



# THE SOCIETY OF UNIVERSITY NEUROSURGEONS

Whitefish, Montana

2021  
ANNUAL MEETING  
August 8-11th, 2021



THE SOCIETY  
OF UNIVERSITY  
NEUROSURGEONS



American  
Association of  
Neurological  
Surgeons

Jointly Provided by the AANS



# Whitefish, Montana 2021

Dear Friends and Colleagues,

It is my distinct privilege and pleasure to invite you to the beautiful Flathead Valley, in Northwest Montana, United States for the 2021 Society of University Neurosurgeons Annual Meeting, being held August 8th through the 11th. 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).

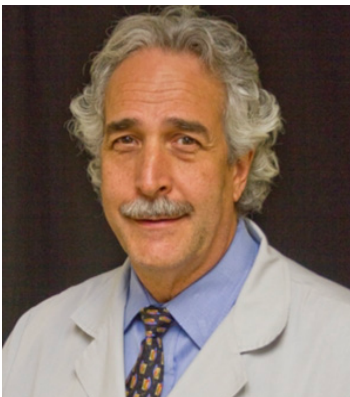
Outside of the scientific sessions there will be opportunities to hike in Glacier Park, scenic float and raft, hot air balloon sightseeing, fly fishing, mountain biking, watersports, unique golfing experiences, and a restorative spa. Please, come early, stay late, and enjoy all the summer in the Flathead 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](mailto:wdeering@krmc.org)) or Jamie Mack ([jmack@krmc.org](mailto: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, M.D., Ph.D.  
Local Host, SUN 2021  
Medical Director  
Neuroscience & Spine Institute  
Department of Neurological Surgery  
Kalispell Regional Medical Center

# Present Officers

## **President**

Erol Veznedaroglu, MD

## **President-Elect**

Felipe Albuquerque, MD

## **Vice President**

Ian McCutcheon, MD

## **Secretary/Treasurer**

Richard Anderson, MD

## **Historian**

Ken Smith, MD

## **Member-at-Large**

Michael Kaiser, MD

## **Membership Committee**

Kadir Erkmen, MD

Daniel Hoh, MD

Christina Notarianni, MD

Mandy Binning, 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 Oritano, 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

~~~~~2019~~~~~  
Richard Ellenbogen, MD

~~~~~2020/2021~~~~~  
Erol Veznedaroglu, 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~~~~~  
Harvard 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~~~~~  
University of Zagreb, Medical School  
Clinical Hospital Centre Zagreb

~~~~~2020~~~~~  
Dubrovnik, Croatia

~~~~~2020~~~~~  
Canceled

# 2021 Meeting Attendees

## SUN Members

Felipe Albuquerque, MD  
Richard Anderson, MD  
Sepideh Amin-Hanjani, MD  
Mandy Binning, MD  
Nicholas Boulis, MD  
Ruth Bristol, MD  
Gavin Britz, MD  
Kim Burchiel, MD  
Paul Camarata, MD  
Fady Charbel, MD  
Lawrence Chin, MD  
Kevin Cockroft, MD  
Carlos David, MD  
Richard Ellenbogen, MD  
Kadir Erkmen, MD  
Carl Heilman, MD  
Pascal Jabbour, MD

Michael Kaiser, MD  
Shekar Kurpad, MD  
Sean LaVine, MD  
Allan Levi, MD  
Michael Levy, MD  
Kenneth Liebman, MD  
Charles Liu, MD  
James Markert, MD  
Ian McCutcheon, MD  
Madison Michael, MD  
Jacques Morcos, MD  
Raj Narayan, MD  
Alfred Ogden, MD  
Thomas Origitano, MD  
Nelson Oyesiku, MD  
Sujit Prabhu, MD  
Craig Rabb, MD

Ron Riesenburger, MD  
Charles Rosen, MD  
Robert Rosenwasser, MD  
Sameer Sheth, MD  
Michael Sisti, MD  
Kenneth Smith, MD  
Jeffrey Sorenson, MD  
Erol Veznedaroglu, MD  
Michael Wang, MD  
John Wilson, MD  
Daniel Yoshor, MD  
Eric Zager, MD

## Members' Guests

Andrew Fanous, MD  
(Milesh Vyas, MD)

Daniel Felbaum, MD  
(Erol Veznedaroglu, MD)

Ira Goldstein, MD  
Mitesh Shah, MD  
(Anil Nanda, MD)

Jason Schwalb, MD  
(Nicholas Boulis, MD)

Martin Sames, MD  
Walter Jean, MD  
(Jacques Morcos, MD)

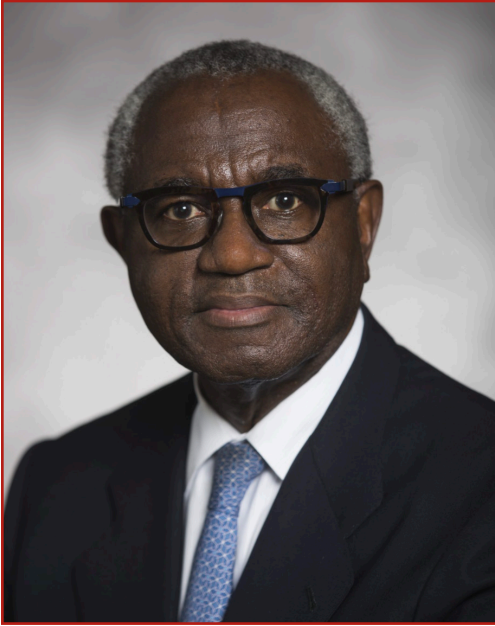
Rajiv Midha, MD  
(Michael Wang, MD)

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

Shelly Timmons, MD  
(Carl Heilman, MD)

Stav Tjoumakaris, MD  
(Pascal Jabbour, MD)

# Distinguished Service Award



## NELSON M. OYESIKU, MD, MSc (Lond.), PhD, FACS

**D**r. Oyesiku is Professor and Chair, Department of Neurological Surgery and Professor of Medicine (Endocrinology) at the University of North Carolina, Chapel Hill. He was previously Professor of Neurological Surgery and Medicine (Endocrinology) at Emory University, Atlanta, GA and the Inaugural Daniel Louis Barrow Chair in Neurosurgery, Vice-Chairman, Dept of Neurological Surgery and Director of the Neurosurgical Residency Program. Dr Oyesiku's clinical expertise is pituitary medicine and surgery. Dr Oyesiku was co-director of the Emory Pituitary Center and has developed one of the largest practices entirely devoted to the care of patients with pituitary tumors in the country and has performed over 3,700 pituitary tumor operations. Dr. Oyesiku obtained his MD

from the University of Ibadan, Nigeria. He obtained an MSc in Occupational Medicine from the University of London, UK and completed a PhD in Neuroscience at Emory University. He completed his Surgery Internship at the University of Connecticut-Hartford Hospital and obtained his neurosurgical training at Emory University, Atlanta. He is board-certified by the American Board of Neurological Surgery. He received an NIH K08 Award and Faculty Development Award from the Robert Wood Johnson Foundation was a recipient of an NIH R01 award and PI of the NIH/NINDS R25 Research Education Program for Residents and Fellows in Neurosurgery. Dr Oyesiku has served on several NIH Study Sections. Dr Oyesiku's research is focused on the molecular pathogenesis of pituitary adenomas, and tumor receptor imaging and targeting for therapy.

Dr Oyesiku has served on various state, regional, national and international committees for all the major neurosurgical organizations. He has served on the Board of Directors and as Chairman of the American Board of Neurological Surgery. He was on the ACGME-Residency Review Committee of Neurosurgery. He is a Fellow of the American College of Surgeons and has served on its Board of Governors. Dr. Oyesiku has been President of the Congress of Neurological Surgeons. He has served as Secretary/Treasurer and President of the Georgia Neurosurgical Society, President of the Society of University Neurosurgeons, and Vice-President of the American Academy of Neurological Surgeons. He is President of the International Society of Pituitary Surgeons. He is President-Elect of the World Federation of Neurological Surgeons.

Dr Oyesiku is Editor-in-Chief of NEUROSURGERY, OPERATIVE NEUROSURGERY and NEUROSURGERY OPEN - leading journals in neurosurgery. He is author of over 180 scientific articles and book chapters.

He has been selected by his peers as one of The Best Doctors in America and was selected by the Consumer Research Council of America as one of America's Top Surgeons. He is named in Marquis Who's Who in America. He is a member of the Honor Medical Society - Alpha Omega Alpha. He was awarded the "Gentle Giant Award" by the Pituitary Network Association for his services to Pituitary Surgery and Medicine. He is on the Medical Advisory Board of the Cushing's Support and Research Foundation. He has been visiting professor and invited faculty at several departments of neurosurgery in the United States and abroad.



# Special Speaker



## JERRY RICE

**H**all of Fame wide receiver and three-time Super Bowl champion Jerry Rice is widely regarded as the best wide receiver to ever play in the National Football League, and arguably the greatest player of all time. During his 15-year career with the San Francisco 49ers, Rice won three Super Bowls (Super Bowl XXIII ('88), Super Bowl XXIV ('89) and SB XXIX ('94)) and one Super Bowl MVP. He enjoyed three seasons with the Oakland Raiders, including a Super Bowl appearance and one season with the Seattle Seahawks before retiring in 2005. Rice was elected into the Pro Football Hall of Fame in January 2010, his first year of eligibility.

Rice's meticulous preparation and work ethic during his 20-year NFL career became legendary. He holds 36 NFL records – a record in itself. He has scored the most touchdowns in NFL history (208) and holds virtually every significant career receiving record, including receptions (1,549), yards receiving (22,895), all-purpose yards (23,546), touchdown receptions (197) and consecutive games with at least one catch (274).

After his retirement, Rice's celebrity grew beyond the football field. He finished second in the second season of the ABC hit reality show *Dancing with the Stars*, led his team to victory on the golf course against other NFL legends on *Big Break NFL Puerto Rico* and has appeared on numerous other television shows. He has extensive broadcasting experience including as an analyst for ESPN, NBC and is a contributor on 95.7 *The Game FM* radio in the Bay Area. He co-authored the New York Times Bestseller, *Super Bowl 50: 50 years 50 Moments* as well as, *America's Game: The NFL at 100* with Randy O. Williams and published by Harper Collins.

This success off the field and renowned work ethic have led Rice to assist numerous corporations, including NIKE, Mitchell & Ness and Panini, where he is working as a brand ambassador and spokesperson. He is also an Honorary Chairman for the San Francisco 49ers Foundation, whose mission is to educate and empower Bay Area youth.

In 2019, Rice and his family launched G.O.A.T. Fuel, a privately held lifestyle brand that empowers individual and collective greatness. G.O.A.T. stands for "Greatest of All Time", a nickname that has been widely used when describing Rice. G.O.A.T. Fuel promotes the unstoppable strength of a hopeful mindset through energy infused products, content and experiences.

Born in Crawford, Mississippi, Rice did not start playing football until he was a sophomore in high school. He was not recruited by many major college football programs and attended Mississippi Valley State University, a public, historically black university and Division I-AA school. As a senior, he broke NCAA records for receptions, yards and touchdowns and acquired the nickname "World" because there wasn't a ball in the world he couldn't catch. He was elected into the College Football Hall of Fame in 2006.

Rice was drafted by the San Francisco 49ers and Hall of Fame coach Bill Walsh as the 16th overall pick in the 1985 NFL Draft. During his career, Rice was selected to the Pro Bowl a record 13 times, won the NFL Most Valuable Player Award in 1987 and was Super Bowl MVP in Super Bowl XXIII. In 1999, he was ranked No. 2 in *The Sporting News*' list of 100 Greatest Football Players – the highest-ranked active player and receiver – and in 2010, was voted the No. 1 player in the NFL Network's *The Top 100: NFL's Greatest Players*. In 2019, he was voted Greatest Player in NFL History by USA Today Sports and was also named to the NFL's All Time Team.

Rice resides in the San Francisco Bay Area with his wife, Latisha, and has four children.

# Welcome to Prague for SUN 2022

It is my highest honor and privilege to invite you to magical and ancient Prague, the capital of the Czech Republic, for the Society of University Neurosurgeons Annual Meeting, being held June 30 – July 2 (arrival June 29), 2022. Prague is located in the heart of Europe on the Vltava River and the SUN meeting will take place at the Marriott hotel, conveniently located right in the historical center of the city.

Members of the SUN Society and their guests will create a valuable scientific program, similarly to previous successful meetings, which have taken place since 1965. Prague with its cultural and historical values will provide a unique, relaxing and inspiring experience as well as spiritual enlightenment from its rich European history.

The Czech Republic with its capital Prague is an accessible, safe and friendly country. A direct flight from New York takes only 7 hours.

The climate in Prague in June is pleasantly dry, with temperatures oscillating around 65 degrees F during the day, with 16 hours of daily sun (the sun rises at 4:50 and sets at 21:14).

Prague was founded in the 9th century during the Romanesque era and flourished during the Gothic and Renaissance periods. The first university was founded in 1348 by the Czech King Charles IV, who was later crowned emperor of the Holy Roman Empire. In addition to the scientific program, we will have the opportunity to visit and explore many gems of Prague such as St. Vitus Cathedral in Prague Castle, the Jewish Quarter with five synagogues, the Museum of the Art Nouveau painter Alfons Mucha, the Museum of the writer Franz Kafka, as well as the chateau of the composer Antonin Dvorak. We are preparing a gala dinner in the Imperial Hall of the Lobkowitz Palace at Prague Castle with an exquisite view of historic Prague.

The scientist Albert Einstein spent part of his life in Prague. In one of his letters from 1911, he wrote to his friend Bess: “Could you ever visit me? The city of Prague is simply beautiful, so beautiful that it deserves a longer journey in itself.”

We cordially invite you to a longer journey to experience the spirit of such a unique city. I wish you good health and I believe in a fruitful and successful SUN meeting 2022 in Prague.

Respectfully,



**Martin Sames, MD**  
Professor and Chairman  
Vice-President of the Czech Neurosurgical Society



# Meeting Schedule

Sunday, August 8, 2021

6:30-9:30 pm: Welcome/ Opening Reception Lakeside Pavilion – Lodge

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Monday, August 9, 2021

6:30-9:30 am: Breakfast Lakeside Pavilion – Lodge

7:25-12:00 pm: **General sessions lectures** Ramsey Ballroom - Lodge

7:25-12:00 pm: **Vendor tables open**

7:25-7:30 am: Opening Comments Erol Veznedaroglu, MD  
7:30-8:00 am: Welcome address Craig Lambrecht, MD  
Tom Orogitano, MD

Moderator: Sameer Sheth, MD  
Ron Riesenburger, MD

8:00-8:12 am: Resection of large vestibular schwannomas with Inferior long axis microsurgical Mitesh Shah, MD

8:12-8:24 am: Residual tumor volume in nonfunctional pituitary adenomas as a predictor of tumor recurrence: a volumetric study Ian McCutcheon, MD

8:24-8:36 am: Comparative Exposure to the Petroclival Region Using Patient-Specific Meningioma Virtual Reality Models Walter Jean, MD

8:36-8:48 am: Addressing pediatric neuro-oncology disparities in the US-Mexico border region: A cross-border initiative between San Diego, California and Tijuana, Mexico Michael Levy, MD

8:48-9:00 am: **Discussion**

9:00-9:12 am: The WEB device preliminary experience after FDA approval: feasibility and early results in 75 cases Pascal Jabbour, MD

9:12-9:24 am: 30-day emergency department utilization for chronic subdural hematomas following surgical evacuation with and without middle meningeal artery embolization Felipe Albuquerque, MD

9:24-9:36 am: Stroke and mechanical thrombectomy in patients with COVID-19: technical observations and patient characteristics Sean Lavine, MD

9:36-9:48 am: ICU care after endovascular treatment of unruptured intracranial aneurysms: Prevalence and predictors of ICU-specific needs. Kevin Cockroft, MD

|                       |                                                                                                                                                        |                                |
|-----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 9:48-10:00 am:        | <b>Discussion</b>                                                                                                                                      |                                |
| 10:00-10:30 am:       | <b>Break with exhibitors</b>                                                                                                                           | <b>Vendor Greeting Session</b> |
| 10:30-10:42 am:       | The microsurgical management of unruptured middle cerebral artery aneurysms: Outcomes, complications, and durability                                   | Carlos David, MD               |
| 10:42-10:54 am:       | Approaching complex posterior communicating aneurysms: anatomical comparison of the pretemporal trans-clinoidal and the pterional trans-sylvian routes | L. Madison Michael II, MD      |
| 10:54-11:06 am:       | The Use of Fibrinogen Levels to Shorten the Post-Alteplase Window                                                                                      | Mandy Binning, MD              |
| 11:06-11:18 am:       | Distinguished Service Award                                                                                                                            | Jacques Morcos, MD             |
| 11:18-11:30 am:       | <b>Discussion</b>                                                                                                                                      |                                |
| 11:30-12:00 pm:       | <b>USGS northern rocky science center</b>                                                                                                              | <b>Daniel Fagre</b>            |
| 12:00-4:30 pm:        | Red jammer bus tour (attendees and family)                                                                                                             |                                |
| 7:00-9:30 pm:         | <b>Dinner</b>                                                                                                                                          | <b>Whitefish Lodge</b>         |
| **Optional: 10:00 pm: | Downtown for nightcaps                                                                                                                                 | Whitefish                      |



Tuesday, August 10, 2021

|                 |                                                                                                                                                                                                     |                                          |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------|
| 6:30-8:30 am:   | Breakfast Buffet                                                                                                                                                                                    | Lakeside Pavilion – Lodge                |
| 7:00-8:00 am:   | Executive committee meeting (Executive only)                                                                                                                                                        | Regatta Room                             |
| 8:00-12:00 pm:  | General sessions lectures                                                                                                                                                                           | Ramsey Ballroom - Lodge                  |
| 8:00-12:00 pm:  | Vendor tables open                                                                                                                                                                                  |                                          |
|                 | Moderators:                                                                                                                                                                                         | Mandy Binning, MD<br>Kevin Crockroft, MD |
| 8:00-8:05 am:   | Introduction of SUN president                                                                                                                                                                       | Ken Liebman, MD                          |
| 8:05-8:30 am:   | presidential address                                                                                                                                                                                | Erol Veznedaroglu, MD                    |
| 8:30-8:42 am:   | A critical reappraisal of the human corticospinal tract                                                                                                                                             | Allan Levi, MD                           |
| 8:42-8:54 am:   | Can a laminectomy prevent heart failure?<br>The ligamentum flavum, the heart,<br>and amyloidosis                                                                                                    | Ron Riesenburger, MD                     |
| 8:54-9:06 am:   | Factors contributing to increased operative time<br>and complications in surgery for thoracolumbar<br>deformity correction: Implicating patient<br>characteristics and associated clinical outcomes | Andrew Fanous, MD                        |
| 9:06-9:16 am:   | <b>Discussion</b>                                                                                                                                                                                   |                                          |
| 9:16-9:28 am:   | Brachial plexus region tumors:<br>Surgical approaches and complication avoidance                                                                                                                    | Eric Zager, MD                           |
| 9:28-9:40 am:   | Factors influencing post-operative motor outcomes<br>in patients with severe proximal peripheral nerve<br>injury: A province wide cohort study                                                      | Rajiv Midha, MD                          |
| 9:40-9:52 am:   | Spinal cord and brain concentrations of riluzole<br>after oral and intrathecal administration: a potential<br>new treatment route for amyotrophic lateral sclerosis                                 | Nicholas Boulis, MD                      |
| 9:52-10:02 am:  | <b>Discussion</b>                                                                                                                                                                                   |                                          |
| 10:02-10:25 am: | <b>Break with exhibitors</b>                                                                                                                                                                        | <b>Vendor Greeting Session</b>           |
| 10:25-10:37 am: | Venous occlusion, with optimal flow reduction,<br>then total excision of cerebral AVMs (VORTEX)                                                                                                     | Fady Charbel, MD                         |
| 10:37-10:49 am: | A single surgeon's series of 1D2R direct bypasses<br>for moyamoya and ischemia                                                                                                                      | Jacques Morcos, MD                       |

|                       |                                                                                                                                                                        |                   |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------|
| 10:49-11:01 am:       | Stuff you do not see in an urban neurosurgical practice: Neurosurgical aspects of bear attack and exercise induced paraspinal rhabdomyolysis with compartment syndrome | Tom Origitano, MD |
| 11:01-11:20 am:       | History of SUN - Invited lecture                                                                                                                                       | Ken Smith, MD     |
| 11:20-11:30 am:       | <b>Discussion</b>                                                                                                                                                      |                   |
| 11:30-12:00 pm:       | Guest lecture                                                                                                                                                          | Michael Goguen    |
| <b>12:00-1:00 pm:</b> | <b>Lunch at Lakeside Pavilion</b>                                                                                                                                      |                   |
| 1:00 pm:              | Shuttle transport to glacier raft                                                                                                                                      |                   |
| <b>6:00-6:45 pm:</b>  | <b>Cocktails and appetizers</b>                                                                                                                                        |                   |
| 7:00 pm:              | Dinner served                                                                                                                                                          | Great Northern    |
| 9:00-9:45 pm:         | Shuttle transport back to lodge                                                                                                                                        |                   |



Wednesday, August 11, 2021

|                |                                                                                                                                               |                                       |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------|
| 6:30-8:30 am:  | Breakfast Buffet                                                                                                                              | Elafiti Restaurant                    |
| 7:15-11:30 am: | <b>Fly fishing – Northern rockies outfitters</b><br>*Shuttle will be provided to take guests downtown or back to the lodge for final session  |                                       |
| 9:00-11:30 am: | <b>Free morning downtown Whitefish</b>                                                                                                        |                                       |
| 9:30 am:       | <b>Shuttle Transport downtown (Provided by the Lodge)</b>                                                                                     |                                       |
| 11:30 am:      | <b>Shuttle back to Lodge</b>                                                                                                                  |                                       |
| 12:00-1:30 pm: | <b>Roll-In lunch in foyer</b>                                                                                                                 |                                       |
| 12:30-1:30 pm: | <b>SUN business meeting (members only)</b>                                                                                                    | <b>Ramsey Ballroom - Lodge</b>        |
| 1:30-5:20 pm:  | <b>General sessions lectures</b>                                                                                                              | <b>Ramsey Ballroom - Lodge</b>        |
| 1:30-5:20 pm:  | <b>Vendor tables open</b>                                                                                                                     |                                       |
|                | <b>Moderators:</b>                                                                                                                            | Pascal Jabbour, MD<br>Gavin Britz, MD |
| 1:30-1:42 pm:  | Cellular transplantation: neurorestoration for mesial temporal lobe epilepsy and other neurological disorders                                 | Kim Burchiel, MD                      |
| 1:42-1:54 pm:  | Unsupervised machine learning can delineate the central sulcus by using the spatio-temporal characteristic of somatosensory evoked potentials | Sujit Prabhu, MD                      |
| 1:54-2:06 pm:  | Robotic carotid stenting                                                                                                                      | Stavropoula Tjoumakaris, MD           |
| 2:06-2:18 pm:  | The changing face of gamma knife radiosurgery and the impact of masked based radiosurgery: The four-year Columbia experience                  | Michael Sisti, MD                     |
| 2:18-2:30 pm:  | <b>Discussion</b>                                                                                                                             |                                       |
| 2:30-2:42 pm:  | Trigeminal nerve stimulation enhances cerebral macro- and microcirculation after subarachnoid hemorrhage in rats                              | Raj Narayan, MD                       |
| 2:42-2:54 pm:  | Predictors of outcome from cranial dural arteriovenous fistulae hemorrhage: analysis of the CONDOR registry.                                  | Sepideh Amin-Hanjani, MD              |



|                       |                                                                                                                                                                                                          |                                |
|-----------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------|
| 2:54-3:06 pm:         | Perspectives from the other side: the role of academic neurosurgery in the modern medical school                                                                                                         | Lawrence Chin, MD              |
| 3:06-3:18 pm:         | The impact of work-related factors on risk of resident burnout: A global neurosurgery pilot study                                                                                                        | Daniel Felbaum, MD             |
| <b>3:18-3:30 pm:</b>  | <b>Discussion</b>                                                                                                                                                                                        |                                |
| <b>3:30-4:00 pm:</b>  | <b>Break with exhibitors</b>                                                                                                                                                                             | <b>Vendor Greeting Session</b> |
| 4:00-4:30 pm:         | Guest lecture                                                                                                                                                                                            | Jerry Rice                     |
| 4:30-4:42 pm:         | Integrating PROMs into daily practice                                                                                                                                                                    | Jason Schwalb, MD              |
| 4:42-4:54 pm:         | The first case of communicating hydrocephalus treated with an endovascular CSF shunt                                                                                                                     | Carl Heilman, MD               |
| 4:54-5:06 pm:         | Craniovertebral stabilization: Comparison of rigid instrumentation with modified galle construct using structural iliac crest autograft versus structural allograft packed with bone morphogenic protein | Ira Goldstein, MD              |
| 5:06-5:18 pm:         | <b>Discussion</b>                                                                                                                                                                                        |                                |
| 5:20 pm:              | Conclusion of scientific session                                                                                                                                                                         |                                |
| 5:30-6:30 pm:         | Shuttle to Whitefish Mountain Resort                                                                                                                                                                     |                                |
| 6:30-7:30 pm:         | Cocktails & Appetizers                                                                                                                                                                                   |                                |
| <b>7:30-10:00 pm:</b> | <b>Awards/Closing dinner</b>                                                                                                                                                                             |                                |



## 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 9.5 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

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## Those who have disclosed a relationship\* with commercial interests are listed below:

| <b>Name</b>        | <b>Disclosure</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | <b>Type of Relationship*</b>            |
|--------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------|
| Allan Levi, MD     | NIH/NINDS<br>AANS / Medtronic                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Department of Defense<br>Honorarium     |
| Carl Heilman, MD   | Cerevasc LLC<br>Cerevasc LLC                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Consultant Fee<br>Stocks or Shareholder |
| Carlos David, MD   | Kogent Surgical                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Stocks or Shareholder                   |
| Fady Charbel, MD   | Transonic, Inc                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Consultant Fee                          |
| Ian McCutcheon, MD | Ashbel Smith Professorship<br>endowment                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | University Grants/Research<br>Support   |
| Ira Goldstein, MD  | In Vivo Therapeutics, Randomized,<br>Controlled, Single-blind Study of<br>Probable Benefit of the Neuro-Spinal<br>Scaffold™ for Safety and Neurologic<br>Recovery in Subjects with Complete<br>Thoracic AIS A Spinal Cord Injury as<br>Compared to Standard of Care,<br>2020-present. AbbVie, Inc., A<br>Randomized, Double-Blind, Placebo-<br>Controlled Proof of Concept Study<br>to Assess the Safety and Efficacy of<br>Elezanumab in Acute Traumatic<br>Cervical Spinal Cord Injury, 2020-present<br>Pfizer Inc, STRIVE - A Phase 2b,<br>Randomized, Double-Blind, Placebo-<br>Controlled Study to Evaluate the<br>Safety and Efficacy of Staphylococcus<br>Aureus 4-Antigen Vaccine (SA4Ag) in<br>Adults Undergoing Elective Open<br>Posterior Spinal Fusion Procedures<br>with Multilevel Instrumentation, 06/2017-present | Industry Grant Support                  |
|                    | Globus Spine - active consulting<br>agreement<br>Alphatec Spine - ongoing consulting<br>agreement                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Consultant Fee                          |

|                     |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |                                                                                                                                                                             |
|---------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Jacques Morcos, MD  | KOGENT<br>Leica                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Stocks or Shareholder<br>Consultant Fee                                                                                                                                     |
| Jason Schwalb, MD   | Medtronic, Neuros, Stimwave<br>BlueRock, Guidant<br>ASSFN, OHSU                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Industry Grant Support<br>Consultant Fee<br>Honorarium                                                                                                                      |
| Kevin Cockroft, MD  | Salary support from BCBS of<br>Michigan paid directly to my<br>employer<br>Nico Corporation<br>Intersocietal Accreditation<br>Commission<br>Idorsia Pharmaceuticals, Ltd.<br>Portola Pharmaceuticals, Inc.<br>Penumbra, Inc.<br>Medtronic<br>Actuated Medical<br>Treasurer, ABNS<br>Vice Chair, NeuroPoint Alliance<br>Board of Directors, Intersocietal<br>Accreditation Commission                                                                                                                                                                                                                                                                                                                                                                           | Other Financial or Material<br>Support<br>Industry Grant Support<br>Consultant Fee<br>Stocks or Shareholder<br>Fiduciary Position [of any<br>organization outside the AANS] |
| Kim Burchiel, MD    | John Raaf Professor, OHSU<br>Co-PI on grant from Neurona<br>Therapeutics to study MGE cell<br>transplantation in Non-Human<br>Primates<br>Founder, Ceremod, Inc.<br>[not related to this presentation]                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | University Grants/Research<br>Support<br>Industry Grant Support<br>Fiduciary Position [of any<br>organization outside the AANS]                                             |
| Mitesh Shah, MD     | Stryker and Synaptiv                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Consultant Fee                                                                                                                                                              |
| Nicholas Boulis, MD | All work was conducted with funds<br>received from Above and Beyond, Inc<br>The owner of Above and Beyond<br>provided partial salary support for<br>Dr Boulis during the project.<br>Dr Boulis cofounded BrainTrust Bio,<br>which will seek to commercialize IT<br>Riluzole therapy. The intellectual<br>property for IT Riluzole therapy was<br>licensed from Above and Beyond and<br>Emory University into BTB. Note,<br>Dr. Boulis has received no payments<br>from BTB, but has invested his own<br>money into the company with the goal<br>of launching a Phase 1 Trial, to be<br>conducted by other investigators to<br>prevent Conflict of Interest under the<br>oversight of the Emory eCOI committee.<br>Dr Boulis is a founder of<br>BrainTrust Bio. | Industry Grant Support<br>Consultant Fee<br>Stocks or Shareholder<br>Fiduciary Position [of any<br>organization outside the AANS]                                           |

Raj Narayan, MD

NIH and DOD grants

Other Financial or Material  
Support

Stavropoula Tjoumakaris, MD Medtronic, Johnson and Johnson

University Grants/Research  
Support

**Those who have reported they do not have any relationships with commercial interests:**

Andrew Fanous, MD  
Christopher S. Ogilvy, MD  
Daniel Felbaum, MD  
Eric Zager, MD  
Felipe Albuquerque, MD  
Kenneth Smith Jr., MD  
L. Madison Michael II, MD  
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Sujit Prabhu, MD  
Walter Jean, MD

\*Felipe Albuquerque, MD  
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\*Sarah Rivers  
\*Stacie Clark  
\*Tagen Vine  
\*Tom Oritano, MD (Host)  
\*Willie Deering  
**\*educational content planners**



# Abstracts

## Resection of large vestibular schwannomas with inferior long axis microsurgical

*Mitesh Shah, MD*

**Authors:** Rick Nelson, M.D., Ph.D. Nathan T. Connell, MD Morgan M. Sandelski, MD Cyrus C. Rabbani, MD Jesse J. Savage, MD, PhD Mitesh V. Shah, MD

**Background:** Facial nerve (cranial nerve VII [CN7]) outcomes after vestibular schwannoma (VS) surgery depend on tumor size and higher rates of subtotal resection have been reported attempting to preserve CN7 function. The cisternal CN7 location relative to the tumor and the microsurgical dissection technique may impact both the degree of resection and the CN7 outcome.

**Objective:** Assess facial nerve outcomes in relation to the degree of resection and location of the cisternal CN7 using the inferior long-axis facial nerve dissection.

**Methods:** Retrospective single institution cohort study of patients with VS  $\geq 2.0$  cm measured parallel to the petrous ridge using the inferior long-axis facial nerve dissection. Degree of resection and CN7 outcomes at last follow-up were documented.

**Results:** Twenty-seven patients with a mean (SD) tumor size of 3.24 (0.89) cm. Nineteen (70%) received gross total resection, 5 near total resection and 3 subtotal resection. The cisternal CN7 location was (number of patients): anterior (10), anterior/superior (6), anterior/inferior (3), superior (5), not documented (3). House Brackmann (HB) grade I/II CN7 function was achieved in 74% of patients at average [SD] follow-up of 14.5.8 [11.5] months. CN7 was anatomically and electrophysiologically intact in 96%. One patient had immediate CN7 neurotomy resulting in HBIII-C. Facial nerve outcomes were not statistically different based upon CN7 location.

**Conclusions:** Microsurgical dissection of the cisternal CN7 using the inferior long axis technique leads to high rates of total or near total resection with excellent facial nerve outcomes and can be employed regardless of CN7 location.

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## Residual tumor volume in nonfunctional pituitary adenomas as a predictor of tumor recurrence: a volumetric study

*Ian McCutcheon, MD*

**Introduction:** Nonfunctional pituitary adenomas (NFPA) recur postoperatively in 25-60% of patients with pituitary neuroendocrine neoplasm. Analysis of impact of overall and sub-regional tumor volumes on postoperative recurrence is lacking for NFPA, but would help in predicting recurrence risk for individual patients after resection.

**Objective:** To establish the relationship of preoperative and postoperative tumor volumes and of extent of resection with risk of postoperative recurrence in patients with NFPA.

**Methods:** This single-institution study includes NFPA (n=276) operated 1993-2016 with follow-up > 1 year. Initial total tumor and cavernous sinus tumor volumes, postoperative residual volume, extent of resection, hormone immunostaining, Hardy-Wilson classification, and Knosp grade were assessed.

**Results:** Median follow-up was 60 months. Tumor recurred in 19.9% (median 33 months; IQR, 22-50 months). 61.2% underwent gross total resection (GTR). Recurrence occurred after GTR (9.5%) and subtotal resection (36.4%) ( $X^2 = 29.9$ ;  $p < 0.001$ ). Mean preoperative volume was 7.58 cm<sup>3</sup> (95% CI 6.3-8.9%), mean preoperative cavernous sinus tumor volume 0.51 cm<sup>3</sup> (95% CI 0.29-0.73%), mean residual volume 1.05 cm<sup>3</sup> (95% CI 0.6-1.5%); mean extent of resection 91.8% (95% CI 89.4-94.2%). At 5 years 36% with resection <85% were recurrence-free vs. 71% after resection >85% (log rank  $X^2 = 18.0$ ;  $p < 0.001$ ). Residual tumor >2 cm<sup>3</sup> progressed in 44% by 5 years vs. 17% with residual <2 cm<sup>3</sup> (log rank  $X^2 = 18.0$ ;  $p < 0.001$ ). Significant predictors of recurrence on univariate analysis included prior surgery, higher preoperative Knosp grades (3 and 4), invasive Hardy grades (3 and 4, D and E), and silent corticotroph adenoma.

**Conclusions:** Significant predictors of recurrence include larger overall and cavernous sinus tumor volume prior to surgery, as well as absence of adjuvant therapy. Residual NFPA volumes >2 cm<sup>3</sup> or extent of resection <85% should prompt additional resection, adjuvant treatment, or close monitoring; such tumors are most likely to progress within 5 years after surgery.

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## Comparative Exposure to the Petroclival Region Using Patient-Specific Meningioma Virtual Reality Models

*Walter Jean, MD*

Walter C. Jean MD<sup>1</sup>, Yang Yang MD<sup>2</sup>, Aneil Srivastava BS<sup>3</sup>, Alexander X. Tai MD<sup>4</sup>, Aalap Herur-Raman MS BME<sup>5</sup>, H. Jeffrey Kim MD<sup>6</sup>, Da Li MD<sup>2</sup>, Zhen Wu MD PhD<sup>2</sup>

<sup>1</sup>George Washington University, Department of Neurosurgery, Washington DC, USA

<sup>2</sup>Beijing Tiantan Hospital, Capital Medical University, Beijing, People's Republic of China

<sup>3</sup>Surgical Theater, Mayfield Village, Ohio, USA

<sup>4</sup>Georgetown University, Department of Neurosurgery, Washington DC, USA

<sup>5</sup>George Washington University, School of Medicine and Health Sciences

<sup>6</sup>Georgetown University, Department of Otolaryngology, Washington DC, USA

**Background:** Despite advancement of surgical techniques, the attachments of petroclival meningiomas near the central clival depression (CCD) remain difficult to visualize. Tumors distort the brainstem, changing the size of the operative corridor for some but not all approaches, so using cadavers with normal posterior fossa, comparisons of tumor exposure are impossible. To overcome this problem, we utilized patient-specific virtual reality models.

**Methods:** CT/MRI data from 15 patients with petroclival meningiomas were used to create anatomically-accurate virtual reality (VR) models. For each model, various surgical approaches were performed, and the surgical freedom to six targets of the regions were measured. Furthermore, portions of the tumor that were visually blocked by the brainstem or bony structures were segregated and recorded as "blinded volumes" for comparison.

**Results:** The extended retrosigmoid approach generated excellent exposure of the petroclival region, but for most specimens, there was inaccessible tumor volume adjacent to the brainstem (mean 641.3 mm<sup>3</sup>, SE: 161.8). In contrast, the brainstem sides of the tumors were well-visualized by all the transpetrosal approaches. The "blinded volume" of the tumor was largest for retrolabyrinthine approach, and this was statistically significant compared to all other approaches (mean 2381.3 mm<sup>3</sup>, SE 185.4).

**Conclusions:** This study utilized patients' imaging data to generate models for a laboratory study comparing surgical approaches. Since it is impossible to perform various approaches in separate surgeries on patients for comparison, VR represents a viable alternative for such comparative investigations.

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## Addressing pediatric neuro-oncology disparities in the US-Mexico border region: A cross-border initiative between San Diego, California and Tijuana, Mexico

*Michael Levy, MD*

**Background/AIMS:** Treatment of children with central nervous system tumors demands a complex, interdisciplinary approach that is extremely limited in low and middle-income countries, leading to major disparities in survival outcomes. In Mexico, cancer is the number one cause of death in children. To address these disparities, we established the Cross-Border Neuro-Oncology Program, between Rady Children's Hospital-San Diego (RCHSD) and Hospital General-Tijuana in Tijuana, Mexico to provide access to neuro-oncology care, including neurosurgical services, for children with CNST diagnosed at Hospital General-Tijuana. We describe the Cross-Border Neuro-Oncology Program implementation and clinical outcomes.

**Methods:** We prospectively assessed clinicopathological and imaging profiles, extent of resection, progression-free survival (PFS), and overall survival (OS) in children with central nervous system tumors at Hospital General-Tijuana.

**Results:** Eighty-five patients with a central nervous system tumor participated in the CBNP. Most common diagnoses were low-grade glioma (24.5%), medulloblastoma (22.4%) and other (28.6%). Sixty patients were amenable for surgery: 16 had resection at Hospital General-Tijuana and 69 at RCHSD. All patients who underwent resection at RCHSD returned back to Hospital General-Tijuana for further management. Gross-total resection (GTR) was achieved in 92% of cases at RCHSD and in 0% at Hospital General-Tijuana ( $P < 0.001$ ). Five-year overall survival (OS) improved from 0% in 2010 to 52% in 2017 at Hospital General-Tijuana. GTR was a predictor of 5-year OS (HR=0.250; 95% CI, 0.067-0.934;  $P = 0.024$ ).

**Conclusions:** The Cross-Border Neuro-Oncology Program facilitated access to comprehensive neuro-oncology, including complex neurosurgical services,

for underserved children across the U.S-Mexico border through binational exchanges of resources and expertise. Survival for patients who participated in the Cross-Border Neuro-Oncology Program dramatically improved. GTR at RCHSD was associated with higher Five-year overall survival, which highlights the critical role of experienced neurosurgical approaches in the treatment of central nervous system tumors. The Cross-Border Neuro-Oncology Program model offers a suitable option for children with central nervous system tumors in low and middle-income countries who require surgical resection, particularly those in close proximity to High-income country institutions capable of offering these complex services.

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### **The WEB device preliminary experience after FDA approval : feasibility and early results in 75 cases**

*Pascal Jabbour, MD*

**Background:** Wide-neck bifurcation cerebral aneurysms have historically required either clip ligation or stent/balloon-assisted coil embolization. This predicament led to the development of the Woven EndoBridge (WEB) Aneurysm Embolization System, a self-expanding mesh that achieves intrasaccular flow disruption and does not require antithrombotic medications.

**Objective:** To report our preliminary experience with our first 75 patients treated via WEB embolization.

**Methods:** We reviewed our first 75 consecutive patients with cerebral aneurysms who underwent WEB embolization after FDA approval from February 2019 -January 2020. We collected data on patient demographics and clinical presentation, aneurysm characteristics, procedural details, post-embolization angiographic contrast stasis, and functional outcomes.

**Results:** A total of 75 patients were included in our study (20 patients with acute SAH and 50 patients with unruptured aneurysms). WEB embolization was successful in 74 aneurysms with a complication occurring in 4 patients. Contrast clearance was seen in the arterial phase in 19.0% of aneurysms, in the capillary phase in 20.7%, in the venous phase in 46.6%, and no contrast seen in 13.8% of the aneurysms studied. 97.8% of the patients with an unruptured aneurysm were discharged without any new neurological deficits and 84.6% of patients with aSAH were discharged with either unchanged or improved mRS, The early occlusion rate was 82 %.

**Conclusion:** Our experience with the WEB device for endovascular aneurysm embolization has been successful with low complication rate. We discuss in detail technical considerations as well as the lessons learned from deployment, device size selection, and dealing with complications from our real-life experience.

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### **30-day emergency department utilization for chronic subdural hematomas following surgical evacuation with and without middle meningeal artery embolization**

*Felipe Albuquerque, MD*

**Background:** Middle meningeal artery (MMA) embolization for chronic subdural hematomas (cSDHs) has been found to be associated with fewer treatment failures compared to surgical evacuation. The present study compares 30-day emergency department (ED) utilization for patients with cSDHs with and without adjunctive MMA embolization.

**Methods:** All patients who presented with a cSDH to a quaternary center from January 1st, 2018 to December 31, 2020 were retrospectively reviewed. Patients were separated into two cohorts: surgery alone and combined surgery with MMA embolization. The surgery only cohort comprised of patients who presented during the first two years of the cohort. The combined surgery and MMA embolization cohort comprised of all patients with a combined treatment during the entire three-year study period. Patients in the combined cohort comprised of planned combined therapies, as well as patients who failed surgery and required MMA embolization. Primary outcome compared was 30-day ED presentation and readmission. Patients with bilateral treatment were analyzed for admission cSDH size.

**Results:** Of the 137 patients who met the study criteria, 28 patients (20%) had combined MMA embolization and surgery. In the 28 combined patients, 15 (54%) were planned MMA embolization and 13 (46%) were due to surgical failure. There was no difference between the two cohorts in mean age, gender, admission Glasgow Coma Score (GCS), discharge GCS, comorbidities, or previous trauma. The mean cSDH size on presentation in the surgery alone cohort (N=123, 20.5mm, sD 6.9) was comparable to the combined group (N=32, 18.7mm, sD 4.5) (p=0.16). A significant higher percentage of patients in the surgery alone (N=32, 29%) cohort presented within 30-days to the ED compared to combined MMA embolization



with surgery (N=2, 7%) (p=0.02). There was no significant difference in readmission rates between the surgery alone (N=16, 15%) and combined cohort (N=1, 4%) (p=0.11). Nine patients (8%) in the surgery alone cohort were readmitted due to significant reaccumulation/residual compared to only one patient (4%) in the combined group (p=0.4).

**Conclusion:** Combined MMA embolization and surgical evacuation in cSDH patients appears to be associated with decrease 30-day ED utilization compared to surgery alone.

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### Stroke and mechanical thrombectomy in patients with COVID-19: technical observations and patient characteristics

*Sean Lavine, MD*

**Background:** COVID-19 infections have been shown to be associated with a range of thromboembolic disease. Objective

To describe our endovascular experience in a consecutive series of patients with COVID-19 who presented with large vessel occlusions, and to describe unique findings in this population.

**Methods:** Mechanical thrombectomy was performed on five consecutive patients with COVID-19 with large vessel occlusions. A retrospective study of these patients was performed. Patient demographics, laboratory values, mechanical thrombectomy technique, and clinical and angiographic outcomes were reviewed.

**Results:** Four patients with COVID-19 presented with anterior circulation occlusions and one patient with COVID-19 presented with both anterior and posterior circulation occlusions. All patients had coagulation abnormalities. Mean patient age was 52.8 years. Three patients presented with an intracranial internal carotid artery occlusion. Two patients presented with an intracranial occlusion and a tandem thrombus in the carotid bulb. One patient presented with an occlusion in both the internal carotid and basilar arteries. Clot fragmentation and distal emboli to a new vascular territory were seen in two of five (40%) patients, and downstream emboli were seen in all five (100%) patients. Patient clinical outcome was generally poor in this series of patients with COVID-19 large vessel occlusion.

**Conclusion:** Our series of patients with COVID-19 demonstrated coagulation abnormalities, and

compared with our previous experience with mechanical thrombectomy in large vessel occlusion, this group of patients were younger, had tandem or multiple territory occlusions, a large clot burden, and a propensity for clot fragmentation. These patients present unique challenges that make successful revascularization difficult.

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### ICU care after endovascular treatment of unruptured intracranial aneurysms: Prevalence and predictors of ICU-specific needs.

*Kevin Cockroft, MD*

**Authors:** Varun Padmanaban, MD1; Michael Gigliotti, MD1; Sonia Majid, MD1; Chanju Fritch, MD1; Sprague W. Hazard, MD1,2; J. Christopher Zacko, MD1; Scott D. Simon, MD1; Ephraim W. Church1, MD; D. Andrew Wilkinson, MD1; Kevin M. Cockroft, MD, MSc1,3,4.

**Affiliations:** 1.Department of Neurosurgery, Pennsylvania State University College of Medicine, Penn State Milton S. Hershey Medical Center, Hershey, PA.  
2.Department of Anesthesia and Perioperative Services, Pennsylvania State University College of Medicine, Penn State Milton S. Hershey Medical Center, Hershey, PA.  
3.Department of Radiology, Pennsylvania State University College of Medicine, Penn State Milton S. Hershey Medical Center, Hershey, PA.  
4. Department of Public Health Sciences, Pennsylvania State University College of Medicine, Penn State Milton S. Hershey Medical Center, Hershey, PA.

**Background:** Efficient resource utilization is integral to cost-effective, safe and high-quality neurosurgical care. Multiple studies suggest routine post-operative intensive care unit (ICU) stays in high risk neurosurgical procedures may be unnecessary. However, this has not been well studied in patients undergoing neuroendovascular surgery. We sought to evaluate factors associated with ICU-specific needs in patients undergoing elective, endovascular repair of unruptured aneurysms.

**Methods:** A retrospective review of consecutive patients undergoing elective, endovascular repair of unruptured aneurysms was performed between January 2010 and January 2020 in a single academic medical center. Patient demographic information, aneurysm and treatment characteristics, intra-operative and post-operative complications, as well

as ICU-specific needs were abstracted. The primary outcome was ICU-specific needs.

**Results:** A total of 382 patient encounters in 344 unique patients were abstracted. ICU-specific needs were required in 13.6% (52/382) of patient encounters. The most common ICU specific needs were infusion of vasoactive medications (7.6%), specialized infusions (4.2%) and resuscitation after prolonged operative case (3.7%). The median number of ICU specific needs was 1 (range 1-7). Seventy-five percent of patients had an ICU specific need on admission to ICU. The majority of ICU-specific needs (94%) occurred within 6 hours of surgery. Multivariable analysis revealed that age (OR 1.04, 95%CI:1.01-1.07, p=0.03), procedure duration greater 200 minutes (OR 2.75, 95%CI:1.34-5.88, p=0.007) and any intra-operative complication (OR 20.41, 95%CI:7.97-56.57, p<0.001) were independent predictors of post-operative ICU-specific needs.

**Conclusion:** Our results show that the majority of ICU-specific needs occur in the immediate post-operative period and that age, procedure duration greater than or equal to 200 minutes and intra-operative complication were independent predictors of post-operative ICU-specific needs. These data can be utilized for more efficient and cost-effective postoperative level of care decision making and may help inform guidelines for optimal postoperative management in this patient population.

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## **The microsurgical management of unruptured middle cerebral artery aneurysms: Outcomes, complications, and durability**

*Carlos David, MD*

**Introduction:** Endovascular advances in the management of intracranial aneurysms have largely supplanted the role of open microsurgical management. The middle cerebral artery location has until recently remained a surgically treated aneurysm. Recent technological advances have now raised debate as to the primary role of surgery in the treatment of unruptured middle cerebral artery aneurysms. We aim to provide information on the overall efficacy, durability, and risks of open microsurgical repair of unruptured middle cerebral artery aneurysms by reviewing the results of a single surgeon series spanning over two decades.

**Methods:** All patients undergoing surgical treatment of unruptured middle cerebral artery aneurysms were identified from a prospectively collected database of

all aneurysms treated by a single surgeon between 1998 and 2021 and retrospectively analyzed. All procedures, including clipping, wrapping, and bypass with trapping were assessed. Previous failed endovascularly treated aneurysms were also included with attention to management of the previously placed coils. Aneurysm occlusion was assessed by DSA or CTA with a minimum of 1 year follow up. Glasgow outcome and Modified Rankin data, in addition to complications and mortality were collected on all patients.

**Results:** There were 172 aneurysms treated in 163 patients: 140 (82.8%) were small, 24 (14.2%) were large, 5 (2.96%) were giant, and 9 (5.2%) were previously coiled. Primary clip reconstruction was employed in 170 (98.8%), muslin wrapping in 2 (1.1%), and bypass employed in 3 (1.7%). Complete angiographic occlusion was obtained in 164 (95.3%), dog-ear residuals were noted in 8 (4.7%) of which none progressed on subsequent follow-up evaluation. Mean Follow-up interval was 36.3 months ranging from 12.0 to 199.7 months. The surgical morbidity rate was 5.8% and the 90-day mortality 1.1% for the entire series. When stratified by size the morbidity rate for small aneurysms was 3.6% and mortality 0.01%, for large aneurysms the morbidity and mortality were 12.5% and 4.2% respectively, and 20% morbidity and 0% mortality for Giant aneurysms. All ischemic stroke rate was found to be 5.8% with major stroke being 4.1% mainly in large and giant aneurysms. At final follow-up, 96.3% were modified Rankin (0-2) and 97.5% had achieved GOS (4-5) with 3.7% modified Rankin (3-6) and 2.5% GOS (1-3).

**Conclusions:** The microsurgical management of middle cerebral aneurysms can be performed with low morbidity and high efficacy particularly in the small aneurysm group. Durability is high with no significant recurrence on subsequent follow-up imaging. Open microsurgery for clipping of unruptured middle cerebral artery aneurysms demonstrates high occlusion rates with low complication rates and should be considered the primary treatment modality.

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## **Approaching complex posterior communicating aneurysms: anatomical comparison of the pretemporal trans-clinoidal and the pterional trans-sylvian routes**

*L. Madison Michael II, MD*

**Authors:** Basma, Jaafar; Moore, Kenneth A; Krisht, Khaled; Abuelem, Tarek; Michael II, Madison L II; Krisht, Ali F

**Introduction:** Posterior communicating (Pcom) aneurysms referred for surgical treatment in the modern era are becoming increasingly complex. The pretemporal transclinoidal approach (PTC) was found to decrease ischemic complications in ruptured Pcom aneurysms. However its anatomical advantages for the Pcom region have not been studied.

**Methods:** We dissected five cadaveric heads (10 sides) by performing a pterional (Pt) craniotomy followed by a PTC extension on each side. While selecting the origin of the Pcom artery as an exposure target, we measured the following variables: 1) exposed length of internal carotid artery (ICA) proximal to the Pcom artery, 2) exposed arc circumference of the supraclinoid ICA, 3) deep working area between the optic nerve and tentorium, 4) superficial working area, 5) fronto-temporal and 6) orbito-sphenoidal angles of exposure.

**Results:** The PTC approach increased the exposed length of the proximal ICA, and thus availability for proximal control, from 3.3 to 11.7mm ( $p=0.0001$ ). The deep and superficial working areas were widened from 53.7 to 92.4mm<sup>2</sup> ( $p=0.0048$ ) and 252.8 to 418.2 ( $p=0.0001$ ) respectively. The fronto-temporal and the spheno-sylvian angles augmented by 17 ( $p=0.0006$ ) and 10 ( $p=0.0037$ ) degrees. With the infero-lateral perspective, the exposed ICA circumference improved from 137 to 210 degrees, and the distal course of the Pcom and its perforators came into more direct view.

**Conclusions:** The PTC is a useful uninterrupted extension of the Pt approach for complex Pcom aneurysms. It provides an unhindered perspective to the Pcom artery origin and its distal course, easier proximal control, wider space and more potential clipping angles.

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## The Use of Fibrinogen Levels to Shorten the Post-Alteplase Window

*Mandy Binning, MD*

**Authors:** Natalie Gofman, Pharm.D. Global Neuroscience Institute  
Christina R. Maxwell, Ph.D. Global Neuroscience Institute  
Tonya Mattei, PA-C Global Neuroscience Institute  
Abhijith Bathini, BS Drexel University College of Medicine  
Bianca Marquez, MS Drexel University College of Medicine  
Zakaria Hakma, M.D. Global Neuroscience Institute

Kenneth Liebman, M.D. Global Neuroscience Institute  
Erol Veznedaroglu, M.D. Global Neuroscience Institute  
Mandy J. Binning, M.D. Global Neuroscience Institute

**Background and Purpose:** Intravenous alteplase is considered standard of care for treatment of appropriate patients with acute ischemic stroke (AIS). The most concerning complication of alteplase use is intracranial hemorrhage. It is common practice to wait 24 hours after alteplase administration to start antithrombotic therapy, work with physical therapy, or obtain blood draws. Current AHA/ASA guidelines recommend CT or MRI of the head 24 hours following alteplase administration and before initiation of antiplatelet/anticoagulation agents. This recommendation is not based on alteplase pharmacokinetics (half-life 5 minutes, terminal half-life 72 minutes) but rather the body's ability to form clot. We are seeking to decrease the 24-hour window by checking a marker of the blood's ability to clot, fibrinogen, at 8 hours.

**Methods:** The following pilot study looks at 2 groups of patients: Group A-Consecutive cases (controls) treated using the standard 24-hour protocol but had fibrinogen levels checked at 8 hours and Group B-The 8-hour protocol that allowed for early treatment and early mobilization if fibrinogen levels were greater than 150 ng/dL and brain imaging (CT/MRI) was negative for ICH at 8 hours. Both groups maintained blood pressure goals and every 1-hour neurological checks for 24 hours. Endpoints were symptomatic intracranial hemorrhage (sICH), systemic bleeding complications, or access site hematoma.

**Results:** Group A included 51 patients. The average fibrinogen level was 285. One patient had a sICH and another GI bleeding but was also found to have subsequent thrombocytopenia during the hospital course. Group B included 58 patients. The average fibrinogen level was 287. One patient had a large ICH. There were no additional bleeding complications.

**Conclusion:** This is the first early treatment protocol post alteplase for AIS using fibrinogen as a marker for bleeding risk, or lack thereof, following administration of alteplase. This study suggests that early mobilization and antithrombotic/anticoagulation therapy can be safely initiated in an abbreviated window.

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## Timing of carotid endarterectomy after intravenous thrombolysis and mechanical thrombectomy

*Martin Sames, MD*

**Authors:** Sames M., Orlicky M., Cernik D., Vachata P., Cihlar F.1 Department of Neurosurgery, J. E. Purkinje University, Masaryk Hospital, Usti nad Labem, Czech Republic 2 Department of Neurosurgery, University Hospital of L. Pasteur, Kosice, Slovak Republic

**Aim:** Aim of this study was to verify the safety of an early carotid endarterectomy (CEA) after intravenous thrombolysis (IVT) or mechanical thrombectomy (MT) in terms of hemorrhagic, ischemic, and other complications.

**Material and Methods:** 65 CEA patients were operated after the IVT or MT (from 1/2012-12/2019 at the Department of Neurosurgery, Usti nad Labem, Czech Republic). In a prospective study all mentioned complications were studied and their relationship to (a) timing of the procedure; (b) antithrombotic and statin therapy; (c) blood pressure; (d) imaging and other findings were evaluated.

**Results:** In the group where CEA followed IVT (a) within 6 h: 2 ischemic complications (3,08%) were noted – one periprocedural and one 12 h after CEA; (b) 6-12 h: one (1,54%) ischemic stroke 12 h after CEA; (c) 12-24 h: one (1,54%) ischemic stroke 16h after CEA; (d) 24-72 h: one (1,54%) ischemic stroke 10 h after CEA; (e) 3-14 days: zero complications; (f) over 14 days: zero complications. The total number of ischemic complications in the whole group was 7,7%. The only prognostic factor of postoperative ischemic complications was post-operative arterial hypotension ( $P=0,001$ ). No postoperative intracerebral hematoma (ICH) was noted.

**Conclusion:** Early CEA after IVT is justified to reduce the risk of recurrent stroke or carotid re-occlusion. We recorded a higher number of ischemic complications in the group where surgery followed IVT within 6 hours. It is necessary to verify the possible association of the procoagulant effect of thrombolysis by global testing of coagulation and fibrinolysis. Early CEA surgeries following IVT administration are not burdened with a higher risk of hemorrhagic complications. Nevertheless, in all cases before CEA, we recommend evaluating the size of the ischemia using DW MR. Early CEA is safer than emergent cervical carotid

stenting with iv antithrombotic agents (symptomatic ICH rate 20%) and than emergent stenting without antithrombotic agents (27% risk of acute stent thrombosis).

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## A critical reappraisal of the human corticospinal tract

*Allan Levi, MD*

The corticospinal tract (CST) is the pre-eminent voluntary motor pathway that controls human movements. The current presentation summarizes the evidence that there is no somatotopic organization of the corticospinal tract within the spinal cord in humans and as well as the critical importance of the CST for hand function. The evidence includes 1. data from central nervous system (CNS) tract tracing studies in both humans and non-human primates, 2. selective ablative studies of the CST in primates, 3. evolutionary assessment of the CST in mammals, 4. clinical and neuropathological examination of syndromes involving the CST after functionally incomplete spinal cord injury (SCI) with prominent arm and hand dysfunction.

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## Can a laminectomy prevent heart failure? The ligamentum flavum, the heart, and amyloidosis

*Ron Riesenburger, MD*

**Introduction:** Cardiac amyloidosis (CA) can be fatal without early diagnosis and treatment. A growing body of literature shows amyloid deposits in the ligamentum flavum (LF) are identical to cardiac amyloid deposits that cause life threatening CA. My center has previously reported a patient with transthyretin amyloid deposition in the heart and lumbar LF. This patient's stenosis symptoms preceded heart failure by several years. It is possible that pathological analysis of LF during laminectomy could identify patients at risk for development of CA.

**Methods:** An IRB-approved registry of patients who underwent spinal surgery had ligamentum flavum specimens analyzed with Congo-red staining, and, if indicated, typed for amyloid by mass spectrometry. Patients with positive specimens were offered clinical evaluation as standard of care including TTR gene sequencing and cardiac  $^{99m}\text{Tc}$ -PYP scintigraphy to assess for cardiac involvement.

**Results:** In 2018 and 2019, 324 patients underwent surgery for symptomatic spinal stenosis with pathological evaluation of the LF. Forty-three specimens (13%) harbored wild type

transthyretin amyloid. These patients had higher rates of non-ischemic cardiomyopathy and atrial fibrillation. Thirty-seven of the 43 patients underwent 99mTc-PYP scintigraphy, which resulted in a diagnosis of CA with initiation of medical treatment (tafamidis) in one patient. Scintigraphy results were equivocal or strongly suggestive of CA in 29 (9%) patients. These patients will be followed by cardiology for signs of CA.

**Conclusion:** This study reports the first known patient initiated on CA treatment as a result of LF analysis following laminectomy. Testing showed 9% of patients in this study may be at risk of CA. These at risk patients are being followed and I hope to report on them again in 5 and 10 years. This study suggests there may be an opportunity for neurosurgeons to help laminectomy patients beyond pain relief and functional improvement.

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### **Factors contributing to increased operative time and complications in surgery for thoracolumbar deformity correction: Implicating patient characteristics and associated clinical outcomes**

*Andrew Fanous, MD*

**Background:** Operative technique and operating room workflow both contribute to a wide variation in operative time for a given procedure in neurosurgery. While this is commonly recognized, no studies have examined or quantified the factors that influence operative times, or the clinical implications of this variation in operative durations.

**Methods:** We undertook an IRB approved, retrospective analysis of patients who underwent deformity surgery at our institution during a 12-year period. Patients  $\geq 18$  years of age undergoing surgery for correction of thoracolumbar scoliosis were included. After initial analysis, incidents of complications were compared between patients whose operative time was  $< 3$  hours compared to those with an operation lasting  $\geq 3$  hours. Binomial logistic regression was used to identify factors predictive of increased perioperative complications.

**Results:** A total of 476 patients were identified with an average operative time of 3.8 hours. 146 patients had a short operation ( $< 3$  hrs) and 330 had a long operation ( $\geq 3$  hrs). Patients who underwent a prolonged operation were noted to be significantly older ( $p < 0.001$ ). Intra-operatively, no statistically significant difference was seen between long and short operations in terms of the number of levels fused

(6.2 vs 5.6, respectively;  $p = 0.084$ ). Intra-operative blood loss and incidence of durotomies were among the statistically significant intra-operative factors associated with long operations (598 vs 539,  $p = 0.007$  and 13% vs 5.5%,  $p = 0.014$ ). After logistic regression, BMI and increased operative duration were the two patient characteristics noted to be significantly associated with iatrogenic durotomies ( $p = 0.038$  and  $< 0.001$ , respectively).

**Conclusion:** We quantitatively demonstrate that longer operative time is associated with increased risk of iatrogenic durotomy. Additionally, our study suggests that higher BMI is also associated with increased risk of iatrogenic durotomy. In turn, older age is a risk factor for prolonged operative time.

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### **Brachial plexus region tumors: Surgical approaches and complication avoidance**

*Eric Zager, MD*

**Background:** Tumors of the brachial plexus region pose significant challenges and risks for operative exposure and resection.

**Objective:** To describe our surgical strategies, operative approaches, surgical adjuncts and indications for collaboration with other surgical subspecialists.

**Methods:** We report a retrospective case series of brachial plexus tumors operated on by a single surgeon at a single institution over 15 years. Metastatic lesions or neoplasms adjacent to the plexus in the upper extremity were included. Medical records, radiological images, and operative reports were reviewed. Outcome data were recorded from the most recent follow-up office visit. Findings were compared to a prior internal series and comparable series in the literature over time.

**Results:** From 2001 to 2016, 103 consecutive brachial plexus tumors in 98 patients met inclusion criteria. Ninety percent of patients presented with a palpable mass, and 81% had deficits in sensation, motor function, or both. Benign nerve sheath tumors (NSTs) made up 68% of tumor types. Mean follow-up time was 10 months (range 1-127 months). Serious complications were infrequent. For patients with a pre-operative motor deficit, the rate of post-operative motor decline was 10%. For patients without a pre-operative motor deficit, the rate of post-operative motor decline was 35%, which decreased to 27% at 6

months. There were no differences in motor outcome based on extent of resection, tumor pathology, or age. Among patients with follow-up data regarding pain (n=85), 13 patients had no pain at presentation and two of these patients (2%) had worsened pain at follow-up after the surgery. Among patients with pain at presentation (n=72), after surgery, 48 patients (66%) had improvement or resolution of pain, 11 patients (16%) had unchanged pain, and 13 patients (18%) had worsening of pain.

**Conclusion:** Tumors of the brachial plexus region pose unique challenges for operative intervention. The surgeon must use cautious judgment regarding the indications for intervention, the operative approach, judicious use of surgical adjuncts and collaboration with other surgical subspecialists in selected cases.

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### **Factors influencing post-operative motor outcomes in patients with severe proximal peripheral nerve injury: A province wide cohort study**

*Rajiv Midha, MD*

**Background:** Despite the importance of timing of nerve transfer or graft after proximal peripheral nerve injury, optimal timing of intervention has not been clearly delineated in closed proximal peripheral nerve injuries. Consequently, many patients often present in a delayed manner for surgical intervention.

**Objectives:** This study explores factors, including time to surgical intervention that have a significant impact on clinical outcomes of patients with severe proximal peripheral nerve injury requiring reconstruction with nerve transfer or graft.

**Methods:** Adult patients who underwent peripheral nerve transfer or grafting in Alberta from 2005 to 2017 were reviewed. All patients had a minimum of one-year follow up, or earlier documented functional reinnervation after peripheral nerve surgery. A clustered multivariable logistic regression analysis was completed to examine the association of time to surgery, type of nerve repair, patient and injury characteristics on strength outcomes.

**Results:** In this sample of 129 patients, the mean (SD) time to surgery was 216 (107) days. For every week delay from injury to time of surgery, the adjusted odds of achieving a MRC strength grade  $\geq 3$  decreases by 3% ( $p=0.02$ ). If a patient received a nerve transfer, the adjusted odds of achieving antigravity strength was 388% when compared to nerve grafting ( $p=0.003$ ); while the adjusted odds decreased by 65% if the injury

sustained had a pre-ganglionic injury component ( $p=0.05$ ).

**Conclusions:** Mitigating delays in surgical intervention is crucial to optimizing outcomes. However, the nature of initial nerve injury and surgical reconstructive techniques are additional important factors that impact post-operative outcomes.

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### **Spinal cord and brain concentrations of riluzole after oral and intrathecal administration: a potential new treatment route for amyotrophic lateral sclerosis**

*Nicholas Boulis, MD*

Riluzole is the only treatment known to improve survival in patients with Amyotrophic Lateral Sclerosis (ALS). However, oral riluzole efficacy is modest at best, and dosing is limited by both hepatic toxicity and asthenia. We postulated that continuous intrathecal (IT) infusion of low doses of riluzole could provide consistent elevations of the drug spinal cord (SC) concentrations above those achieved with oral dosing, without increasing the risk for adverse events associated with systemic drug exposure or off-target side effects in the brain. We developed a formulation of riluzole for IT delivery and conducted our studies in purpose-bred hound dogs. Our non-GLP studies revealed that IT infusion alone was able to increase SC concentrations above those provided by oral administration, without increasing plasma concentrations. We then conducted two GLP studies that combined IT infusion with oral administration at human equivalent dose, to evaluate SC and brain concentrations of riluzole along with assessments of safety and tolerability. In the 6-week study, the highest IT dose (0.2 mg/hr) was well tolerated by the animals and increased SC concentrations above those achieved with oral riluzole alone, without increasing brain concentrations. In the 6-month study, the highest dose tested (0.4 mg/hr) was not tolerated and yielded SC significantly above those achieved in all previous studies. Our data show that IT riluzole infusion, alone or in combination with oral therapy, may safely enhance lower motor neuron neuroprotection and, with careful selection of IT doses, could be implemented in patients with ALS, hoping for improved efficacy. Based on this data, two humans were treated with IT Riluzole at the maximum tolerated dose (0.2 mg/hr) over a 2.5 year period. One patient, reported delayed onset of numbness in the feet at 2 years leading to termination of therapy. This complication profile justifies a Phase 1 Human Trial of IT Riluzole in ALS.

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## Venous occlusion, with optimal flow reduction, then total excision of cerebral AVMs (VORTEX)

*Charbel Fady, MD*

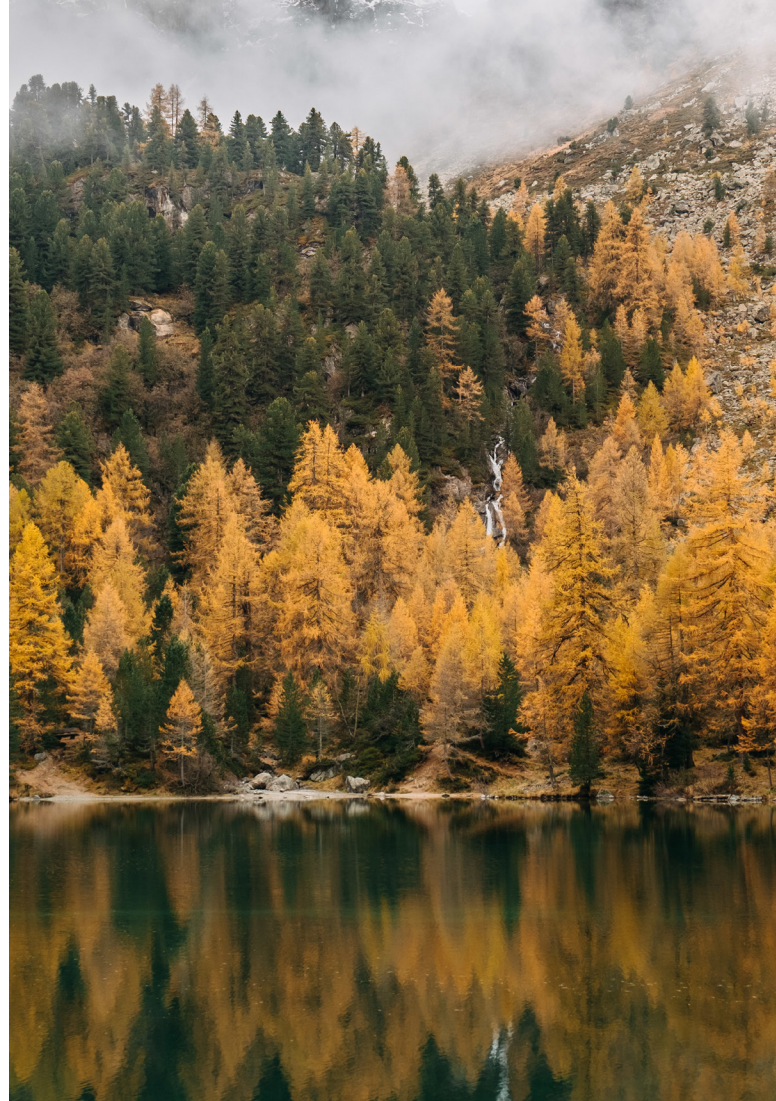
**Background:** The Endovascular transvenous approach to treat cerebral arteriovenous malformation (AVM) currently benefits from high consideration, yet selective success. While inherently and mechanistically attractive, it is hampered by various limitations, including: Difficulty of access, complications (vessel perforation, hemorrhage), inability to tackle large AVMs and potential residual nidus.

**Objective:** We sought to develop a method to fully capture the potential of the transvenous approach, yet systematically address its limitations and yield a definitive cure for Brain AVMs. We hereby describe our experience with the coordinated application of various tools to treat AVMs with a particular quantitative focus on the effects of flow. These entail flow-targeted arterial embolization, followed by a microsurgical approach to provide further flow-guided arterial inflow reduction, open venous catheterization and outflow control, bulk embolization and then complete resection of the AVM.

**Methods:** This is a retrospective review of radiographic and intraoperative imaging and videos of cases where the VORTEX technique was applied.

**Results:** Six patients with cerebral AVM were treated with the VORTEX technique. They represent a wide variety of presentations (headache without rupture, deficit from rupture, deficit from arterial steal phenomenon, deficit from surrounding edema and venous congestion, and deficit from associated seizure). Four patients underwent pre-operative embolization and achieved flow reduction to <150 mL/min without complication. All patients underwent successful transvenous embolization and resection of the AVM with no residual on post-operative angiography. One patient had complications of embolisate penetration into the internal cerebral vein with a sustained dense hemiparesis and modified Rankin scale of 4 compared to a pre-procedural mRS of 1. No other patient had any new change in mRS.

**Conclusion:** The VORTEX approach, combining physiological flow-guided therapies with Hybrid interdisciplinary application of microsurgical and endovascular transvenous techniques can resolve the limitations of each and greatly facilitate the definitive treatment of AVMs.



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## A single surgeon's series of 1D2R direct bypasses for moyamoya and ischemia

*Jacques Morcos, MD*

**Methods:** After receiving Institutional Review Board (IRB) approval, we reviewed hospital, office, and radiographic imaging records for all patients who underwent cerebral revascularization using a 1D2R bypass by the senior author (J.J.M). The patients' demographic information, clinical presentation, associated medical conditions, intraoperative information, and post-operative course were obtained from reviewing the medical records.

**Results:** A total of twenty-one 1D2R bypasses were performed in 19 patients during the study period. Immediate bypass patency was 100%, and 90% on delayed follow-up. The mean initial Cut Flow Index (CFI(i)) was 0.64 +/- 0.33 prior to the second anastomosis, and mean final value (CFI(f)) was 0.94 +/- 0.38 after the second anastomosis (p<0.001). The overall bypass flow increased on average by 50% (mean 17.9 ml/min, range -10 to 40 ml/min) with the addition of the second anastomosis. There was no

difference in the overall flow measurements when the end-to-side anastomosis or side-to-side anastomosis was performed first. There was a statistically significant difference in the proportion of patients with a mRS of 0 or 1 postoperatively compared to preoperatively ( $p < 0.01$ ). Through the application of Poiseuille's law, we analyze flow dynamics, deduce the component vascular resistances based on analogy to electrical circuits and Ohm's Law, and introduce the new concepts of SARA and SASI in the evaluation of 1D2R bypasses.

**Conclusion:** The application of the 1D2R technique in a series of 21 consecutive patients undergoing direct EC-IC bypass for flow augmentation demonstrated high patency rates, statistically significantly higher cut-flow indices compared to 1D1R, and improved mRS scores at last clinical follow up. Additionally, the technique allows a shorter dissection time and preserves blood flow to the scalp. The routine utilization of intraoperative volumetric flow measurements in such surgeries allows a deeper understanding of the hemodynamic impact on individual patients.

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**Zebras in the mist. Unique cases encountered by neurological surgery in a semi-rural environment: neurosurgical aspects of bear attack, exercised para-spinal compartment syndrome, and post hip arthroplasty with bilateral C5/6 palsy.**

***TC Origitano, MD***

**Authors:** Kelly S Schmidt MD, TC Origitano MD PhD  
Department of Neurological Surgery  
Neuroscience and Spine Institute  
Logan Health  
Kalispell, Montana

Neurological Surgery is currently in an era of ever increasing sub-specialization and selective referral patterns. Neurological Surgeons in rural and semi-rural areas are often called upon to utilize skills across the scope of neurosurgical specialties and require significant neurologic diagnostic/medical skills. Three cases will be presented:

**Bear Attack:**

A 28 year old woman engaged in studying grizzly bear behavior was mauled by a male grizzly bear. Neurosurgical treatment was based on the unique aspect of the mechanism of bear attacks related to their behaviors, unique aspects of their microbiological pathogens, and secondary injury patterns.  
**Exercise induced paravertebral compartment syndrome**

A 21 year old female presented with increasing and intractable back pain after enrollment evaluation work up at a local gym. Her neurological examination was intact and non-focal except for pain to palpation of her low back. Serum cpk was 10,000 at admission rapidly climbing to 40,000 over subsequent days. Diagnostic work up and management will be discussed.

**Bilateral C5 and C6 palsy after a Anterior Approach Hip Replacement**

A 65 year old male woke up from a routine anterior approach hip replacement with bilateral profound C5 and significant bilateral C6 palsy. Mechanism of injury, diagnostic evaluation and treatment will be presented.

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## **History of SUN**

***Kenneth R. Smith, MD***

Dr Smith will discuss the founding of the SUN organization and present images of the initial years of SUN.

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## **Cellular transplantation: Neurorestoration for mesial temporal lobe epilepsy and other neurological disorders**

***Kim Burchiel, MD***

**Authors:** Kim J. Burchiel, M.D.<sup>1</sup>, Virginia Cuzon Carlson, Ph.D.<sup>2</sup>, Cory R. Nicholas, Ph.D.<sup>3</sup>, Christopher Kronke, Ph.D.<sup>2</sup>, Andrew Adler, Ph.D.<sup>3</sup>, Luis Fuentealba, Ph.D.<sup>3</sup>, Seonok Lee, Ph.D.<sup>3</sup>, Sonja Kriks Ph.D.<sup>3</sup>, Gautam Banik, Ph.D.<sup>3</sup>, Catherine Priest, Ph.D.<sup>3</sup>, and Ann Mitchell, B.S.<sup>1</sup>

<sup>1</sup>Department of Neurological Surgery, Oregon Health and Science University, Portland, OR.

<sup>2</sup>Oregon National Primate Research Center, Oregon Health and Science University, Portland, OR

<sup>3</sup>Neurona Therapeutics, San Francisco, CA

**Introduction:** Functional Neurosurgery has in the past relied on neuroablative procedures for the treatment of epilepsy, pain and movement disorders. In the past five decades, neuromodulation for all of these disorders has become an important adjunct to ablation. While attempts at neurorestoration have a history in all of these areas, restorative therapy has achieved minimal, if any, success. Based on recent research methods and discovery, neurorestoration is now likely within reach.



**Summary:** Medial ganglionic eminence (MGE) precursor cells are the source of most interneurons and early myelin-forming glia in the developing forebrain. MGE-type cells can be derived in vitro from human pluripotent stem cell lines and their fate directed down the pathway of GABAergic inhibitory interneurons for the purpose of cellular transplantation. Proof of concept safety and efficacy have been demonstrated in a rodent model of mesial temporal lobe epilepsy (MTLE). Following delivery into the hippocampus, the human cells distributed on-target, persisted long-term, matured into pallial-type interneuron sublineages, silenced focal seizures, and reduced hippocampal pathology. These results will be reviewed as well as recent results from the implantation of human interneurons into the nonhuman primate (NHP) hippocampus.

**Results:** 15 NHPs (Macaque) were implanted with human MGE-type interneuron cells or control vehicle injections in an iMRI unit. All animals were immunosuppressed prior to implant and during the survival period. The trajectory of implantation used a parieto-occipital approach to achieve a 1.0-1.5 cm linear injection in the anterior section and body of the left hippocampus. Image-guidance was used to obtain these trajectories. MRI was used to additionally confirm the on-target human cell delivery. There were no serious operative or postoperative complications, and necropsy was performed on schedule for all animals. Histology on these NHPs was acquired from 0-30 days post-implant.

**Conclusions:** These results echo earlier work in rodents, demonstrating that human MGE-type interneurons can be safely and effectively transplanted into the NHP hippocampus. Moreover, this is the first demonstration, to our knowledge, using a clinically-relevant MRI-guided imaging system to deliver cells into the primate hippocampus from a parietal-occipital entry point in resemblance to the approach used in laser interstitial thermal therapy (LITT) for drug-resistant MTLE. These data support further development of human interneuron cell therapy (NRTX-1001) toward a potential clinical trial in people with drug-resistant MTLE.

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## Unsupervised machine learning can delineate the central sulcus by using the spatio-temporal characteristic of somatosensory evoked potentials

**Sujit Prabhu, MD**

Unsupervised Machine Learning Can Delineate

the Central Sulcus by Using the Spatio-Temporal Characteristic of Somatosensory Evoked Potentials  
Sujit Prabhu<sup>2</sup>, Priscella Asman<sup>1</sup>, Dhiego Bastos<sup>2</sup>, Sudhakar Tummala<sup>2</sup>, Sheryes Bhavasar<sup>3</sup>, Thomas McHughe<sup>3</sup> and Nuri F. Ince<sup>1</sup>

<sup>1</sup> Department of Biomedical Engineering, University of Houston, Houston, TX, USA

<sup>2</sup> Department of Neurosurgery, UT MD Anderson Cancer Center, Houston, TX, USA

<sup>3</sup> Department of Anesthesiology, UT MD Anderson Cancer Center, Houston, TX, USA

**Objective:** Somatosensory evoked potentials (SSEPs) recorded with electrocorticography (ECoG) for central sulcus (CS) identification is a widely accepted procedure in routine intraoperative neurophysiological monitoring. Clinical practices test the short-latency SSEPs for the phase reversal over strip electrodes. However, assessment based on waveform morphology is susceptible to variations in interpretations due to the localized nature of the hand area and, usually requires multiple electrode placements or electrode relocation. We investigated the feasibility of unsupervised delineation of the CS by using the spatiotemporal patterns of the SSEP captured with ECoG grid. Approach. Intraoperatively, SSEPs were recorded from 7 patients using ECoG grids placed over the sensorimotor cortex. Neurosurgeons blinded to the electrophysiology identified the sensory and motor gyri using neuronavigation based on sulcal anatomy. We visualized the amplitude gradient of the SSEP over a 2D heat map and, using Fisher discrimination criterion, we quantified the most discriminative time points in its temporal profile that distinguishes between primary motor (M1) and somatosensory (S1) cortex. Subsequently, we employed spectral clustering on the temporal profile of the SSEP without selecting any time points and grouped ECoG channels in an unsupervised fashion. Main results. Consistently in all patients, two distinct time points provided almost equal discrimination between anterior and posterior channels, which vividly outlined the CS when the SSEP amplitude distribution is viewed as a spatial 2D heat map. The first discriminative time point was in proximity the conventionally favored ~20ms peak (N20) and the second time point was slightly later than the markedly high ~30ms peak (P30) but the location of these time points varied noticeably across subjects. The unsupervised clustering approach separated the anterior and posterior channels with an accuracy of 93.97% based on the time derivative of SSEP trace whereas the raw trace resulted in an accuracy of 81.64%. Significance. We show that the unsupervised

clustering of the SSEP from subdural electrode grids can delineate the CS automatically with high accuracy, and constructed maps can be used to localize the motor cortex. We anticipate that spatiotemporal patterns of SSEP fused with machine learning can serve as an effective tool to assist in surgical planning.

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## Robotic carotid stenting

*Stavropoula Tjoumakaris, MD*

**Objective:** The objective of this study was to validate the feasibility and safety of CorPath GRX robotic-assisted (RA) carotid artery stenting (CAS) compared with manual CAS.

**Methods:** A retrospective analysis of a prospectively maintained database included 25 consecutive patients who underwent CAS. A matched analysis was conducted between 10 procedures completed via RA to 15 procedures completed via a manual approach.

**Results:** Among 10 patients in the RA group with a mean age of  $69.8 \pm 10.2$  years, technical success was achieved in all 10 (100%) procedures; there were no technical or access-site complications. Transfemoral conversion was required in 1 (12.5%) case due to a tortuous aortic arch. There were no perioperative complications, including myocardial infarction, stroke, and mortality. The mean procedure duration ( $85.1$  minutes  $\pm 12.7$  vs  $56.4 \pm 19.4$  minutes,  $p = 0.001$ ) and fluoroscopy time ( $20.51 + 7.4$  vs  $28.9 + 6.5$ ,  $p = 0.007$ ) was significantly longer in the RA group. There was no significant difference in baseline characteristics, contrast dose, radiation exposure, technical success, transfemoral conversion, technical complications, myocardial infarction, stroke, other complications, or mortality.

**Conclusions:** The data demonstrates that RA CAS is feasible, safe, and effective. Further refinement is needed prior to complete remote control. Future clinical investigations among larger cohorts are needed to demonstrate reliable performance and patient benefit.

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## The changing face of gamma knife radiosurgery and the impact of masked based radiosurgery: The four-year Columbia experience.

*Michael Sisti, MD*

More than 6000 Gamma Knife radiosurgery procedures have been performed at NYP/Columbia since 1998

by 15 neurosurgical attendings for a wide variety of radiosurgery indications. Before 2017 all of these treatments were done in the Leskell stereotactic headframe in a single treatment fraction. Since the introduction of the Icon thermoplastic masked based treatment option in 2017 at NYP/Columbia the majority of patients are now being treated in the mask in either a single or multiple treatment sessions. The 625 unique patients treated since 2017 with the Icon mask now represent 53% of all patients treated in our center. The transition to mask-based treatments is due to many factors but the ease, accuracy and possibility of treating larger lesions with a higher dose of radiation has expanded the acceptance and indications of radiosurgery and offers new opportunities to treat lesions that cannot be readily achieved in a single fraction frame-based treatment. Our preliminary experience with the mask-based system in the treatment of brain metastases, acoustic neuromas, skull-based tumors and glioblastoma will be discussed as well as some of the limitations we have encountered with the Icon system and how this changed the face of radiosurgery at our institution.

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## Trigeminal nerve stimulation enhances cerebral macro- and microcirculation after subarachnoid hemorrhage in rats

*Raj Narayan, MD*

**Authors:** Chunyan Li and Raj Narayan

**Introduction:** Delayed cerebral ischemia (DCI) can be a very consequential secondary insult after aneurysmal subarachnoid hemorrhage (SAH). It is a multifactorial process caused by a combination of large artery vasospasm and microcirculatory shut-down. Despite numerous efforts, no effective pharmacological strategies are yet available to prevent DCI, arguing for a new approach that preferably targets both the macro- and microcirculation. The trigeminal nerve richly innervates cerebral blood vessels via connections to brainstem nuclei resulting in intrinsic control of cerebral perfusion and systemic control of autonomic function. Therefore, electrical trigeminal nerve stimulation (TNS) may be able to enhance cerebral circulation. The present study was undertaken to assess the efficacy of TNS to restore impaired cerebral macro- and microcirculation in a rat model of SAH.

**Methods:** An endovascular perforation model was used to induce SAH in male Sprague-Dawley rats. A bipolar electrode was inserted percutaneously into the left infraorbital nerve and rectangular biphasic pulses

were delivered (50Hz, 0.5–2.5V) for 1 minute every 10 minutes over a 60-minute stimulation session. 48 hours after SAH induction, cerebrospinal fluid was drawn for calcitonin gene-related peptide (CGRP) measurement. Transcardiac perfusion of the brain was performed and the brains were serially cryosectioned. Vessel lumen diameters were measured in the internal carotid (ICA), middle cerebral (MCA) and anterior cerebral (ACA) arteries and vessel wall thickness was recorded in cortical pial arterioles. Microthrombi were identified and counted manually in H&E sections of the cortices.

**Results:** CGRP is a vasodilatory molecule secreted by trigeminal nerve endings in response to vasoconstriction and is a key regulator of cerebrovascular tone. TNS increased CGRP levels by 118.5% and 333.3% compared to SAH-control and sham rats, respectively. Luminal diameters of the ICA, MCA, and ACA in SAH-control rats were reduced by 22.9%, 35.7%, and 30.2% respectively, compared to sham rats. Treatment with TNS significantly increased luminal diameters of the ICA, MCA, and ACA by 33.3%, 59.7% and 61.1%, respectively. Pial arteriole wall thickness was significantly increased after SAH when compared to sham rats, while treatment with TNS decreased this. Further, SAH-control rats demonstrated a 4.9-fold increase in microthrombi, compared to sham rats, with a 2.5-fold decrease with TNS.

**Conclusion:** Our results strongly suggest that TNS can ameliorate vasospasm of large arteries, reduce micro-vasospasm of cortical arterioles and decrease intravascular micro-thrombosis formation. This study highlights the importance of further exploring TNS as a new strategy for the treatment of SAH.

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### **Predictors of outcome from cranial dural arteriovenous fistulae hemorrhage: analysis of the CONDOR registry.**

*Sepideh Amin-Hanjani, MD*

**Introduction:** Dural arteriovenous fistulae (dAVF) are a source of secondary intracranial hemorrhage (ICH). Although natural history studies have examined predictors of hemorrhage risk, there is a paucity of knowledge regarding outcomes following dAVF hemorrhage. CONDOR, (Consortium for Dural Arteriovenous Fistula Outcomes Research), a large multi-institutional retrospective registry, provides a unique opportunity to evaluate the outcomes of patients presenting with dAVF-related hemorrhage.

**Methods:** We performed a retrospective review

of 1077 dAVF patients from the CONDOR registry and selected those patients who presented with hemorrhage secondary to the dAVF. Patient characteristics, clinical presentation/follow-up, and radiographic details were analyzed for associations with patient outcomes. An outcome of mRS 0-2 was categorized as a “good” outcome and 3-6 as “poor”. Univariable and multivariable analysis was performed to examine predictors of poor outcome;  $P < .05$  was marked as the level for statistical significance.

**Results:** The CONDOR dataset yielded 262 patients presenting with hemorrhage. The mean age of the population was  $59 \pm 13$  y.o, 30% were female. The median follow-up was 1.4 years. The overall mortality was 3.6% (95% CI 1.3%-6.0%) at follow-up; 83% of patients had a good outcome (mRS 0-2). On univariable analysis age ( $p=0.001$ ), anticoagulant use ( $p=0.009$ ), and recurrent hemorrhage ( $p=0.02$ ) were associated with poor outcome at follow-up. Subtype of hemorrhage (parenchymal hemorrhage or subarachnoid hemorrhage), venous drainage pattern (i.e. Cognard grade), type of treatment, and fistula location did not reach statistical significance. On multivariable analysis age  $>65$  (OR 2.3, 95% CI 1.1-4.8,  $p=0.02$ ), anti-coagulant use (OR 5.1, 95% CI (1.2-22.2,  $p=0.03$ ) and recurrent hemorrhage (OR 7.6, 95% CI 1.6-36.8,  $p=0.01$ ) were associated with poor outcome.

**Conclusion:** Within the largest individual patient series to date, we found that dAVF presenting with hemorrhage was associated with a lower risk of morbidity and mortality than other arterialized cerebrovascular pathologies, but still at clinically consequential rates. Older age, anticoagulant use at presentation, and recurrent hemorrhage were most strongly predictive of outcome.

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### **Perspectives from the other side: the role of academic neurosurgery in the modern medical school**

*Lawrence Chin, MD*

The perspective of a neurosurgeon who is now a medical school dean will be explored. The priorities of medical schools have evolved over time, and I will explore several themes that define the future direction of US medical schools. The role of neurosurgeons in each area will be examined. Topics in diversity and health disparities, medical student and resident education, research development, and medical school and practice plan finances will be identified and discussed.

## The impact of work-related factors on risk of resident burnout: A global neurosurgery pilot study

*Daniel Felbaum, MD*

**Objective:** To examine the risk for burnout in neurosurgery trainees across the globe to compare work-related factors that may contribute to burnout and to determine if there are international differences.

**Methods:** A 16-question survey was designed and broadcasted through social media networks of global neurosurgeons. The first half of the survey examined work-related factors that may contribute to burnout. The second half studied the respondents' attitudes and emotional responses toward their training, patients, and work environment.

**Results:** There were 797 responses to the survey from 93 countries, and 243 of those were from countries designated as low- to middle-income countries. Of respondents, 20.7% scored in the range designated at risk for burnout. Logistic regression analysis showed that frequency of on-call duty and total work hours were drivers for burnout in the global cohort, but operative caseload may have a protective effect. Intercontinental comparisons revealed that the United States and Canada had the lowest proportion of trainees at risk for burnout (11.2%), whereas Europe had the highest (26.9%). Trainees from low- to middle-income countries worked more hours and on-call shifts than their global colleagues, but their average total burnout score (15.8) and proportion at risk for burnout (20.7%) were identical by global comparison.

**Conclusions:** Risk for burnout in neurosurgery residents and fellows is driven by multiple factors, including personal, demographic, programmatic, and institutional. Among work-related factors, long and frequent shifts were found to contribute to the risk of burnout in the global cohort. The regional variabilities in the impact of these factors are discussed.

## Integrating PROMs into daily practice

*Jason Schwalb, MD*

Patient-reported outcome measures (PROMs) are important metrics to support clinical research and quality improvement for academic departments, as well as serving as marketing tools and supporting negotiations with insurers. However, collection of these data can be time and resource intensive. Along with our colleagues in Orthopedics and Cancer Care, we have eliminated paper intake forms and increased our collection of patient-reported outcome measures (PROMs). Our team redesigned appointment scheduling algorithms, which allowed us to automatically push PROMs through Epic at specified time points in patients' care journey. We went live in January 2021 and already have 80-95% completion rates at our various sites. This talk will describe the infrastructure and process for developing low-cost systems to collect these data.

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## The first case of communicating hydrocephalus treated with an endovascular CSF shunt

*Carl Heilman, MD*

**Authors:** C. Heilman, M.D., A. Malek, M.D., Ph.D., P. Lylyk, M.D., I. Lylyk, M.D., C. Bleise, M.D., E. Scrivano, M.D., P. Lylyk, M.D. Division of Neurosurgery, ENERI Medical Institute, Equipo de Neurocirugia Endovascular y Radiologia Intervencionista, Buenos Aires, Argentina PL, IL, CB, ES, PL), Department of Neurosurgery, Tufts Medical Center, Boston, MA 02111 USA (CH, AM)

**Introduction:** VP shunt placement for communicating hydrocephalus has changed very little over the past 60 years. A new CSF shunt device has been developed that can be inserted by a percutaneous endovascular approach. A clinical trial in patients with post SAH hydrocephalus is underway in Buenos Aires. This abstract will present the first patient treated in this trial.

**Methods:** An 84-year-old woman with SAH, HH score III was treated for a ruptured MCA aneurysm with coils. A head CT scan showed ventriculomegaly and an EVD was placed. An EVD clamp trial on day 9 showed ICP reaching 44 cmH<sub>2</sub>O. On day 10 after EVD placement she underwent placement of a CSF shunt from the CP angle cistern to the jugular vein by an endovascular approach. General anesthesia was used. Venous access was obtained using standard femoral access.



Navigation of the device delivery system to the inferior petrosal sinus was guided by cone-beam CT (XperCT, Philips). The ideal location for placement of the device along the inferior petrosal sinus was determined by 3D X-ray (SmartCT Angio, Philips). This 3D image was overlaid on real-time 2D fluoroscopy, which provided guidance while deploying the Implant in the target area using 3D road-mapping (Dynamic 3D Roadmap, Philips). The Implant was deployed without difficulty.

**Results:** The patient's EVD was closed eight hours prior to the procedure. ICP immediately prior to Implant deployment was 38 cmH<sub>2</sub>O. Following implant placement the ICP began to decrease immediately, reaching normal levels (< 20 cmH<sub>2</sub>O) within 90 minutes post-procedure. A post implant CT scan showed no evidence of new blood in the CP angle cistern. The patient's ICP was monitored by the EVD for 39 hours after the procedure and remained normal until the EVD was removed. An MRI six days post-procedure showed a reduction in the size of the lateral and third ventricles. On MRI, the implant was visible in the CPA cistern and jugular vein, with no evidence of image distortion. Normal venous blood flow was visible through the IPS and IJV around the Implant.

**Discussion:** We describe the first patient treated for communicating hydrocephalus using a novel endovascular CSF shunt. Following device deployment the patient experienced a rapid and persistent reduction of ICP to normal levels (<20 cmH<sub>2</sub>O), coupled with a reduction in ventricular size. No bleeding was identified at the deployment site and no adverse effects related to the device or procedure were observed during the two week follow-up period. To our knowledge, this represents the first account of any patient with communicating hydrocephalus being treated with a minimally-invasive CSF shunt system, without the need for a burr hole, brain penetration or multiple skin incisions.

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### **Craniovertebral stabilization: Comparison of rigid instrumentation with modified galle construct using structural iliac crest autograft versus structural allograft packed with bone morphogenic protein**

*Ira Goldstein, MD*

**Object:** Occipitocervical stabilization and fusion techniques have greatly evolved over the past 3 decades with improving rates of successful arthrodesis. The author has utilized structural graft with a modification of C1-2 Gallie wiring to enhance the

stiffness as well as the graft loading to improve fusion rates.

**Methods:** A retrospective case series of the author's use of structural autograft from the occiput to C2 lamina/spinous process (2004 to 2014) was compared to the author's subsequent use of structural allograft packed with bone morphogenic protein from the occiput to C2 lamina/spinous process (2014 to present). These two case series are compared for operative duration, fusion rate, and postoperative pain. Fusion was determined by dynamic cervical radiographs and in some cases by CT as well.

**Results:** 34 patients underwent occipitocervical fusion between 2005 and 2014 with rigid occipital plate and polyaxial screw fixation instrumentation, supplemented by structural iliac crest autograft from the occiput to C2, with Songer cable fixation to apply the graft material in place. Between 2014 and 2020, an additional 36 patients underwent occipitocervical fusion with rigid occipital plate and polyaxial screw fixation instrumentation, supplemented by structural fresh frozen fibula allograft packed with a small Infuse bone morphogenic protein graft from the occiput to C2, with Songer cable fixation to apply the graft material in place. Operative time was faster in the allograft group (mean 3.6 vs 4.1 hours,  $p < 0.05$ ). Estimated blood loss was lower in the allograft group (mean 175 vs 320 ml,  $p < 0.01$ ). Assessment of solid fusion by the last followup was similar between the two groups (94.2% vs 97.2%, NS). Only one case of instrumentation revision was performed – in a patient in the allograft group with osteogenesis imperfecta with extremely poor bone density and volume. Two cases of reoperation for graft donor site hematoma were performed, in addition to an additional case of bowel hernia at the donor site. Postoperative donor site pain was noteworthy (>3/10 in 62% of patients).

**Conclusion:** Occipitocervical fusion rates were extremely favorable in both groups. The use of structural graft from the occiput to C2 likely enhances fusion rates in addition to stiffness compared to rigid instrumentation with the use of nonstructural posterolateral graft alone. The use of structural uncortical iliac crest autograft compared to fibula allograft packed with bone morphogenic protein seem to demonstrate similar fusion rates. Costs are lower with the use of autograft but may be offset by the increase in operative duration, blood loss, and postoperative donor site pain. Further investigation into patient risk factors for perioperative complication and pseudoarthrosis should help further clarify the cost versus benefit of these graft choices.

**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 shall recommend 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, and

Secretary/Treasurer. The Executive Council shall be composed of the officers, one Active Member-at-Large, 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 be elected at each annual meeting. He/she shall assist the President. He/she shall preside at functions and meetings 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 Neurosurgeons yearbooks, which should document the scientific and social programs of the yearly meeting.

Section 10. The Member-at-Large shall be elected at each annual meeting. He/she shall serve on the Executive Council and participate in all the deliberations thereof.

## 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 be determined each year by the Executive Council.

Section 2. Dues are payable in advance for the succeeding year at the time of or immediately following 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 By-laws 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 meetings and 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 considered for termination. 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.

Section 4. A person whose membership has been terminated for non-payment may make a formal written request to the Secretary/Treasurer for reinstatement. Membership in the prior class may be reinstated (1) once the former member pays two years of dues unpaid for the years prior to his/her termination; (2) is ap-



proved for reinstatement by the Membership Committee; (3) is approved by the Executive Committee; and (4) receives an affirmative vote for reinstatement of three-fourths (3/4) of the Active membership at the annual meeting.

## **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 next annual 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. Each individual guest attending the meeting shall pay the same registration fees as do the members that attend.

## **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 two (2) SUN meetings and presented at least one (1) paper to the Society to be eligible for election to membership. A candidate for membership must attend the meeting during which he/she is being presented and voted upon for induction into the Society.

(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. Voting for membership may occur at the second meeting the candidate attends as a guest, or any meeting the candidate attends subsequent to the second meeting.

(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.



# Exhibitors

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## PLATINUM

Penumbra

Medtronic

Stryker

Longeviti

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## GOLD

ZEISS

Depuy

Globus

Altus-Spine

MIZUHO America

Logan Regional Hospital

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## SILVER

Logan Health Community Relations



American  
Association of  
Neurological  
Surgeons

Jointly Provided by the AANS



THE SOCIETY  
OF UNIVERSITY  
NEUROSURGEONS