equation we defined the true positive nTMS and DCS points. In this cohort the negative predictive value (% true negatives) was high at 90% when nTMS was compared to DCS. The sensitivity was 84.9% and specificity 69.0% with a positive predictive value of 27%. The fMRI sentence completion correlation to DCS was 10%. We discuss the advantages and challenges associated with the use of nTMS in this cohort of awake craniotomy patients.

A Novel Low Profile Shunting System- Dr. Kenneth Liebman- SUNS 2019 Abstract

Kenneth Liebman, MD

Ken Liebman, Hirad Hedayat, Erol Veznedaroglu

Implanting shunt devices are common procedure that neurosurgeons perform for a multitude of reasons. These procedures are critical, potentially life altering and lifesaving for patients suffering from hydrocephalus. The reason for the procedure is obvious and the problems inherent to the procedure are also obvious. There is an elevation in the skin where the reservoir, valve portion of the shunt exists. This elevation is not only a cosmetic issue but is also associated with other complication issues that include scalp dehiscence, exposure and extrusion. There is also a discomfort problem. As such, we sought a new method for integrating shunt valves that avoids the issues associated with the standard shunt placement.

Objective: To safely implant and integrate a hydrocephalus shunt valve device within a customized cranial implant, in an effort to limit its high-profile nature as a main contributor to shunt failure and scalp breakdown, and at the same time, improve patient satisfaction by improving cosmetic results and reduce discomfort.
METHODS: A cranial defect is made that is a specific size and shape. A cranial implant, (InvisiShunt, Longeviti Neuro Solutions, Hunt Valley, Maryland) the same size and shape as the defect made, is then secured. There is a prefabricated depression in the cranioplasty where the shunt tubing and valve reservoir system sit.

Results: To date, we have implanted this low profile shunt cranioplasty (InvisiShunt, Longeviti Neuro Solutions, Hunt Valley, Maryland) system in 14 patients. We were able to reduce the high profile shunt valve system by greater than 90%. There has been no immediate or follow up complaint about the larger incision, only a profound positive patient satisfaction in regards to cosmetics, and comfort. To date there has been no skin breakdown, wound dehiscence or shunt exposure.

Conclusion: The prominence of hydrocephalus shunt devices under the scalp by way of standard implantation is a contributing factor for soft tissue complications associated with hydrocephalus. Integration of the high-profile shunt valve within the confines of a customized cranial implant appears to be both safe and reliable. By significantly reducing the profile of the implanted system will likely result in improved cosmetic results and a significant reduction in scalp dehiscence, and shunt exposure and extrusion.

Forever Young: A Program to Enhance Brain Health and Vitality

James Ecklund, MD

Neurosurgeons do amazing work. As we clip aneurysms, fuse spines, remove brain tumors, and save lives, we measure our results in a variety of ways---extent of resection, post-op angiogram, stability of fusion, return to work, etc. Our patients, however, don't really care about these surrogate markers of our success. They just want to get better, and feel like themselves. Unfortunately these devastating diseases often leave our patients with neurological deficits that limit their pre-morbid function. Standard rehabilitation too often defers to the old adage "the nervous system recovers slowly so it just takes time." The brain is our most complex organ. Deficits for our patients can be profound or subtle, but both significantly impact their ability to function normally. As longevity increases in our society we will also face significant challenges with declining brain vitality and function. While much of our standard medical assessments focus on cardiac health based on data from the original Framingham study, there has never been a "Framingham study" for the brain. Gym memberships for our bodies and cardiac health are commonplace; but there are very few "gyms" for the brain. This presentation will describe Inova's developing Brain and Spine Performance Enhancement Center, focusing specifically on the Brain Health Program. We will highlight the state of the art today, and how best practices and research are responsibly interwoven throughout this program designed to preserve God's greatest gift—The Human Brain.

The Role of Evidence Based Medicine in Neurosurgical Education: A survey of United States Residency Training Programs

Beverly C Walters, MD

Background: The application of evidence-based medicine (EBM) has played an increasingly larger role within neurosurgical education over the last several decades. The Accreditation Council on Graduate Medical Education (ACGME) has mandated that residents are now required to demonstrate academic productivity and mastery of evidence-based medicine principles.

Objective: The goal of this study is to assess how neurosurgery programs around the United States are dealing with the challenges of fulfilling these program requirements from the ACGME.

Methods: A 21-question survey was developed and electronically delivered to residency program directors of the 110 ACGME-approved MD and DO training programs in the country utilizing a modified Dillman technique, a stringent and well-tested survey methodology.

Results: Responses were received from 102 of the 110 (92.7%) neurosurgical training programs in the United States. Ninety-eight programs (96.1%) confirmed a regularly scheduled journal club. Approximately half of programs (51.5%) designated that the primary goal of their journal club was to promote critical appraisal skills. Only 58.4% of programs reported a formal EBM curriculum. 57.4% of programs confirmed an annual resident publication requirement.

Conclusion: There remains much variability among individual neurosurgical residency programs in EBM training. However, there is a paradigm shift in graduate medical education with increasing emphasis being placed upon this as a foundation of residency training.

BYLAWS

OF

THE SOCIETY OF UNIVERSITY NEUROSURGEONS, INC

ARTICLE I

NAME AND OBJECT

Section 1. This organization shall be known as "The Society of University Neurosurgeons, Incorporated."

Section 2.

The objectives of this Society shall be: to promote scientific and social discourse among its members, to encourage investigative work in the neurological sciences, to improve teaching methods and techniques in neurological surgery, and to inspire its members to acquire humanistic ideals and to achieve clinical excellence in the practice of medicine."

Vision:

To enhance academic neurosurgeons throughout the world and improve the state of clinical and laboratory neuroscience globally

Mission:

a)To improve the exchange of new ideas and scientific disclosures,

b)To enhance comprehension of global activities, university settings, and specific regional challenges in the academic sector, and

c) To mentor and direct emerging academic neurosurgeons during the mid-career period.

Section 3. No part of the income or property of this Society shall inure to the benefit of any Individual.

ARTICLE II

MEMBERSHIP QUALIFICATIONS

Section 1. The membership of the Society shall be divided into four classes:

(a) Active

(b) Senior

(d) Honorary

(e) Inactive

A member shall be elected as provided in Article V- CANDIDATES FOR MEMBERSHIP.

Section 2. Classification of Membership

(a) ACTIVE. Active members shall be neurological surgeons who are certified by the governing body in their respective countries, and who are engaged in the practice of neurological surgery and/or substantially engaged in research on neurological surgery.

(b) SENIOR. An Active member may, upon request to and approval of the Executive Council, transfer to Senior membership upon attaining the age of sixty-five (65) years or upon retirement from practice of neurological surgery, whichever comes first. Senior members may not vote or hold office (except for the office of Historian), but may serve on Committees; and are not required to pay dues or regularly attend annual meetings.

(c) HONORARY. Honorary members shall be chosen as recognized leaders in the field of neurological sciences. They shall not exceed five (5) in number at any given time. They shall not be required to pay dues or attend annual meetings. They shall not vote or hold office but may serve on committees.

(d) INACTIVE. Inactive members shall be former Active members who by virtue of illness or other reasons can no longer maintain Active membership and are not eligible for any other classification of membership. An Active member may, upon request to and approval of the Executive Council, transfer to Inactive status. An Inactive member may be restored to Active status by request to

and approval of the Executive Council. Inactive members shall not vote, hold office, or serve on Committees. They shall not be required to pay dues or attend annual meetings.

Section 3. Qualifications for Membership

The Membership Committee shall be cognizant of the objectives of the Society and shallrecommend for membership individuals who are affiliated with a medical school or outstanding group practice. If an Active member ceases to comply with the membership requirements as provided in Section 2(a), he/she must resign from the Society or be transferred to a different membership classification. Individual exception to this rule requires recommendation by the Executive Council and approval by majority vote of the Active membership.

Section 4. Limitation of Membership

The number of Active members in the Society may be limited upon recommendation of The Executive Council and approval by a majority vote of the Active membership.

ARTICLE III

OFFICERS

Section 1. The officers of the Society shall be President, President Elect, Vice-President, andSecretary/Treasurer. The Executive Council shall be composed of the officers, one Active Member-at-Large appointed by the President, and the Immediate Past-President of the Society.

Section 2. The Nominating Committee shall present a slate of proposed officers to be elected for the succeeding year at each annual meeting. Active members present at the meeting may make additional nominations. Election of officers shall be by ballot; the member receiving the largest number of votes cast for that office shall be elected. Officers so elected shall take office at the close of that annual meeting.

Section 3. Vacancy of an office shall be filled by an appointee of the Executive Council.

Section 4. The President shall serve for a term of one (1) year. He/She shall preside at all meetings and decide all questions of order, appoint committees, and cast the deciding vote in ties.

Section 5. The President Elect shall be elected at each annual meeting. He/She shall become President of the Society at the close of the subsequent annual meeting.

Section 6. The Vice-President shall assist the President. He/She shall preside at functions andmeetings in the absence of the President.

Section 7. The Secretary/Treasurer shall serve for a term of three (3) years. The Executive Council shall determine at which year the election for Secretary/Treasurer will be held. He/She shall keep records of attendance and minutes of each meeting, read all correspondence to the Society, handle all notices and correspondence of the Society. He/She shall account for the finances of the Society, and collect dues and notify members of delinquent standing. He/She shall receive all applications for membership or guest attendance and forward this information to the Membership Committee at least one (1) month prior to the annual meeting.

Section 8. The Executive Council shall be the governing body of the Society and have charge of activities of the Society not otherwise provided in these Bylaws. The Executive Council shall work in close coordination with the Membership Committee concerning the proposal of candidates for membership in the Society.

Section 9. The Historian of the Society shall maintain and update the Society of University yearbooks, which should document the scientific and social programs of the yearlymeeting.

ARTICLE IV

MEETINGS

Section 1. The Society shall meet annually in the Spring or early Summer at a site determined by the Future Sites Committee.

Section 2. The annual meeting shall be a three (3)-day scientific program that includes a weekend. The scientific presentations shall be balanced between clinical and investigative topics.

Section 3. The Chairman of the Program Committee shall serve as Host for the annual meeting, assisted by his/her Committee, and will be responsible for arrangements of both social and scientific activities during the meeting.

Section 4. Robert's Rules of Order (Revised) shall govern the conduct of the business meetings of the Society and the duties of its officers. The order of business shall consist of a roll call, reading of minutes, reading of correspondences, old business, new business, election of new members, reports of committees, the Secretary/Treasurer's report, election of officers, appointment of

committees, and adjournment.

Section 5. Members of any class shall be assessed a pro rata share of the expenses of the annual meetings which they attend.

ARTICLE V

CANDIDATES FOR MEMBERSHIP

Section 1. Candidates for membership shall have the qualifications as provided in Articles 1, 2, & 3.

Section 2. No candidate shall be elected to Active membership who has not attended at least two annual meetings as a guest, and presented a scientific paper during at least one of those meetings.

Section 3. Each candidate shall be nominated in writing by a minimum of two (2) Active members to the Secretary/Treasurer at least two (2) months prior to the next annual meeting. The nomination shall include the candidate's curriculum vitae and a statement of his/her present academic and professional status. The completed proposal for membership shall be forwarded to the Membership Committee for consideration. The Membership Committee shall present to the Executive Council their recommendations for new members. On approval of the Executive Council, candidates shall be proposed to the Active Membership by written secret ballot at the annual meeting of the Society. Election of a member requires an affirmative vote of three-fourths (3/4) of the Active members present and voting at the annual meeting.

Section 4. The Membership Committee shall present no more than ten (10) candidates for active membership each year with no requirement of a minimum number to be presented.

Section 5. The Secretary/Treasurer shall notify each candidate elected to membership not earlier than two (2) weeks following the date of his/her election.

Section 6. A candidate who has failed to be elected may be reconsidered at subsequent annual meeting upon written request of three (3) Active members to the Executive Council.

ARTICLE VI

DUES

Section 1. All Active members of the Society shall be assessed annual dues, the amount to bedetermined each year by the Executive Council.

Section 2. Dues are payable in advance for the succeeding year at the time of or immediatelyfollowing the annual meeting, at the discretion of the Secretary/Treasurer.

ARTICLE VII

STATUS OF MEMBERS

Section 1. To maintain membership in good standing, members of all classes must fully abide by the Bylaws of the Society.

Section 2. An Active member shall be suspended when dues or assessments have not been paid for the previous two (2) years. If he/she fails to attend two (2) consecutive annual meetingsand does not present an excuse acceptable to the Executive Council, a warning letter will be sent. If an active member fails to attend three (3) consecutive meetings, then his/her membership will be terminated. Termination on the grounds of non-payment or failure to attend does not require a vote of the Active membership.

Section 3. A member may be suspended or dropped from any class of membership in the Society by an affirmative vote of three-fourths (3/4) of the Active membership.

ARTICLE VIII

COMMITTEES

Section 1. The Society may have standing and ad hoc committees as determined by the President and the Executive Council. There shall be at least six (6) standing committees: Membership Committee, Nominating Committee, Bylaws Committee, Future Sites Committee, Program Committee, and Senior Advisory Committee.

Section 2. The Membership Committee shall be composed of three (3) members, one (1) to be elected at large each year to serve a term of three (3) years. The senior member of the Committee shall serve as Chairman. This Committee shall review nominations

for new members and present the applications of the most worthy and desirable candidates to the Executive Council. The names of the candidates approved by the Executive Council shall be submitted to a vote by the Active membership at the next annual meeting of the Society.

Section 3. The Executive Council shall serve as the Nominating Committee, with the Immediate Past-President of the Society as Chairman. The duties of the Council shall include the yearly nomination of: President-Elect (1), Vice President (1), Member-at-Large (1), as well as new Members to the following Committees: Membership (1), Future Sites (1), Bylaws (1), and Senior Advisory (1-2).

Section 4. The President taking office at the close of the annual meeting shall appoint the Program Committee for the upcoming year. The new President is an automatic member of the Program Committee. The Chairman of the Committee shall be the Host for the nextannual meeting. The Program Committee may invite guests to complement the scientific program of the meeting.

Section 5. The Future Sites Committee shall be composed of three (3) members, one to be elected at large each year to serve a term of three (3) years. The senior member of the Committee shall serve as Chairman. This Committee shall recommend the site of future meetings at least two (2) years in advance.

Section 6. The Bylaws Committee shall make recommendations to the Executive Committee by proposing amendments to the bylaws, rules, and regulations. The Bylaws Committee will be composed of three (3) members, each serving a term of up to three (3) years. Recommendations so approved will then be voted upon by the Membership via email ballot or at the Annual Meeting.

Section 7. The Senior Advisory Committee shall make recommendations to the Executive Committee for maintaining the Vision and Mission of the Organization. Senior Advisory Committee members will be able to attend Executive Committee meetings. This Committee will be composed of three (3) to six (6) members, each serving a term of up to three (3) years.

ARTICLE IX

GUESTS

Section 1. The Society shall encourage the presence of guests at its annual meeting.

Section 2. Certain invited guests of the Society shall not pay a registration fee or be charged for a share of the group expenses of the meeting. Such guests shall include individuals approved by the Executive Council.

Section 3. Individual guests to the annual meeting may be invited by members. The member shall notify the Secretary/Treasurer of the name and address of his/her proposed guest, and the Secretary/Treasurer shall officially invite the guest to the meeting.

ARTICLE X

AMENDMENTS

Section 1. Amendments to these Bylaws may be proposed in writing by a member of the Executive Council at any time. The amendment shall be voted on at the subsequent annual meeting. The Secretary/Treasurer shall notify all Active members in writing of the proposed amendment prior to the annual meeting, and such amendment shall require for adoption an affirmative vote of three-fourths (3/4) of the Active members present and voting.

Section 2. Amendments to the Bylaws and voting procedures may also be conducted by email. The Secretary will notify members by email of the need to vote on an Amendment to the Bylaws, permitting fourteen (14) days for voting. Such proposed amendments shall require for adoption an affirmative vote of three quarters (3/4) of the Active Members responding.

RULES AND REGULATIONS

Of THE SOCIETY OF UNIVERSITY NEUROSURGEONS, INC.

SUBJECT 1

MEMBERSHIP

Section 1. Candidate Profile

(a) Candidates should be committed to an academic career.

(b) Candidates should have sufficient publications that the quality of their academic activity can be evaluated.

(c) Candidates should have attended a SUN meeting, presented a paper before the Society, and expressed an interest in the Society.

(d) It is desirable to consider Candidates who have potential for hosting a future SUN meeting.

Section 2. Membership Process

(a) Candidates must have attended at least one (1) SUN meeting and presented at least one (1) paper to the Society before being recommended for membership.

(b) No voting for membership will occur at the first meeting that the candidate attends as a guest and at which he/she presents a paper to the Society.

(c) The membership process shall be initiated by proposal of the name of the Candidate to the Secretary/Treasurer by two (2) Active members. The candidate shall then complete the membership application form and submit it to the Secretary/Treasurer.

(d) After documentation of the completeness of an application for membership, the Secretary/Treasurer shall forward it to the Chair of the Membership Committee for consideration.

(e) The candidate is proposed for membership to the Membership Committee and a recommendation is made to the Executive Committee based on the candidate's profile.

(f) At the next regular meeting of the Society, the candidate is brought forward for a vote during the Business Meeting.

(g) If elected by the membership, the candidate will be invited to membership and upon joining the Society, is then eligible to attend the next regular meeting.

Platinum

Penumbra
Aegis Spine, INC

Gold Plus

Zeiss
DePuy

Silver

Transonic Europe B.V.