

Western Neurosurgical Society

*The Hyatt Tamaya,
Santa Ana Pueblo,
New Mexico*

67th Annual Meeting, September 10 - 13, 2021



Calendar of Events		
Friday, September 10 th , 2021		
12:00 PM – 04:00 PM	Executive Committee Meeting	Council Room
12:00 PM – 11:00 PM	Exhibitors Setup	Tamaya F,G,H
02:00 PM – 05:00 PM	Registration	Tamaya Prefunction
06:30 PM – 09:30 PM	Welcome Reception	Tamaya Veranda
Saturday, September 11 th , 2021		
06:30 AM – 07:45 AM	Breakfast with Exhibitors	Tamaya F,G,H
06:45 AM – 11:15 AM	Registration	Tamaya Prefunction
07:45 AM – 07:50 AM	President's Welcome	Tamaya E
07:50 AM – 08:50 AM	Scientific Session I	Tamaya E
08:00 AM – 10:30 AM	Spouses/Companion Breakfast	Puma
08:50 AM – 09:50 AM	Inaugural Prolo Lecture/Robert Phillips, MD MSPH	Tamaya E
9:50 AM – 10:15 AM	Coffee Break with Exhibitors	Tamaya F,G,H
10:15 AM – 11:15 AM	Scientific Session II	Tamaya E
11:15 AM – 12:00 PM	Local Interest Lecture/ The Los Alamos Legacy	Tamaya E
12:00 PM	Adjourn for day	
12:45 PM – 04:45 PM	Feast and Float Native River Ride	Bus staging area, outside conference lobby
12:45 PM – 04:45 PM	Bosque Biking Tour	Bus staging area, outside conference lobby
12:45 PM – 04:45 PM	GOLF & TENNIS-arrange on own	Golf course/Tennis courts
06:00 PM – 09:30 PM	Local Night/Dinner	Bus staging area, outside conference lobby
Sunday, September 12 th 2021		
06:30 AM – 08:00 AM	Breakfast with Exhibitors	Tamaya F,G,H
06:45 AM – 11:00 AM	Registration	Tamaya Prefunction
07:00 AM – 08:00 AM	Business Meeting (Members only breakfast)	Wolf
08:00 AM – 10:30 AM	Spouses/Companion Breakfast	Puma
08:00 AM – 09:00 AM	Scientific Session III	Tamaya E
09:00 AM 9:50 AM	Scientific Session IV	Tamaya E
9:50 AM – 10:15 AM	Coffee Break with Exhibitors	Tamaya F,G,H
10:15 AM – 11:00 AM	Cloward Award Lecture/Richard Ellenbogen, MD	Tamaya E
11:00 AM – 12:00 PM	Presidential Address	Tamaya E
12:00 PM	Adjourn for the Day	
12:45 PM – 04:45 PM	Rodeo and Horse Riding	Shuttle outside Corn Maiden
12:45 PM – 04:45 PM	Sandia Peak Tramway	Bus staging area, outside conference lobby
12:45 PM – 04:45 PM	GOLF & TENNIS-arrange on own	Golf course/Tennis courts
06:00 PM – 06:30 PM	New Member Reception w/Exec Committee	Tamaya Veranda
06:00 PM – 10:00 PM	Camp Hyatt Children's buffet & entertainment	Badger
06:30 PM – 10:30 PM	Reception/Black Tie Dinner/Dancing	Tamaya Veranda & Tamaya E
Monday, September 13 th 2021		
07:30 AM – 08:30 AM	Breakfast with Exhibitors	Tamaya F,G,H
07:45 AM – 11:15 AM	Registration	Tamaya Prefunction
08:30 AM – 09:15 AM	Resident Award Presentations	Tamaya E
08:00 AM – 10:30 AM	Spouses/Companion Breakfast	Puma
09:15 AM -10:30 AM	Scientific Session V	Tamaya E
10:30 AM – 11:00 AM	Coffee Break with Exhibitors	Tamaya F,G,H
11:00 AM – 11:50 AM	Scientific Session VI	Tamaya E
11:50 AM – 12:00 AM	Closing remarks	Tamaya E
12:00 PM	Meeting Adjourns	See you in Hawaii!

Western Neurosurgical Society 67th Annual Meeting

2021 LEARNING OBJECTIVES

The purpose of this meeting is to provide an update in the basic and clinical Sciences underlying neurosurgical practice through lectures, discussions, interactive sessions with neurological surgeons, neurologists, neuroradiologists, and other allied health personnel.

Upon completion of this program, participants should be able to:

- 1. Increase attendees' confidence in the surgical care of intracranial pathology.**
- 2. Increase attendees' confidence in the surgical care of spinal disorders.**
- 3. Increase the understanding of the challenges facing neurosurgeons in regard to the decreasing overall labor force within neurosurgery as overall numbers of practicing neurosurgeon shrink, as well as in regard to increasing scrutiny from many directions on outcomes, and stewardship of limited financial resources in caring for neurosurgery patients.**
- 4. Increase attendees' confidence in the critical care of neurosurgery patient, focusing on improving efficiency within the ICU.**
- 5. Improve understanding of regulatory, financial and bureaucratic changes in healthcare environment that may impact outcomes as well as cost effectiveness of care.**

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2021 Officers & Committees

EXECUTIVE COMMITTEE

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Tom Scully, MD, Past President
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Marco B. Lee, MD, Secretary-Treasurer
Charles E. Nussbaum, MD, Historian

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Laura Snyder
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David Westra
Isaac Yang

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Greg Gerras
Jay Morgan
Praveen Mummaneni

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Melanie Hayden Gephart
ChrisTaylor
IsaacYang

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Marc Vanefsky
Patrick Wade
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Charles Nussbaum
Richard Wohns

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Charles Nussbaum

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Randall Smith, Chair
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William Ganz
Greg Gerras
Marco Lee

SITE SELECTION COMMITTEE

David Pitkethly, Chair
David Morgan
Charles Nussbaum
Jeff Rush

EXHIBITORS

The Western Neurosurgical Society would like to thank the following exhibitors for their generous support in 2021

SILVER SUPPORT

Globus Medical

<http://www.globusmedical.com>

Medtronic

<http://www.medtronic.com>

EXHIBITORS

The Western Neurosurgical Society would like to thank the following exhibitors for their support in 2021

Abor Pharmaceuticals <https://arborpharma.com>

Bioventus Global <https://www.bioventusglobal.com>

BK Medical <https://www.bkmedical.com>

Brainlab <https://www.brainlab.com>

DePuy Synthes <https://www.jnjmedicaldevices.com>

Fujifilm Hitachi <https://www.hitachimed.com>

GT Medical Technologies <https://www.gtmedtec.com>

Hyperfine, Inc <https://www.hyperfine.io>

Invenio Imaging <https://www.invenio-imaging.com>

EXHIBITORS

The Western Neurosurgical Society would like to thank the following exhibitors for their support in 2021

Omniscient <https://www.o8t.com>

Oss Dsign <https://www.ossdesign.com>

PMT Corporation <https://pmtcorp.com>

Specialty Care <https://specialtycareus.com>

Stryker <https://www.stryker.com>

Surgical West <https://www.surgicalwest.com>

Sutter Medical USA <https://www.sutter-usa.com>

2021 SOCIETY MEETING GUESTS

Richard Ellenbogen, MD	Cloward Medal	WNS
Robert Phillips, MD MSPH	Prolo Lecture	WNS
Jim Walther, BFA	Local Interest Speaker	WNS
Jessica Eaton, MD	Clinical Science Resident Award	WNS
Matthew Sun, MD	Basic Science Resident Award	WNS

Scott Berta, MD	Member Nominee	Dr. Lee
Travis Dumont, MD	Member Nominee	Dr. Weinand
Samer Ghostine, MD	Member Nominee	Dr. Dye
Mazyar Kalani, MD	Member Nominee	Dr. Lee
Dante Vacca, MD	Member Nominee	Dr. J. Morgan

Devin Khosla, MD	Member Candidate	Dr. J. Morgan
Matthew McDougall, MD	Member Candidate	Dr. Dye
Laura Prolo, MD	Member Candidate	Dr. Dye

Guilherme Barros, MD	Guest	Dr. Pikethly
Christine Canner-Peterson, MD	Guest	Dr. J. Morgan
Thomas Epplin-Zapf, MS CNIM	Guest	Dr. Harragher
Neil Joshi, MD	Guest	Dr. Weinand
Kevin Kumar, MD	Guest	Dr. Harragher
Ali Murad	Guest	Dr. Westra
James Pan, MD	Guest	Dr. Ellenbogen
Jennifer Price, APRN	Guest	Dr. J. Morgan

JOINT PROVIDERSHIP ACCREDITATION STATEMENT:

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 Western Neurosurgical Society. The AANS is accredited by the ACCME to provide continuing medical education for physicians."

DESIGNATION STATEMENT

The AANS designates this live activity for a maximum of **9.5 AMA PRA Category 1 CreditsTM**. Physicians should claim only the credit commensurate with the extent of their participation in the activity."

JOINT PROVIDERSHIP DISCLAIMER

Before the program, anyone in control of the educational content of this activity will disclose the existence of any financial interest and/or the relationship they or their significant other have with the manufacturer(s) of any commercial product(s) to be discussed during their presentation. Disclosures will be included in the final program.

The material presented at the Western Neurosurgical Society, 67th Annual Meeting has been made available by the Western Neurosurgical Society and the AANS for educational purposes only. The material is not intended to represent the only, nor necessarily the best, method or procedure appropriate for the medical situations discussed, but rather it is intended to present an approach, view, statement, or opinion of the faculty, which may be helpful to others who face similar situations.

Neither the content, whether written or oral of any course, seminar or other presentation in the program, nor the use of a specific product in conjunction therewith, nor the exhibition of any materials by any parties coincident with the program, should be construed as indicating endorsement or approval of the views presented, the products used, or the materials exhibited by the Western Neurosurgical Society and jointly provided by the AANS, or its Committees, Commissions, or Affiliates.

Neither the AANS nor the Western Neurosurgical Society makes any statements, representations or warranties, whether written or oral, regarding the Food and Drug Administration (FDA) status of any product used or referred to in conjunction with any course, seminar or other presentation being made available as part of Western Neurosurgical Society 67th Annual Meeting. Faculty members shall have sole responsibility to inform attendees of the FDA status of each product that is used in conjunction with any course, seminar or presentation and whether such use of the product is in compliance with FDA regulations.

Disclosure Statement:

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Speakers, paper presenters/authors and staff (and the significant others of those mentioned) who have disclosed a relationship* with commercial interests whose products may have a relevance to their presentation are listed below.

NAME	DISCLOSURE	TYPE OF RELATIONSHIP
Terry Burns, MD	Yes	Industry Grant (Abbvie, Codman); Consultant fee (Alector, Neurametrix)
Ray Chu, MD	Yes	Industry Grant (Leica Microsystems)
Thomas Epplin-Zapf, MS CNIM	Yes	Employee (Specialty Care)
Marco Lee, MD PhD*	Yes	Consultant Fee (DePuy Synthes)
Linda Liao, MD	Yes	University (NIH) Industry Grant (Merck, Northwest Biotherapeutics)
Matthew McDougall, MD	Yes	Consultant fee (Neuralink); Stock/Shares (Neuralink); Employee (Neuralink)
Praveen Mummaneni, MD*	Yes	University (ISSG, AO Spine) Industry Grant (DePuy Synthes, Stryker, Globus) Stock or Shareholder (Spinicity/ISD) Fiduciary Position (VP CNS) Other Financial/Material Support (DePuy Synthes, Thieme, Springer)
Gary K. Steinberg, MD, PhD	Yes	Consultant Fee (Zeiss, Surgical Theater, SanBio); Other Financial (Peter Latic US, Inc.)

Speakers, paper presenters/authors and staff (and the significant others of those mentioned) who have reported they do not have any relationships with commercial interests:

***educational content planner of this meeting**

Marvin Bergsneider, MD*
Travis Dumont, MD
Justin Dye, MD*
Jessica Eaton, MD
Richard Ellenbogen, MD
Ciara Harraher, MD *
Neil Joshi, MD
Maziyar Kalani, MD
Deven Khosla, MD
Phillip Kissel, MD
Kevin Kumar, MD
Jay Morgan, MD
David Newell, MD
James Pan, MD
Robert Phillips, MD MSPH
David Pitkethly, MD*
J. Adair Prall, MD *
Donald Prolo, MD
Laura Prolo, MD
Mark Sedrak, MD
Matthew Sun, MD
Anthony Wang, MD

DR. DON PROLO



Donald Prolo has been a member of the WNS since 1974 and an almost constant attendee at our annual meeting.

To anyone who has known Don Prolo over the past few decades, his love of classical thinking and values stands out as a real weathervane for who he is and what he stands for.

Don has been a champion of physician control of patient care as compared to what has become control by government and insurance companies. He gallantly tried, where no others ever went, to get a California based Sherman antitrust

exemption so docs could gather together and bargain with the government and the insurance companies for their services. He has continued to work on maintaining physician independence and loudly laments the erosion of private practice with now half of physicians employed by commercial interests.

As he said in his WNS Presidential address in 2002, it is “. . . a citizen's natural right to rebel against unjust positive laws and determinations not made with respect to antecedent principles of natural justice. Coercive threats of fines, sanctions, incarcerations are forces against American medicine without moral authority.” He went on to say “In the first two books of the Republic, Plato raised the question why should one be just in his actions toward others or in relation to the community in which he or she lives? The answer lies in the fact that the moral virtues of prudence, temperance, courage and justice underlie happiness, the primary good we desire for ourselves and others.”.

In the pursuit of the above values, Don and his wife Joanne have endowed an annual lecture, the Prolo Lecture, to be delivered by diverse speakers addressing professionalism and ethics in medicine. The first such lecture will occur at this year's meeting.

Inaugural Prolo Lecturer 2021 - Robert Phillips, MD



The Western is fortunate to have Robert L. Phillips, Jr., MD, MSPH deliver the inaugural Prolo lecture on ethics and professionalism in medicine.

Dr. Phillips' road to his current position as Executive Director, Center for Professionalism & Value in Health Care, of the American Board of Family Medicine, began in the Missouri University of Science and Technology where he got his BS in 1990

followed by an MD at the U. of Florida then back to Missouri at the UM for his Family and Community Medicine residency and a Masters in Family and Community Medicine. He currently holds a Clinical Professorship in the Department of Family Medicine at Virginia Commonwealth University in Richmond plus being a Clinical Lecturer at the School of Public Health at George Washington University in DC.

Robert previously served on the American Medical Association's Council on Medical Education, as president of the National Residency Matching Program, vice chair of the US Council on Graduate Medical Education, and co-chair of Population Health on the National Committee for Vital and Health Statistics. He served as a Fulbright Specialist to the Netherlands in 2012 and New Zealand in 2016. A nationally recognized leader on primary care policy and health care reform, Dr. Phillips was elected to the National Academy of Medicine in 2010 and currently chairs the NAM Membership Committee.

We look forward to his presentation entitled "Professional Autoimmune Disorder and the State of the Social Contract".

Dr. Ralph B. Cloward 1908-2000



In 2002 the Western Neurosurgical Society established a Medal and Lecture to honor one of its most innovative and pioneering members, Ralph Bingham Cloward. With the gracious support of the Cloward family, this award honors Ralph and his devoted wife Florence, our former president and first lady, both treasured friends who have enriched the Western.

Ralph Cloward was born in Salt Lake City, Utah, in 1908. He completed his undergraduate studies at the Universities of Hawaii and Utah, and his medical

education subsequently at the University of Utah and Rush Medical School in Chicago. He interned at St. Luke's Hospital, Chicago, and then trained to become a neurosurgeon under Professor Percival Bailey at the University of Chicago. He began practicing neurology and neurosurgery in the Territory of Hawaii in 1938.

His academic accomplishments include Professor and Chair of Neurosurgery at the University of Chicago, 1954-55, and visiting professorships at the University of Oregon, University of Southern California, and Rush Medical School. He served long-term as Professor of Neurosurgery at the John A. Burns School of Medicine at the University of Hawaii. He authored numerous papers and book chapters.

Dr. Cloward's inspired, pioneering quantum leaps encompassed many areas of neurosurgery, but his enduring interest was the spine, where he devised three major operations. He first performed the posterior lumbar interbody fusion in 1943, reporting the operation at a meeting of the Hawaiian Territorial Medical Association in 1945 and publishing it in the *Journal of Neurosurgery* in 1953. His unique approach for treating hyperhydrosis was reported in 1957. Independently he conceived an anterior approach to the cervical spine, devised instruments for its implementation, and published his classic paper in the *Journal of Neurosurgery* on anterior cervical discectomy and fusion in 1958. He designed over 100 surgical instruments, which continue to be used today by practicing neurosurgeons.

Throughout his career he educated the international community of neurosurgeons in the operations he devised. He performed them throughout the United States and in 41 cities within 27 countries of the world and in the process healed patients of their painful conditions. Hundreds of thousands of patients benefited both directly and indirectly from his creativity, technical genius, insight and enthusiasm as a teacher and medical evangelist.

In first recognizing all lesions of the spine to be in the province of neurosurgeons, Dr. Cloward engendered controversy and endured severe criticism from upsetting the environment of establishment neurosurgeons by his pioneering breakthroughs. He demonstrated that even in a complex technological world with large research efforts, budgets, and bureaucracies, the individual is key. Engraved on the Medal are words the Cloward legacy epitomizes, which honors recipients "For Epochal Innovation and Pioneering Application."

2021 CLOWARD AWARD RECIPIENT - Richard Ellenbogen, MD



The Western takes great pleasure in awarding the Cloward medal to one of its own, Dr. Ellenbogen, for his innovative work in pediatric neurosurgery and sports related head injuries.

Dr. Ellenbogen got his education in the Ivy League, receiving his BA and MD from Brown University in Rhode Island, then did his residency at Harvard, finishing in 1989.

He then spent 8 years on the faculty of the Uniformed Services University in Bethesda before being lured to the West Coast in 1997 as Associate Professor at the University of Washington in Seattle where he resides to this day, now as Full Professor and Chairman of UW neurosurgery.

He is also Director of the UW Medicine Neurosciences Institute. In addition, he is Director of the Neurological Surgery Residency Program and Founding Co-Director of the Seattle Sports Concussion Program, a joint program sponsored by Seattle Children's Hospital and UW Medicine. He is currently a member of the ACGME Residency Review Committee for Neurological Surgery. He has served as Chair of the American Board of Neurological Surgery, President of the American Society of Pediatric Neurosurgeons (ASPN), President of the Society of University Neurological Surgeons and President of the Congress of Neurological Surgeons (CNS).

He met his wife Sandy when he was interning at Walter Reed where she was an Army surgical nurse and after 37 years and three children, they are enjoying empty nesting—somewhat. His daughter is a family practice doc at the U. of Rochester and his two sons are on the East Coast as computer security experts. Dr. Ellenbogen also served as Commander of the 252nd Medical Detachment KE Team (XVIII Airborne Corp) during Operation Desert Shield/Storm and was awarded a Bronze Star for his service. Richard joined the Western Neurosurgical Society in 1999 and has been an active member ever since.

We look forward to his presentation entitled "The Myth of Equipoise".

PRIOR CLOWARD AWARD RECIPIENTS

2003 George Ojemann, MD, Professor of Neurosurgery University of Washington.
"Investigating Human Cognition during Epilepsy Surgery"

2005 Donald Prolo, MD, Clinical Professor of Neurosurgery Stanford University.
"Legacy Giants in the Treatment of Spinal Disorders: Ralph Cloward and Marshall Urist"

2006 Martin Weiss, MD, Professor of Neurosurgery University of Southern California.
"A Historical Walk through Pituitary Surgery"

2007 Charles Wilson, MD, Past Chairman, Department of Neurosurgery University of California, San Francisco. "The Future of Neuroscience"

2008 Peter Jannetta, MD, Past Professor and Chairman Department of Neurosurgery, University of Pittsburgh. "Vascular Compression in the Brainstem: Main Streaming Neurosurgery"

2009 L. Nelson Hopkins, MD, Professor and Chairman of Neurosurgery University at Buffalo, State University of New York. "Neurosurgeons and Stroke: From Prevention to Treatment"

2010 Sean Mullan, MD, Professor Emeritus of Neurosurgery University of Chicago.
"Some Neurosurgical Fossils"

2011 John A. Jane, Sr., MD, PhD, Professor of Neurosurgery University of Virginia Health System. "Anterior vs Posterior Approaches to the Cervical Spine"

2012 John R. Adler, Jr., MD Professor of Neurosurgery. Stanford University. "Stepping-Out of the OR: A Surgeon's Foray into Entrepreneurship"

2014 Andres M. Lozeno, MD, Professor of Neurosurgery, University of Toronto.
"Taming Dysfunctional Brain Circuits"

2015 Edward Oldfield, MD, Professor Neurosurgery, University of Virginia. "The origin of concepts in neurosurgery: One neurosurgeon's perspective"

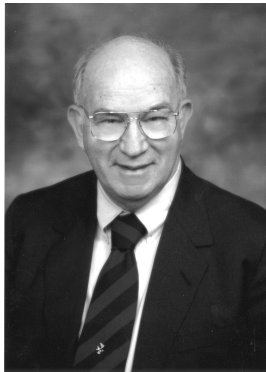
2016 Donald P. Becker, MD *Brain Trauma and Beyond: A Career in Neurosurgery*

2017 Volker K.H. Sonntag, MD "The Journey of Spinal Neurosurgery in the United States"

2018 Edward R. Laws, Jr., MD, FACS Professor of Neurosurgery, Harvard Medical School Hospital "Virtuosity in Surgery and Neurosurgery"

2019 Robert F. Spetzler, MD "My Journey in Neurosurgery"

DR. GEORGE ABLIN 1923-1999



In 2000, the members of the Western Neurosurgical Society inaugurated a new lectureship designed to honor, in a tangible and enduring manner, one of the Society's most outstanding members. In its long history, the Society has had no more devoted contributor than Dr. George Ablin. He brought to the group stunning ability and experience, especially in matters of local, national, and international organization, in which he had few peers. He contributed through service in many

areas including a memorable term as President. He was a wise and thoughtful counselor whose advice concerning many professional and personal questions always included a careful analysis, given with words of encouragement.

There was no more active and engaged participant in all of the Society's affairs.

George Ablin was raised in Chicago, received his BS and MD from the University of Michigan, interned at Charity Hospital, New Orleans, Louisiana, did his residency at the University of Wisconsin, later was Instructor at the University of Michigan, and also became a Clinical Professor at California State University, Bakersfield. Dr Ablin was Board Certified in Neurological Surgery, a Fellow of the American College of Surgeons, and a Diplomat of the National Board of Medical Examiners.

Dr Ablin began practice in neurosurgery in Bakersfield, California, in 1953, was President of the Kern County Medical Society in 1984, and was very active in the California Medical Association in various leadership positions. He was Treasurer of the California Medical Review Board and received Distinguished Service awards from the Congress of Neurological Surgeons and the American Association of Neurological Surgeons. He was named Honorary President of the World Neurological Society and in 1989 he was selected as the Kern County Physician of the Year. George was the devoted father of seven children, three of whom became physicians.

George combined an exceptionally perceptive understanding of others, including hundreds of fellow neurosurgeons, with warmth and gentleness and lively humor. He loved his colleagues and friends, and he loved this Society. With this permanent lectureship, the members of the Western Neurosurgical Society honor George Ablin and his cherished wife, Millie.

There is no Ablin Lecture in 2021

PRIOR ABLIN LECTURES

2000 Arthur L. Day, MD, Professor of Neurosurgery, University of Florida. *"Unruptured Intracranial Aneurysms and Sports Medicine in Neurosurgery"*

2002 Tom Campbell, JD, PhD, Professor of Law, Stanford University. Former Congressman. *"Is Freedom Possible in Medicine"*

2003 Frederic H. Chaffee, PhD, Director, WM Keck Observatory, Hawaii. *"The WM Keck Observatory at the Dawn of the New Millennium"*

2004 Gerald Kooyman, PhD, Research Professor, Scripps Institute of Oceanography, San Diego. *"Emperor Penguins: Life at the Limits"*

2005 Lt. Col. Rocco Armonda, MD, Neurological Surgeon, U.S. Army Bethesda, Maryland. *"The Modern Management of Combat Neurotrauma Injuries: Battlefield to the Medical Center"*

2006 August Turak, Spiritual and Business Consultant. *"Spirituality and the Neurosurgeon"*

2007 Donald Trunkey, MD, Internationally Renowned Trauma Surgeon. *"The Crisis in Surgery with Particular Emphasis on Trauma"*

2008 Michael Bliss, PhD, Emeritus Professor, University of Toronto. *"Working Too Hard and Achieving Too Much? The Cost of Being Harvey Cushing"*

2009 Michael A. DeGeorgia, MD, Professor of Neurology, Case Western Reserve University, Cleveland, Ohio. *"Struck Down: The Collision of Stroke and World History"*

2010 Chris Wood, PhD, Vice President for Administration, Santa Fe Institute. *"What Kind of Computer Is The Brain?"*

2011 Volker Sonntag, MD, Vice Chairman, Division of Neurological Surgery Barrow Neurological Institute, Phoenix, Arizona. *"Cervical Instrumentation: Past, Present & Future"*

2012 Robert Schrier, MD, Professor of Medicine, University of Colorado. *"Illnesses in the US Presidents in the 20th Century: Potential Impact on History"*

2013 Samuel Eric Wilson, MD, Professor, Department of Surgery, University of California, Irvine. *"Between Scylla and Charybdis: Can Academic Surgery Survive?"*

2014 Jon H. Robertson, MD, Professor of Neurosurgery, University of Tennessee. *"The challenge of the Future Neurosurgical Education"*

2015 David Piepgras, MD, Professor of Neurosurgery, Mayo Clinic. *"Frontier Surgery: Lessons for Today from Beaumont and St. Martin"*

2016 Larry R. Squire, Ph.D. *The Legacy of Patient H.M. – Cognitive Neuroscience of Human Memory*

2017 Lucy Kalanithi, MD, FACP *"When Breath Becomes Air-A Conversation with Lucy Kalanithi"*

2018 Michael Edwards, MD, *"40 years of Pediatric Neurosurgery: The impact of Moore's Law"*

2019 Regis Haid, MD. *"Spinal Alignment: Keys to the Kingdom"*

SPECIAL LOCAL LECTURER Jim Walther, BFA



The Western is pleased to present a venue specific special lecture by Jim Walther who is the Museum Director of the National Museum of Nuclear Science & History in Albuquerque.

The museum is an AAM Accredited Museum affiliated with Smithsonian Institution.

Jim is also Chairman of the National Steering Committee for Nuclear Science Week. Mr. Walther earned a BFA in Visual Arts from West Virginia University in 1978 and then began his museum career as an art teacher and exhibit designer in his home state. He worked at several museums over the years culminating in his Directorship of the Albuquerque museum in 1996. Mr. Walther is also a working landscape artist, involved in numerous community groups and an advocate for STEM education and science and history understanding. He continues as a practicing visual artist depicting the beauty of the New Mexico landscape and sky in watercolor and oil paint.

His talk entitled "Nuclear Science & History in New Mexico and the World" will address the legacy of the Manhattan project that was conducted in secrecy in Los Alamos, just over an hour away from us.

2021 RESIDENT AWARD RECIPIENTS



Clinical Science Award

Complications Associated with Early Cranioplasty for Traumatic Brain Injury Patients: A 25-year Single-Center Analysis

Jessica Eaton, MD Univ. Washington

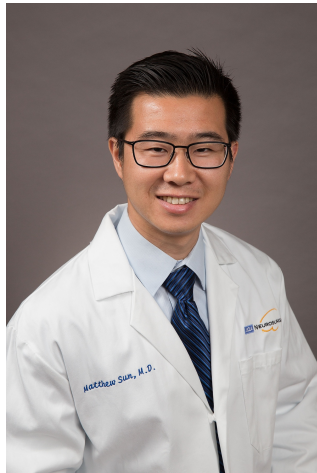
The Western is proud to award the 2021 annual resident prize in clinical research to Jessica Eaton, MD of the University of Washington where she is a 3rd year trainee.

Jessica began her academic career at the University of Louisville where she received a cum laude BA in Physics and English in 2013. At the UL she was a member of the inaugural class of James Brown Graham Fellows, a scholarship that supports students to pursue yearly enrichment experiences. Through this program she studied and worked in Panama, Greece, Thailand, Nigeria, and India.

Med school was also at the UL where she continued her eclectic approach to education. She was awarded a Fulbright-Fogarty Fellowship to spend a year away from routine med school, building a traumatic brain and spinal cord injury database in Lilongwe, Malawi.

Her particular interest is in brain tumors, and she plans to pursue a skull base fellowship following the completion of her residency at the UW. Her current research is focused on genetic drivers of skull base tumors, as well as DTI tractography in tumor patients.

Her husband Michael is an accomplished runner and a three-time Olympic Marathon Trials qualifier. Currently, Jessica spends most of her free time hiking, climbing, and learning mountaineering.



Basic Science Award

*Systemic Adoptive Cell Transfer
Immunotherapy with TCR-
transduced T-Cells Targeting
NY-ESO-1 for Meningiomas*

Matthew Sun, MD UCLA

The Western is delighted to honor Dr. Sun for his basic science research.

Matthew Sun is a PGY7 neurosurgery resident at UCLA.

He was born in China and grew up in Beijing before his family immigrated to California when he was 12 years old. He attended Stanford University, where he also met his wife, Sophia. They both played in the Stanford Symphony Orchestra, where he was the concertmaster. He went to medical school at UCSF, where he first developed his interest in neurosurgical oncology.

Matt has a research interest in brain tumor immunology, particularly focusing on developing new immunotherapy treatments for malignant meningiomas. He has won numerous research awards, including the Firestone Medal for Excellence in Undergraduate Research at Stanford for his work done at Dr. Ben Barres' lab and the Chih Foundation Award in Neuroscience research at UCSF for his work done at Dr. Andrew Parsa's lab, studying the molecular mechanisms of brain tumor invasion.

He has received training grants from the NIH and HHMI while in medical school and received NIH R25 funding during his PGY4 and PGY7 years. He has received the Resident Award for Academic Excellence as well as other research awards at UCLA.

After residency, Matt will pursue a fellowship in skull base and cerebrovascular surgery with Dr. Morcos at the University of Miami, to prepare for an academic career in skull base neurosurgical oncology.

Outside of neurosurgery, Matt enjoys spending time with his wife Sophia and their beautiful Bengal cats, as well as hiking and traveling.

WNS 2021 SCIENTIFIC PROGRAM
The Hyatt Regency Tamaya,
Santa Ana Pueblo, New Mexico,
September 10 – 13, 2021

Saturday September 11th, 2021

6:30-7:45 Breakfast with Exhibitors

7:45-7:50 Welcome, Marvin Bergsneider, MD WNS President

7:50-8:50 **Scientific Session I** (12 min talks, 3 min discussion)

Moderator: Justin Dye, MD

1. Gary Steinberg, MD PhD (Member): Role of Surgical Revascularization in the Current Era of Endovascular Therapies, Stanford University.
2. Matthew MacDougall, MD (Member Candidate): Optical Brain Machine Interface in Rhesus Macaque, California Pacific Medical Center.
3. Mark Sedrak, MD (Member): Frame-based Stereotactic Localization: Innovations and Updates, Kaiser Permanent; Redwood City
4. David Newell, MD (Member): Physiological Significance of Intracranial B waves, Seattle Neuroscience Institute

8:50-9:00 Introduction to Prolo Lecture: Marvin Bergsneider, MD; Donald Prolo, MD

9:00-9.50 Inaugural Prolo Lecture, Robert Phillips, MD MSPH, "Professional Autoimmune Disorder and the State of the Social Contract"

9:50-10:15 Break with Exhibitors

10:15-11:15 **Scientific Session II** (12 min talks, 3 min discussion)

Moderator: Jay Morgan, MD

1. Phil Kissel, MD (Member): Far Lateral Lumbar Disc Herniation: The Ganglionic Syndrome, San Luis Obispo.
2. Thomas Epplin-Zapf, MS CNIM (Guest): Contextual Intraoperative Monitoring Led by Motor Evoked Potentials: Evidence from 27,808 extradural cervical spine procedures considering alert categorization and spinal pathology, SpecialtyCare IOM.
3. Praveen Mummaneni, MD (Member): Use of New Technology and Navigation in spine surgery, UCSF.
4. J Deven Khosla, MD (Member Candidate): Do PEEK Rods for Posterior Instrumented Fusion in the Lumbar Spine Reduce the Risk of Adjacent Segment Disease? Santa Monica.

11:15-12:00 **Local Interest Lecture** by Jim Walther, Director of the National Museum of Nuclear Science & History, "Nuclear Science & History in New Mexico and the World"

Sunday September 12th, 2021

7:00-8:00 Annual Business Meeting (Members only)

8:00-9:00 Scientific Session III (12 min talks, 3 min discussion)

Moderator: J Adair Prall, MD

1. Terry Burns, MD PhD (Member): Intraoperative Microdialysis: Glioma intelligence from behind enemy lines, Mayo Clinic Rochester, MN.
2. Ray Chu, MD (Member): Navigated Suction as an Adjunct to Maximize Tumor Resection, Cedars Sinai Medical Center.
3. Justin Dye, MD (Member): Ruptured blister aneurysms: treatment with flow diversion and IV Cangrelor, Loma Linda University.
4. Travis Dumont, MD (Member Nominee): Cytotoxic irrigation may prevent local brain metastatic tumor recurrence, University of Arizona.

9:00-9:50 Resident Scientific Session IV (10 min talk, 2 min discussion)

Moderator: Ciara Harraher, MD MPH

1. Guilherme Barros, MD: Modeling the effect of hemodynamics on the endothelial cell transcription profile of cerebral aneurysms after endovascular flow diversion treatment, University of Washington.
2. Neil Joshi, MD: Leukocyte RNA Expression Predicts Human Temporal Lobe Epilepsy Seizure Frequency, University of Arizona.
3. James Pan, MD: Complications of Pediatric Tethered Cord Release: Seattle Children's Hospital Experience, University of Washington.
4. Kevin Kumar, MD PhD: High efficiency microglia replacement ameliorates motor deficits and improves survival in a mouse model of Gaucher disease, Stanford University.

9:50-10:15 Break with Exhibitors

10:15-10:20 Introduction to Cloward Award Winner, David Pitkethly, MD

10:20-11:00 Cloward Award Winner, Richard Ellenbogen, MD
"The Myth of Equipose"

11:00-11:05 Introduction to Presidential Address, Brandon Bergsneider

11:05-12:00 Presidential Address, Marvin Bergsneider, MD

"Intracranial Pressure: From Merlin to Copernicus"

Monday September 13th, 2021

7:30-8:30 Breakfast with Exhibitors

8:30-9:15 **Resident Award Presentations** (15 min talks, 5 min discussion)

Moderator: Ciara Harraher, MD MPH

1. **Clinical Science Award**, Jessica Eaton, MD "Complications Associated with Early Cranioplasty for Traumatic Brain Injury Patients: A 25-year Single-Center Analysis, University of Washington."
2. **Basic Science Award**, Matthew Sun, MD "Systemic Adoptive Cell Transfer Immunotherapy with TCR-transduced T-Cells Targeting NY-ESO-1 for Meningiomas, UCLA."

9:15-10:30 Scientific Session V (12 min talks, 3 min discussion)

Moderator: Justin Dye, MD

1. Laura Prolo, MD PhD (Member Candidate): Prediction of shunt placement following neonatal intraventricular hemorrhage using an integrated risk scale, Stanford University.
2. Anthony Wang, MD (: Dendritic cell vaccination targeting neoantigens derived from alternative splicing variants results in increased intratumoral infiltration of CD8+ T lymphocytes and improved survival in a novel murine model of H3G34R mutant high-grade glioma, UCLA
3. Ray Chu, MD: The Utility of ICG Vascular Fluorescence with Augmented Reality in Tumor Resection, Cedars Sinai Medical Center.
4. Linda Liau, MD PhD: Tackling Glioblastoma Resistance: New Concepts, UCLA

10:30-11:00 Break with Exhibitors

11:00-11:50 Scientific Session VI Case Discussions: What would you do?

Moderator: Marvin Bergsneider, MD

1. Jay Morgan, MD. L4/5 Spondylolisthesis
2. Marco B. Lee, MD PhD. Traumatic Brain Injury

11:50-12:00 Wrap-up and Adjourn: 2022 Annual Meeting Updates and Closing Remarks

ABSTRACTS

Scientific Session I

1) Gary Steinberg, MD PhD, Stanford University

Role of Surgical Revascularization in the Current Era of Endovascular Therapies.

Introduction

In 1967, Gazi Yasargil performed the first STA-MCA bypass in a patient with an occluded MCA, initiating the era of cerebral revascularization. However, with the failure of the International Randomized EC-IC Bypass Study in 1985 and the subsequent failure of the Carotid Occlusion Surgery Randomized Study in 2011, this procedure was largely abandoned for atherosclerotic occlusive cerebrovascular disease. Then with the advent and rapid development of endovascular techniques for treating aneurysms and intracranial arterial stenosis/occlusion, the need for surgical revascularization has decreased further.

Methods

The author reviewed his series of surgical revascularization procedures over 34 years to determine the current indications and technical aspects of bypass procedures in 2021.

Results

Between 1987-2021, 2194 revascularization bypasses were performed at Stanford Health Care Hospital or Lucile Packard Children's Hospital. This included 1956 direct bypasses (1881 STA-MCA, 46 other EC-IC or IC-IC bypasses), 29 interposition grafts using saphenous vein, femoral artery or Dacron), 238 indirect grafts using STA, temporalis muscle, pericranium or omental-brain transposition (40). These were performed for ischemic cerebrovascular disease, complex aneurysms or skull base tumors.

Conclusions

Current indications for surgical cerebral revascularization include: 1) Non-atherosclerotic occlusive vasculopathies and vasculitis (Moyamoya Disease & Takayasu's Arteritis); 2) Deliberate large vessel arterial occlusion for aneurysms, tumors or dissection after failure of temporary balloon occlusion, recurrence following endovascular tx or prophylactic; 3) Very occasionally, occlusive, atherosclerotic cerebrovascular disease in the setting of symptomatic brain ischemia despite maximal medical therapy and not amenable to angioplasty/stenting, with evidence of hemodynamic compromise. Important principles include: Proper patient selection; Deciding on need for low flow versus high flow bypass; Reconstruction of the native anatomy, as much as possible; Developing proficiency with various arterial and interposition graft techniques; Choosing the revascularization technique that will provide adequate blood flow, highest patency, and lowest risk.

2) Matthew MacDougall, MD. California Pacific Medical Center

Optical Brain Machine Interface in Rhesus Macaque,

Co-Authors

Eric M. Trautmann, PhD, Daniel J. O'Shea, PhD, Stephen I. Ryu, MD, Karl Deisseroth, PhD, Krishna V. Shenoy, PhD.

Optogenetics has become an important tool in the study of functional neuronal circuitry. Common marmosets (*Callithrix jacchus*) are now recognized as a key primate model for genetic manipulation, providing a potentially powerful model for studies of neural circuitry and disease in primates. In this work we demonstrate a method to photostimulate cortical neurons altered by adeno-associated virus (AAV) to express channelrhodopsin (ChR2) in awake, behaving marmosets. We found that populations of neurons could be stably activated following viral transduction for several months. This study demonstrates techniques for viral transduction and optical manipulation of neuronal in marmosets and can be applied to existing behavioral preparations to study neural correlates of behavior in these primates.

3) Mark Sedrak, MD. Kaiser Permanent; Redwood City, California

Frame-based Stereotactic Localization: Innovations and Updates.

Introduction: Frame-based stereotaxis has been in use for over 40-years since the invention of the N-localizer by Russ Brown. Since then, there have been significant improvements in 3D imaging such as with computed tomography (CT) and magnetic resonance imaging (MRI). However, little changes have been made to localizer systems. Herein, opportunities were explored to improve localization.

Methods: Several commonly used localizer systems were analyzed using Monte-Carlo (MC) simulations to evaluate the propagation of errors to a sample target. These errors were given as Root Mean Square Errors (RMS-e). Mathematics to incorporate an overdetermined set of equations was used to optimize the stereotactic matrix, which converts screen coordinates (2D) to and from frame-based coordinates (3D). Several novel designs were then developed and analyzed using MC simulations.

Results: Optimizations were identified for reducing RMS-e. One such optimization included using all fiducial information on images to optimize the stereotactic matrix. Use of overdetermined equations in the form of matrices was found to minimize errors and be a rapidly expandable method. Existing frame systems had significant variation in their RMS-e, with the most accurate systems containing 4 N-localizer plates. Errors at targets varied in a non-linear fashion as deviation from the stereotactic triangle, interpolation towards increasing extrapolation. Considering bipanel localizer systems as a constraint, modification of localizers could be used to achieve high accuracy in the stereotactic space without volumetric regression.

Conclusions: Frame-based stereotaxis revolutionized the field of neurosurgery over the last 40 years. Stereotactic accuracy is determined initially by localizer registration. Several methods and novel arrangements allow high accuracy, a reduction in RMS-e, and can offer significant improvements in the field. Ramifications of the findings have influence on frame and frameless stereotaxy and are important concepts for stereotactic neurosurgeons.

4) David Newell, MD. Seattle Neuroscience Institute Seattle, WA

Physiological Significance of Intracranial B waves

Introduction Slow spontaneous cerebral blood flow (CBF) and cerebrospinal fluid oscillations (CSF) driving glymphatic flow in the brain, occur at a similar frequency as intracranial B-waves.

Objective Our objective was to re-analyze our previously published recordings of B waves, and compare the results to published MRI frequency measurements of CBF and CSF slow wave oscillations.

Methods B-waves in 20 patients with severe head injury (previously reported), and 6 additional head injury patients, were analyzed, including middle cerebral artery (MCA) velocity using transcranial Doppler (TCD), and ICP. The frequency was compared to published spontaneous fluctuations of CBF measured using functional MRI (f-MRI) BOLD sequence, EEG, and CSF movement using MRI, in humans.

Results Frequency analysis revealed MCA velocity and ICP fluctuations during B waves showed cross-correlation of the $-d/dt$ FV vs. the $-d/dt$ ICP signals show a similar correlation and time relationship as the published $-d/dt$ MRI BOLD descriptions. In 26 patients demonstrating clear B-wave activity, the FV signal had maximum activity at 0.025-0.03 Hz, and time derivative maximum at 0.035 Hz. The frequency range was between 0.3-4 cycles per minute or 0.024-0.067 Hz.

Conclusions Re-analysis of our B wave measurements, compared to spontaneous f-MRI BOLD, EEG, and CSF oscillations in the brain, indicate that both methods (TCD and MRI) are measuring a similar physiologic process. The slow oscillations causing intracranial B waves can provide a driving force for CSF movement and glymphatic flow of fluid in the brain, even when the ICP is not significantly affected, and have important clinical implications.

Scientific Session II

2) Phillip Kissel, MD FACS . UCSF and Sierra Vista Regional Medical Center, San Luis Obispo, CA

Far Lateral Lumbar Disc Herniation: The Ganglionic Syndrome

BACKGROUND CONTEXT: This discussion reviews the clinically distinct presentation and the neurosurgical care for a select group of far lateral disc herniation patients. “The Ganglionic Syndrome” best characterizes their often dramatic symptomatology and need for acute surgery. Post-op recovery is prolonged as the intrinsic neurological repair of the dorsal root ganglion(DRG) injury is more complex than a routine radiculopathy.

PURPOSE: The main aim of this study was to revisit the far lateral disc herniation and delineate a new clinical syndrome based on DRG compression.

STUDY DESIGN: Community based retrospective review of 29 cases accrued over a 30 year time span. The MRI findings are consistent with a far lateral disc herniation. Surgery was via a paramedian, muscle splitting approach and microdiscectomy.

METHODS: Data was extracted from hospital and office records. Specific attention was directed to age, gender, laterality, time of symptom onset to surgery, time of imaging study (MRI) prior to surgery , number of ER visits before surgery, operative level and outcome.

RESULTS: This cluster of patients were older; 93% greater than 50 years of age. There was 69% males and only 31% females. 69% of the far lateral herniations were left sided and only 31% right sided. Greater than ½ of the cases occurred at the L3-L4 level (55%). Approximately 1/3 occurred at the L4-L5 level (35%). Previous operations had been performed in 24% of the patients. One quarter of these patients visited the ER as they were in extreme distress prior to surgery.

F/U length varied from 5 weeks to one year. Outcomes were Excellent 35% ; Good 61% ; Fair 4%.

SUMMARY: This report is a small series of a specific subgroup of patients that have clinical characteristics related to their DRG compression and resultant pathophysiology. By labelling this “The Ganglionic Syndrome” it is hopeful that this becomes a teachable concept and further data can be collected to more clearly define this distinct group of lumbar far lateral disc herniation patients.

3) Thomas Epplin-Zapf, MS, MA, CNIM. SpecialtyCare IONM

Contextual Intraoperative Monitoring Led by Motor Evoked Potentials: Evidence from 27,808 extradural cervical spine procedures considering alert categorization and spinal pathology

Introduction

The ability of the motor evoked potential (MEP) to avert neurologic injury during spinal surgery relies upon the accurate interpretation of critical changes to MEPs within the context of the class of alert and pathophysiologic landscape.

Methods

27,808 adult cervical extradural spine procedures with a diagnosis of myelopathy, radiculopathy, or stenosis were obtained from a national multi-institutional database. All procedures utilized an optimal multimodality IONM plan with motor evoked potentials (MEPs), somatosensory evoked potentials (SSEPs), and spontaneous electromyography (EMG). Risk of new-onset neurological deficit according to alert modality type (No alert, MEP, SSEP, EMG, or combined MEP & SSEP) and resolution at closure (Resolved or Unresolved) was assessed using a mixed-effects logistic regression model controlling for various factors. The same was performed based on alert anatomic pattern type.

Results

The rate of MEP and combined MEP & SSEP alerts was significantly higher in myelopathic patients (8.75%) than radiculopathic patients (5.62%), as was the rate of new neurologic deficit (0.96% versus 0.45% respectively). The model-adjusted probability of a new deficit was highest for procedures with unresolved MEP and SSEP alerts (Myelopathy: 17.9%; Radiculopathy: 16.0%; Stenosis: 17.8%, all $p < 0.001$), and was significantly lower if those alerts were resolved by closure (Myelopathy: 0.6%, Radiculopathy: 0.5%, Stenosis: 0.7%, all $p < 0.001$). Regarding the functional pattern of MEP/SSEP alerts, spinal cord alerts had the highest rate of new neurologic deficit (16.1%) followed by C5 nerve root alerts (9.1%), total arm alerts (8.9%), and hand alerts (3.1%). For each pattern, the deficit rate was significantly reduced when the alert was resolved by closure.

Conclusions

The probability of new neurological deficit is significantly increased across all studied patient populations when an MEP alert is unresolved by the time of closure, and, most importantly, is significantly decreased if the alert is resolved.

Do PEEK Rods for Posterior Instrumented Fusion in the Lumbar Spine Reduce the Risk of Adjacent Segment Disease?

Co-authors: Daniel Hirt, MD¹ Heather A. Prentice, PhD² Jessica E. Harris, MS² Elizabeth W. Paxton, PhD² Daniel T. Nagasawa³ Steven M. Kurtz, PhD⁴

Affiliations:

- 1 Southern California Permanente Medical Group, Los Angeles Medical Center
- 2 Surgical Outcomes and Analysis, Kaiser Permanente, San Diego, CA
- 3 Achieve Brain & Spine, Neurological Surgery, Santa Monica, CA
- 4 Exponent, Inc., and Drexel University, Philadelphia, PA

Introduction: Polyetheretherketone (PEEK) rods were clinically introduced in the mid-2000s as an alternative to titanium (Ti) rods for posterior instrumented lumbar spine fusion, theorized to reduce the risk of adjacent segment disease (ASD). However, few studies have follow-up beyond 2 years. Consequently, we conducted a matched cohort study using data from a healthcare system's Spine Registry to compare the two rod systems and risk for outcomes.

Methods: Patients aged 18+ undergoing first posterior lumbar fusion for a degenerative diagnosis from 2009-2018 using either a PEEK or Ti rod were identified. Fusions using Ti rods were 2:1 propensity score-matched to PEEK rods on the following factors: patient age, body mass index, American Society of Anesthesiologists classification, smoking, diagnosis, interbody use, BMP use, fusion levels, number of levels fused, and operative year. The matched sample included 154 PEEK and 308 Ti fusions. Median follow-up was 7.8 (interquartile range [IQR]=2.4-9.1) years and 7.7 (IQR=3.1-9.0) years for PEEK and Ti groups, respectively. We used Cox regression to evaluate ASD and nonunion, and logistic regression to evaluate 90-day emergency department [ED] visit, readmission, and complication.

Results: We did not observe a difference in risk for ASD (hazard ratio=1.02, 95% confidence interval [CI]=0.66-1.59) or ED visit (odds ratio [OR]=0.88, 95% CI=0.48-1.59). A lower likelihood of readmission (OR=0.34, 95% CI=0.13-0.94) was observed following PEEK fusion compared with Ti. No nonunions or 90-day complications were observed for the PEEK group; 5 (2-year cumulative incidence=0.7%) nonunions and 4 (1.3%) complications were observed for the titanium group.

Conclusion: Our study failed to support the hypothesis that PEEK rods are associated with a lower ASD risk. Reasons for readmission need to be identified to better understand the differences observed here. Further study of patients with TLIF using Ti and PEEK rods and posterolateral fusion with Ti and PEEK rods is needed.

Scientific Session III

1) Terry C Burns, MD, PhD. Mayo Clinic, Rochester, Minnesota

Intraoperative Microdialysis: Glioma intelligence from behind enemy lines

Co-authors: Cecile Riviere-Cazaux, BS; Lucas Carlstrom, MD, PhD

Introduction

Gliomas present a formidable challenge for translational progress. Heterogeneity within and between tumors may demand empirically individualized and adaptive paradigms requiring rapid mechanistic feedback. We asked if tumor-associated metabolic biomarkers from glioma extracellular fluid could impart mechanistic “intelligence” reflecting intra- and inter-tumoral heterogeneity.

Methods

Five live human gliomas (2 oligos; 2 IDH-WT GBMs; 1 IDH-mutant GBM), were evaluated in situ with high molecular weight (100kDA) intraoperative microdialysis using 3 disparately placed catheters. Isotonic 3% dextran perfusate was collected in 20 min (40 L) aliquots. CSF samples (n=21) were additionally evaluated from these and other patients with diverse brain tumors. The IDH-mutant glioma-associated oncometabolite D2-hydroxyglutarate (D2-HG) was quantified with targeted Liquid Chromatography-Mass Spectrometry (LC-MS); >200 metabolites were evaluated via untargeted LC-MS. Correlation, clustering, ROC and enrichment analyses ensued.

Results

CSF samples from patients with IDH-mutant gliomas contained over twenty-fold higher levels of D2-HG (median 4.1 M, range 1.6-13.2, n=7) compared to those from IDH-wild type tumors (median 0.19 M; range 0.089-0.35, n=14). Microdialysate from IDH-mutant gliomas contained 10-953 M D2-HG, 9-63x higher than paired CSF samples. Interestingly, IDH status failed to predict the global metabolic signature of microdialysate. Microdialysate samples clustered into 2 major metabolic phenotype clusters with IDH-WT and IDH-mutant gliomas in each cluster. A superimposed metabolic signature distinguishing enhancing from non-enhancing tumor, was conserved in both patient clusters. Amino acid and carnitine metabolism predominated in microdialysate signatures. TCA cycle and Warburg-associated metabolites were differentially enriched in CSF samples after prior therapy independent of tumor burden.

Conclusions

Extracellular glioma biomarkers may provide “intelligence” regarding the phenotype, burden, and metabolism of live human gliomas. Future work will evaluate individualized responsiveness to standard and novel candidate therapies.

2) Ray Chu, MD. Cedars Sinai Medical Center

Navigated Suction as an Adjunct to Maximize Tumor Resection

Introduction: Several methods are available to aid in maximal safe tumor resection, but little has been published in the modern era pertaining to use of a navigated suction in conjunction with the heads up display now available in the operating microscope.

Methods: The author reports a prospective series of 20 patients who underwent craniotomy for tumor resection from 2020 to 2021 using a navigated suction. A standard navigation tracker was added to a suction and registered in the system. The heads-up display was activated in the microscope to allow real time information as to suction location as resection was proceeding. Straightforward brain metastases, vestibular schwannomas, and meningiomas were excluded.

Results: 14 patients (70%) had a complete or near complete tumor resection. 3 patients (15%) had an intentional subtotal resection especially for recurrent tumors with some treatment effect. 3 patients (15%) had intentional partial resection due to involvement of the insula or motor cortex. There were no patients with unintended residual tumor. These results were a bit better than a contemporaneous series of patients without use of a navigated suction. All patients with residual tumor were gliomas. Tumor pathology included 8 newly diagnosed GBMs, 7 recurrent GBMs, 3 metastases, 1 hemangiopericytoma, & 1 neurocytoma. The navigated suction seemed the most useful for gliomas and recurrent tumors/ tumors with treatment effect. Setup and suggestions for navigated suction use in tumor resection will be discussed.

Conclusions: Maximal safe tumor resection may be aided by the use of a navigated suction. Further studies could be beneficial.

3) Justin Dye, MD. Loma Linda University

'Ruptured blister aneurysms: treatment with flow diversion and IV Cangrelor'

Ruptured blister type aneurysms are challenging to manage, and the ideal treatment remains debated. Recently, endovascular procedures, particularly flow diversion, gained popularity in treating blister aneurysms; however, the need for dual antiplatelet therapy remains a significant concern. Cangrelor is a novel intravenous P2Y₁₂ platelet receptor antagonist with reversible binding and rapid onset and offset of action. These characteristics are appealing for use in endovascular procedures and may mitigate some concerns associated with other P2Y₁₂ receptor antagonists. We report our case series of ruptured blister aneurysms and highlight their pathogenesis, describe current treatment paradigms, and illustrate the benefits of IV cangrelor. Previously studied in the cardiac literature, this is one of the first reports of the use of cangrelor in neuro-endovascular procedures. Cangrelor has the potential for improving the safety of endovascular procedures, especially in patients where treatment is associated with high risks of intraprocedural bleeding or other complications that may require further intervention.

4) Travis Dumont, MD. University of Arizona, Tucson Arizona

Cytotoxic irrigation may prevent local brain metastatic tumor recurrence

Introduction: Despite standard-of-care surgical resection and radiosurgery for brain metastatic lesions, local recurrence remains on the order of 20%. **Hypothesis:** local irrigation with cytotoxic irrigation of betadyne and peroxide after tumor resection may reduce rate of local tumor recurrence.

Method: All patients were treated by the same surgeon from 2013-2021 with diagnosis of metastatic brain tumor numbering one or two lesions with plan for resection. Betadyne and peroxide irrigation was used after resection at the discretion of the surgeon. All patients underwent standard postoperative care including chemotherapy and radiation prescribed by oncology team. Patients were followed up with routine imaging to assess for tumor regrowth. Recurrence was defined as new enhancement in the area of prior resection consistent with tumor. The primary endpoint for study was time in months to local tumor recurrence. The data was collected retrospectively by the author and represents a consecutive series. Analysis was performed with Graphpad Prism; including comparison of median survival without local recurrence with Log-rank test.

Results: A total of 30 lesions in 26 patients were treated in this series. This included 13 lesions in 12 patients with no cytotoxic irrigation and 17 lesions in 14 patients with cytotoxic irrigation. Local recurrence occurred in 6 patients to date (20% of lesions) with median follow-up 7.9 months (range 2.0 months to 62 months). The median follow-up is similar between the cytotoxic irrigation group (7.9 months) compared with no cytotoxic irrigation group (7.1 months). Incidence of local recurrence is higher in the group without cytotoxic irrigation (39%) compared with the cytotoxic irrigation group (6%) though not statistically significant $p = 0.06$, Fisher's Exact. Median survival without local progression was higher in the cytotoxic irrigation group $p = 0.02$, Log-rank test.

Conclusion: Cytotoxic irrigation may reduce local recurrence after metastatic tumor resection.

Scientific Session IV

1) Guilherme Barros, MD. University of Washington, Seattle.

Modeling the effect of hemodynamics on the endothelial cell transcription profile of cerebral aneurysms after endovascular flow diversion treatment

Co-Author: Samuel Levy, BS; Patrick Fillingham, PhD; Emma Federico, BS; Ying Zheng, PhD; Michael R. Levitt, MD; Louis J. Kim, MD

Introduction: Endovascular flow diverting stents (FDS) are a valuable option to treat unruptured cerebral aneurysms, with a single endoluminal device placed in the parent vessel, ultimately promoting thrombosis and occlusion of the aneurysm sac. Computational flow dynamic (CFD) simulations have demonstrated hemodynamic differences between known FDS treatment outcomes, but questions remain regarding the endothelial biologic responses behind successful and failed aneurysm occlusion. We hypothesize that hemodynamic changes within the aneurysm dome after FDS directly drive endothelial cell transcription and protein expression levels, resulting in quantifiable differences associated with each patient's treatment outcome.

Methods: We will create 3D-printed models of aneurysms, deploy commercially-available FDS, and populate each stented model with human carotid endothelial cells. Using a modifiable pulsatile pump, we will reproduce intra-aneurysmal hemodynamics similar to in vivo stresses based on previously obtained patient-specific physiological measurements and CFD simulations in the aneurysm model, seen in Figure 1. We will then extract endothelial cells from the aneurysm dome of each model for RNA and protein analysis to identify levels of key vascular remodeling factors, including ADAMTS-1 and NOS3.

Results: Data collection and analysis is currently ongoing. There are n=4 patients with successful aneurysm occlusion and n=4 patients with failures (recurrence or retreatment) in our current study set. In contrast to a significant decrease in ADAMTS-1 and NOS3 expression in successful treatment models, we predict treatment failure models will demonstrate little or no change before and after treatment and may have other increased inflammatory factors.

Conclusions: Direct study of the vascular endothelial genetic response to changes in hemodynamic stress experienced in cerebral aneurysms after FDS has not yet been performed. This work has the potential to link hemodynamics, endothelial genetic expression, and treatment outcome to help identify potential targets for endothelial cell-directed therapy and improved FDS to treat cerebral aneurysms.

2) Neil Joshi, MD. University of Arizona Neurosurgery, Tucson, AZ.

Leukocyte RNA Expression Predicts Human Temporal Lobe Epilepsy Seizure Frequency

Introduction: This study was performed to test the hypothesis that systemic leukocyte RNA expression has prognostic value differentiating low from high seizure frequency refractory temporal lobe epilepsy (TLE).

Methods: A consecutive series of sixteen patients with refractory temporal lobe epilepsy was studied. Based on a median baseline seizure frequency of 2.0 seizures per month, low versus high seizure frequency was defined as < 2 seizures/month and > 2 seizures/month, respectively. Systemic leukocyte RNA expression was analyzed for prognostic value for TLE seizure frequency. All differentially expressed genes were analyzed with Ingenuity® Pathway Analysis (IPA®) to identify biological pathways with predictive value for low versus high TLE seizure frequency and for functional annotations wherein clustering of low seizure frequency associated RNAs were significantly over-expressed.

Results: There were ten males and six females with a mean age of 39.4 years (range: 16 to 62 years, standard error of mean: 3.6 years). There were five patients in the high and eleven patients in the low seizure frequency cohorts, respectively. Based on a threshold of 2-fold change ($p < 0.001$, $FC > 2.0$, $FDR < 0.05$), 13 differentially expressed leukocyte genes were identified which were all upregulated in the low and downregulated in the high seizure frequency group, including NCF2 (Neutrophil Cytosolic Factor 2, p67phox), HMOX1 (Heme Oxygenase 1), RHOB (Ras Homolog Family Member B; Rho-Related GTP-Binding Protein RhoB), FCGR2A (FcγRIIA, Fc Fragment of IgG Receptor IIa, CD32), PRKCD (PKCδ, Protein Kinase C Delta), RAC2 (Family Small GTPase 2), TLR1 (Toll Like Receptor 1), CHP1 (calcineurin homologous protein 1), TNFRSF1A (TNFR1, Tumor Necrosis Factor Receptor Superfamily Member 1A; p55), IFNGR1 (Interferon Gamma Receptor 1, IFN-γ R1), LYN (LYN Proto-Oncogene, Src Family Tyrosine Kinase), MYD88 (MYD88 Innate Immune Signal Transduction Adaptor), and CASP1 (Caspase 1, Apoptosis-Related Cysteine Protease, Interleukin-1β Convertase).

Conclusions: Among patients with temporal lobe epilepsy, low versus high seizure frequency is predicted by respective upregulation and downregulation of leukocyte gene expression involved in the biological processes of neuroinflammation, oxidative stress and lipid peroxidation, GABA (γ-aminobutyric acid) inhibition, and AMPA (α-amino-3-hydroxy-5-methyl-4-isoxazolepropion-ic acid) and NMDA (N-Methyl- d-aspartate) receptor signaling.

3) James Pan, MD. University of Washington, Seattle, WA

Complications of Pediatric Tethered Cord Release: Seattle Children's Hospital Experience

Introduction: We describe six years of surgical experience at our pediatric neurosurgery center, with a wide variety of operative complexity and etiologies related to tethered cord syndrome. While complications are well-described, the risk of complications associated with complexity of the procedure needs further investigation. Based on our findings, we propose guidelines to minimize complications and give attention to certain high-risk groups of patients.

Objective: To identify overall risk factors associated with pediatric tethered cord surgeries at our high-volume tertiary children's hospital and to further assess risk factors associated with surgeries defined as either simple or complex procedures.

Methods: Medical records of children who underwent surgery for tethered cord release (CPT 63200) from July 2014 to December 2020 were retrospectively reviewed after approval by the Institutional Review Board at Seattle Children's Hospital. Data collected included demographics, surgical technique, follow-up, and complications. We defined surgeries as complex if they involved usage of any of the following: plastic surgeon assistance, drain placement, duraplasty, or operative laser. Univariate analysis and multivariate logistic regression were used to determine covariates that were protective or risk factors for development of complications.

Results: In 242 contiguous tethered cord operations (51.8% male, mean age 74.8 months), the overall complication rate of any type was 10.7% (3.45% simple, 17.46% complex). Median time until complication was 11 days. Complications were associated with usage of the operative laser, increasing hospital length of stay, and increasing operative time. Plastic surgery assistance (OR 0.357, 95% CI 0.197-0.647, $p=0.0007$) and placement of a drain (OR 0.314, 95% CI 0.134-0.739, $p=0.008$) for complex cases were protective against development of complications.

Conclusion: Our complication rate is comparable to those of others (1-4). However, multivariate logistic regression analysis suggests that plastic surgery assistance and drain placement can be protective factors, and should be considered in complex tethered cord operations.

4) Kevin Kumar, MD PhD. Stanford University

High efficiency microglia replacement ameliorates motor deficits and improves survival in a mouse model of Gaucher disease

Introduction: Gaucher disease (GD) is the most common lysosomal storage disease. Children with GD have **progressive** neurodegeneration which is recalcitrant to conventional therapy. Recently, we have developed a bone marrow transplantation (BMT) technique that repopulates microglia within the CNS with circulation derived microglia-like cells (CDMCs).

Objectives: We hypothesized that CDMCs could serve as a cellular delivery platform to the brain, allowing restoration of dysfunctional proteins in GD. Using the prosaposin (Psap)/glucocerebrosidase (Gba1) mouse model, we assessed the impact of microglial replacement on motor function and survival.

Methods: BMT harvest from Psap/Gba1 donors was followed by injection into 6-week-old recipient mice. Recipients were subsequently treated with PLX5622, a CSF1R inhibitor, to deplete endogenous microglia. Behavioral characterization was performed at 10 and 20 weeks. Brains were processed to quantify donor chimerism and Psap expression.

Results: BMT-treated mice exhibited high efficiency replacement of microglia by Iba1+ Psap+ CDMCs. BMT ameliorated the increase in area measured in mutant mice ($p < 0.0001$). BMT from Psap/Gba1 control donors to mutant recipients prevented decline in unilateral forelimb and hindlimb stride ($p < 0.0001$). BMT-treated mice had no increase in falls from 10 to 20 weeks and significantly less falls at 20 weeks compared to mutants ($p < 0.0001$). BMT from Psap/Gba1 control donors to mutant recipients improved overall survival ($p < 0.05$).

Conclusions: Here we demonstrate that a near complete replacement of microglia with CDMCs improves motor phenotypes and extends lifespan in a mouse model of neuronopathic GD. Microglial replacement has great potential as a therapeutic strategy for a variety of neurodevelopmental disorders.

Resident Award Presentations

1) Jessica Eaton, MD. University of Washington, Seattle, WA.

Complications Associated with Early Cranioplasty for Traumatic Brain Injury Patients: A 25-year Single-Center Analysis

Objective

Cranioplasty is a technically simple procedure, but one with potentially high rates of complications. Ideal timing of cranioplasty should minimize risk, but research investigating cranioplasty timing and complication risk has generated conflicting findings. Previous studies include mixed populations undergoing cranioplasty following decompression for traumatic, vascular, and other cerebral insults, making results challenging to interpret. The objective of this study was to examine complication rates associated with cranioplasty specifically for traumatic brain injury (TBI) patients receiving this procedure at our high-volume level 1 trauma center over a 25-year time period.

Methods

We conducted a single institution retrospective review of patients undergoing cranioplasty after decompression for trauma. Clinical and demographic variables were obtained from 2 neurotrauma databases. Patients were categorized into 3 groups based on cranioplasty timing: early (≤ 90 days after craniectomy), intermediate (91-180 days after craniectomy) and late (> 180 days after craniectomy). We also conducted a subgroup analysis of complications in TBI patients associated with ultra-early cranioplasty (< 42 days after craniectomy).

Results

Of 435 patients identified, 141 underwent early cranioplasty, 187 received intermediate cranioplasty, and 107 underwent late cranioplasty. A total of 54 patients underwent ultra-early cranioplasty. Among the total cohort, the mean rate of post-op hydrocephalus was 2.8%, rate of seizure was 4.6%, rate of post-operative hematoma was 3.4%, and rate of infection was 6.0%. Total complication rate for the entire population was 16.8%. There was no significant difference in complications between the 3 groups. No significant differences in post-operative complications were found comparing the ultra-early cranioplasty group with all other patients combined.

Conclusions

In this cohort of TBI patients, early cranioplasty, including ultra-early procedures, were not associated with higher rates of complications. Early cranioplasty may confer benefits, such as shorter or fewer hospitalizations, decreased financial burden, and overall improved recovery, and should be considered based on patient-specific factors.

2) Matthew Sun, MD. UCLA

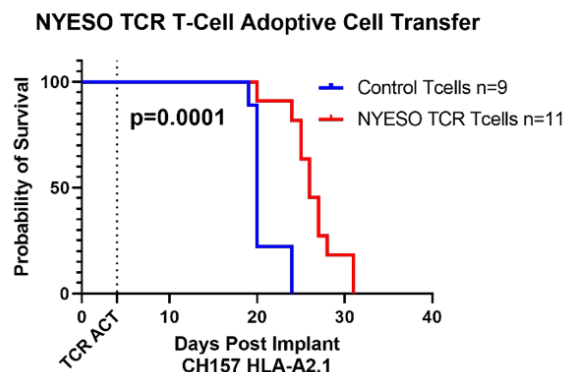
Systemic Adoptive Cell Transfer Immunotherapy with TCR-transduced T-Cells Targeting NY-ESO-1 for Meningiomas

INTRODUCTION: High grade meningiomas lack effective adjuvant therapy. Cancer-Testis-antigens(CTA) are ideal immunotherapy targets, and NY-ESO-1 is the most frequently expressed CTA in meningiomas. Decitabine is a hypomethylating agent known to upregulate CT-antigens and augment immunotherapy. Because NY-ESO-1 is expressed cytoplasmically rather than on the cell-surface, it can be targeted by engineered T-cell-receptors(TCR) rather than by CAR-T's. To evaluate the feasibility of systemic adoptive-cell-transfer(ACT) for meningiomas, we tested the efficacy of NY-ESO-1 TCR-transduced T-cells in vitro and in vivo, and the role of decitabine in augmenting meningioma immunotherapy.

METHODS: Immunohistochemistry for NY-ESO-1 was performed on meningioma samples(Grade I-III) from the OR. TCR-Transduced T-cells were generated by double-transfection with supernatants from PG-13 retroviral packaging cells encoding HLA-A2.1-restricted NY-ESO-1(157 – 165)-specific TCR. We utilized human meningioma cells SF1335(Grade I, HLA-A2.1 positive) and CH157(Grade III, HLA-A2.1 negative) in vitro and in vivo. NSG mice were intracranially implanted with meningioma cells, treated with ACT, and assessed for survival.

RESULTS: NY-ESO-1 expression positively correlated with meningioma grade($p=0.039;n=30$). SF1335 and CH157 have low and high NY-ESO-1 expression, respectively. Decitabine treatment for 48-hours significantly upregulated NY-ESO-1 mRNA expression in SF1335, with similar effect on protein expression. Co-culturing CH157, CH157-HLA-A2.1(CH157 transduced with HLA-A2.1 vector), SF1335, and decitabine-treated-SF1335 cells individually with NY-ESO-1 TCR transduced T-cells at a ratio of 1:1 resulted in 0%, 65%, 20% and 40% cytolysis at 10hours, respectively. Systemic(intravenous) ACT of TCR-transduced T-cells significantly increased overall survival in NSG mice bearing intracranial xenografts of CH157-HLA-A2.1($p=0.0001$; figure below) and SF1335(not treated with decitabine)($p=0.06$).

CONCLUSIONS: TCR-transduced T-cells induce NY-ESO-1 and HLA-A2.1-specific cytolysis in meningiomas in vitro, and systemic ACT confers a statistically significant survival benefit in vivo for meningiomas with high NY-ESO-1 expression. Decitabine upregulates NY-ESO-1 expression and increases tumor cytolysis by TCR-transduced T-cells in meningiomas. Targeting NY-ESO-1 may be a clinically feasible immunotherapeutic strategy to treat high-grade meningiomas.



Scientific Session V

1) Laura M Prolo, MD, PhD. Stanford University

Prediction of shunt placement following neonatal intraventricular hemorrhage using an integrated risk scale

Co-Author Names and Degrees: Michael C. Jin BS, Jonathon J. Parker MD, PhD, Adrian J. Rodrigues BA, Gabriela D. Ruiz Colón BA, Cesar A. Garcia BA, Kelly B. Mahaney MD, Gerald A. Grant MD

Introduction

Neonatal intraventricular hemorrhage (IVH) is a major source of morbidity and mortality due to posthemorrhagic hydrocephalus and affects approximately 3000 infants annually. Currently, there are no risk classification methods to predict prognosis which integrate maternal and neonatal clinical data.

Methods

Neonates with IVH were identified from the Optum Clinformatics DataMart administrative claims database. Matched maternal and neonatal characteristics were obtained. Primary endpoints-of-interest were short-term (30-day) mortality and long-term VPS placement. Classification of short-term mortality risk was evaluated using five different machine learning approaches and the best-performing method was validated using a withheld validation subset. Prediction of long-term shunt risk was performed using a multivariable Cox regression model with stepwise variable selection, which was subsequently converted to an easily applied integer risk scale.

Results

A total of 5,926 neonates with IVH were identified. Most patients were born before 32 weeks' gestation (67.2%) and with low birthweight (81.2%). 30-day mortality risk was 10.9% across all IVH grades and highest among grade IV (34.3%). Among those surviving beyond 30 days, 12-month post-diagnosis risk of shunt placement was 5.4% across all IVH grades and 31.3% for grade IV IVH. The optimal short-term risk classifier was a random forest model achieving an AUROC of 0.882 with gestational age being the strongest predictor. Selected features for long-term shunt risk stratification were IVH grade, respiratory distress syndrome, disseminated intravascular coagulation, and maternal preeclampsia/eclampsia. An integer risk scale was developed from these four features which demonstrated improved risk stratification compared to IVH grade alone (Harrell's concordance index 0.869 vs 0.852).

Conclusions

In a large cohort of neonates with IVH, we developed a two-pronged integrated risk classification approach to anticipate short-term mortality and long-term shunt risk. The application of such approaches may improve outcome prognostication and identify a higher risk cohort warranting more careful surveillance and earlier intervention.

3) Ray Chu MD. Cedars Sinai Medical Center

The Utility of ICG Vascular Fluorescence with Augmented Reality in Tumor Resection

Introduction: The use of ICG (indocyanine green) has been well described in surgery for aneurysms and vascular malformations. However, its use in tumor surgery is less discussed. There is also now a technique using augmented reality to improve the performance of ICG during the resection.

Methods: A new microscope uses a technique in which ICG fluorescence is obtained, but the data can be overlaid in the normal microscope field allowing simultaneous viewing of the ICG data and the regular operative field; the technique is called GLOW 800. This is a report of the use of the GLOW 800 and resection of a hemangioblastoma.

Results: With GLOW 800, vascular shunting was seen within the hemangioblastoma, and the technique aided in identifying arterial feeders and venous drainage. This technique offers the advantage that the information is available immediately in the regular microscope view without the distraction of looking at a separate monitor, without the extra steps of picturing where the fluorescence was compared to the regular operative view, and with the ability to manipulate structures for better viewing in real time. The outcome was gross total resection with no neurologic deficits. Suggestions for GLOW 800 use in tumor resection will be discussed.

Conclusions: The use of ICG in resection of vascular tumors may be beneficial, especially with the augmented reality technique GLOW 800.

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*deceased

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2. Timberline Lodge, OR	Dec 9-11, 1956
3. Holiday Hotel, Reno, NV	Sept 29-Oct 1, 1957
4. Del Monte Lodge, Pebble Beach, CA	Oct 19-22, 1958
5. La Valencia Hotel, La Jolla, CA	Sept 27-30, 1959
6. Del Monte Lodge, Pebble Beach, CA	Oct 23-26, 1960
7. Bayshore Inn, Vancouver, BC	Oct 29-Nov 1, 1961
8. Camelback Inn, Phoenix, AZ	Oct 28-31, 1962
9. El Mirador Hotel, Palm Springs, CA	Oct 20-23, 1963
10. Fairmont Hotel, San Francisco, CA	Oct 18-21, 1964
11. Olympic Hotel, Seattle, WA	Oct 3-6, 1965
12. Hotel Utah, Salt Lake City, UT	Nov 6-9, 1966
13. Kona Kai Club, San Diego, CA	Oct 15-18, 1967
14. Mauna Kea Beach Hotel, Kamuela, HI	Nov 16-19, 1968
15. Del Monte Lodge, Pebble Beach, CA	Oct 15-18, 1969
16. Bayshore Inn, Vancouver, BC	Oct 4-7, 1970
17. The Broadmoor, Colorado Springs, CO	Oct 31 -Nov 3, 1971
18. The Skyline Country Club, Tucson, AZ	Oct 29-Nov 1, 1972
19. Airport Marina Hotel, Albuquerque, NM	Sept 16-19, 1973
20. Santa Barbara Biltmore Hotel, CA	Oct 27-30, 1974
21. Mauna Kea Beach Hotel, Kamuela, HI	Sept 28-Oct 1, 1975
22. Harrah's Hotel, Reno, NV	Sept 26-29, 1976
23. La Costa Resort Hotel, Carlsbad, CA	Sept 18-21, 1977
24. The Lodge, Pebble Beach, CA	Oct 8-11, 1978
25. Camelback, Inn, Scottsdale, AZ	Sept 23-26, 1979
26. Mauna Kea Beach Hotel, Kamuela, HI	Sept 21-24, 1980
27. The Empress Hotel, Victoria, BC	Sept 20-23, 1981
28. Jackson Lake Lodge, Jackson Hole, WY	Sept 12-15, 1982
29. Hotel del Coronado, Coronado, CA	Oct 2-5, 1983
30. The Broadmoor, Colorado Springs, CO	Sept 9-12, 1984
31. Silverado Country Club & Resort, Napa, CA	Sept 22-25, 1985
32. Maui Intercontinental, Wailea, Maui, HI	Sept 28-Oct 1, 1986
33. Banff Springs Hotel, Banff, AB	Sept 6-9, 1987
34. The Ritz-Carlton, Laguna Niguel, CA	Sept 11-14, 1988
35. The Lodge, Sun Valley, ID	Sept 10-13, 1989
36. Mauna Lani Bay Hotel, Kawaihae, HI	Sept 9-12, 1990
37. The Pointe, Phoenix, AZ	Sept 22-25, 1991
38. The Whistler, Whistler, BC	Sept 20-23, 1992
39. Mauna Lani Bay Hotel, Kawaihae, HI	Sept 19-22, 1993
40. Le Meridien Hotel, San Diego, CA	Sept 18-21, 1994
41. Salishan Lodge, Gleneden Beach, OR	Sept. 9-12, 1995
42. Manele Bay, Island of Lanai, HI	Sept 14-17, 1996
43. Ojai Valley Inn, Ojai, CA	Sept 20-23, 1997
44. Silverado Resort, Napa, CA	Sept 12-15, 1998
45. Coeur d'Alene Resort, Coeur d'Alene, ID	Sept 18-21, 1999
46. Mauna Lani Bay Hotel, Hawaii, HI	Sept 9-11, 2000
47. Ocean Pointe Resort, Victoria BC (Cancelled)	Sept 15-18, 2001
48. Delta Victoria Resort, Victoria, BC	Oct 12-15, 2002
49. Hapuna Beach Prince Hotel, Kamuela, HI	Sept 20-24, 2003
50. Rancho Bernardo Inn, San Diego, CA	Sept 11-14, 2004
51. Squaw Creek Resort, Lake Tahoe, CA	Sept. 17-20, 2005
52. Semiahmoo Resort & Spa, Blaine, WA	Sept. 16-19, 2006
53. Mauna Lani Bay Hotel, Kawaihe, HI	Sept. 8-11, 2007
54. Hotel Captain Cook, Anchorage, AK	Aug. 16-19, 2008
55. Sun River Resort, Bend, OR	Sept. 11-14, 2009

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MEMBERSHIP DIRECTORY

M. Samy Abdou M.D.

O: (619)528-0501 F: (858)759-3488
Dept. of Neurosurgery Kaiser Hospital
4647 Zion St. San Diego, CA 92120
Robin Moyer, MD
abdoul@msn.com Active - 2007

Moustapha Abou-Samra M.D.

Joanie
557 Via Cielito Ventura, CA 93003
681 Buena Vista Ventura, CA 93001
mabousamra@aol.com Active-1992

Bret Abshire M.D.

O:(951) 587-3739 F: (951) 693-0731
2515 Hancock Ave., Suite 210
Murrieta, CA 92562 H: (951) 699-5774
Beth
42925 Calle Corto Temecula, CA
92590
bretabshire@yahoo.com Active-2011

David Adler M.D.

O: (503) 796-2743 F:(503)796-2742
1040 NW 22nd Avenue, Ste. 630
Portland, OR 97210 H: (503)702-5021
3773 NE Devoto Lane Portland, OR
97229
dadler@columbianeurosurgical.net
Active-2013

John R. Adler M.D.

O: (650) 723-5573 F: (650) 723-1784
Stanford Medical Center
Neurosurgery, R205
300 Pasteur Drive Stanford, CA
94305-5327
Marilyn
894 Tolman Drive Stanford, CA 94305
ira@stanford.edu Honorary-1991

Brian T. Andrews M.D.

O: (415) 600-7760 F: (415) 600-7765
45 Castro Street, Suite 421
San Francisco, CA 94114 H: (650)
579-1073
Linda
btanevro2@aol.com Active-1994

Henry Aryan M.D.

O: (559) 256-1030 F: (559) 434-5742
1630 E. Herndon Ave
Fresno, CA 93720
Hala
haryan@spoc-ortho.comActive-2012

Farbod Asgarzadie M.D.

O: (909) 556-4952
9961 Sierra Ave, MOB#1 Fontana, CA
92335
Allie Blackburn
951 Sunset Hills Lane Redlands, CA
92373
farbodasgarzadie@yahoo.com
Active-2014

James I. Ausman M.D.

O (760) 779-8253 H: (760) 202-7198
F(760) 770-4453
39000 Bob Hope Drive P 311 Rancho
Mirage, CA 92270
Carolyn
70950 Fairway Drive Rancho Mirage,
CA 92270
jamesausman@mac.com
Active-2006

Hillel Z. Baldwin M.D.

O: (520) 881-8400 F: (520) 881-6563
Western Neurosurgery, LTD
6567 E. Carondolet Dr., # 305
Tucson, AZ 85710 H:(520) 529-0289
Jennifer
5091 N. Avenida de Castilla Tucson
AZ 85718
hillelbaldwin@comcast.net
Active 2007

Ulrich Batzdorf M.D.

O: (310) 825-5079 F: (310) 825-7245
UCLA Medical Center
Division of Neurosurgery H: (310)
451-5092
10833 LeConte Ave Box 956901 Los
Angeles, CA 90095-6901
Ellen
401 Marguerita Ave. Santa Monica,
CA 90402
ubatzdorf@mednet.ucla.edu
Senior-1970

Carter E. Beck M.D.

O: (406) 728-6520 F: (406) 329-2936
Neurosurgical Associates, P.C.
500 W Broadway, Third Floor Ste 310
H: (406)721-8282, Missoula, MT 59802
Susan
4860 Sundown Rd Missoula, MT 59804
carter.beck@providence.org
Active - 2010

Mark G. Belza M.D.

O: (541) 647-1638 F: (541) 647-1643
2275 NE Doctor's Drive, Suite 9 Bend,
OR 97701 H: (541) 318-0416 Josie
Fitzsimons, M.D.
85 NW Wilmington Ave. Bend, OR
97701
markgbelza@yahoo.com
belzagom@icloud.com Active-1998

Sharona Ben-Haim, M.D.

9300 Campus Point Drive, MC 7893
La Jolla, CA 92037
132 Verdi Ave Cardiff, CA 92007
C: 858-444-7009
tosharona@gmail.com Active 2017

Mitchel S. Berger M.D.

O: (415) 353-3933
UCSF Neurosurgery F: (415) 353-3910
505 Parnassus, M-786
San Francisco, CA 94143-2722
Joan
850 Vista Road Hillsborough, CA
94010
bergerm@neurosurg.ucsf.edu
Active-2002

Marvin Bergsneider M.D.

O: (310) 206-4100 F: (310) 825-9385
300 Stein Plaza, Suite B 200
Los Angeles, CA 90095
Linda Liao, M.D. H: (310) 474-1640
10418 Windtree Drive
Los Angeles, CA 90077
mbergsneider@mednet.ucla.edu
Active-1999

Blake Berman, M.D.

1180 N. Palm Canyon Dr., Ste 214,
Palm Springs, CA 92262
O: 760-323-4511 F: 760-323-4562
Cyndi Berman
9715 Louise Way, Rancho
Cucamonga, CA 91730
H: 909) 477-0893
drbermanb@yahoo.com
Active-2018

Estrada Bernard, MD

3831 Piper St. Ste S-450
Anchorage, Alaska
(907) 644-0399,
estrada.bernard@gmail.com
Active-2019

Keith L. Black M.D.

O: (310) 423-1773 F: (310) 423-1008
Maxine Dunitz Neurosurgical Inst.
127 S. San Vicente Blvd., Suite A6600
Los Angeles, CA 90048
Carol Bennett, M.D.
black@cshs.org Active-1996

W. Ben Blackett M.D.

O: (253) 752-4987
Neurosurgery Consulting L.L.C. H:
(253) 752-3970
PO Box 6903 F: (253) 752-4987
Tacoma, WA 98406
Glenna
4366 North Lexington
Tacoma, WA 98407
wbsurgconsult@comcast.net
Senior-1974

Kenneth Blumenfeld M.D.

O:(408) 358-0133 F: (408) 358-8134
2577 Samaritan Dr, Suite 710 San
Jose, CA 95124 H: (408) 356-2483
Ellen
208 Harding Ave Los Gatos, CA
95030
kennethblumenfeld@mac.com
Active-2011

Harsimran Brara, M.D.

O: 323-783-4011
1505 N Edgemont St, Los Angeles, CA
90027
harsimran.s.brara@kp.org
Active-2017

Neil Brown, M.D.

6444 Medicine Springs Drive
Colorado Springs, CO 80923
(954) 644-9820
mdneur@aol.com Active-2004

Kim J. Burchiel M.D.

O: (503) 494-7978 F: (503) 494-7161
OHSU Department of Neurosurgery
H: (503) 697-0969
3303 SW Bowd Ave CH8W
Portland, OR 97239
Debra
11010 SW Esquiline Circle Portland,
OR 97219 burchiek@ohsu.edu
Active-1993

Terrance Burns, MD

200 Fist St SW, Rochester, MN 55905
O: 507-284-8167 F: 507-284-5206
Kirsten Burns 710 9th Ave SW,
Rochester, MN 55902 H:
612-812-7223 burns.terry@mayo.edu
Corresponding-2018

Melvin L. Cheatham M.D.

H: (805) 643-4843 F: (805) 856-2220
244 Barnard Way Ventura, CA 93001
Sylvia
nurosgn@aol.com Senior-1975

Bahram "Barry" Chehraz M.D.

O: (916) 771-3300 F: (916) 771-3443
1301 Secret Ravine Pkwy. Ste. 200
Roseville, CA 95661 (916) 791-1171
Simi
chehraz@snamg.com Active-2005

Jeff W. Chen M.D., Ph.D.

O: (657) 210-4383 F: (714) 323-6148
101 The City Drive Building 200, Suite
210 Orange, CA 92868
Jeanne
2856 Sawgrass Drive Santa Ana, CA
92706
jeffewc1@uci.edu Active-2010

Joseph C.T. Chen M.D., PhD.

O: (323) 422-9226
309 Grand Avenue H: (626) 441-3784
South Pasadena, CA 91030
Lisa Road
JCTChen@yahoo.com Active-2013

Thomas C. Chen M.D., PhD.

O: (323) 226-7421 F: (323) 226-7833
LAC-USC Medical Center
1520 San Pablo St., Suite 3800 H:
(818) 952-5453
Los Angeles, CA 90033
Rosa
4902 Alta Canyon Rd
La Canada, CA 91011
Tchen6870@gmail.com Active-2004

Sam Cheshier, M.D.

O: (801) 585-3599 F: 650-681-7022
100 North Mario Capecchi Drive
Suite 3850 Salt Lake City UT 84113
Darci Ann Hebenstrei
835 E 18th Ave N
Salt Lake City UT 84103
samuel.cheshier@hsc.utah.edu
Active-2016

Ray Chu, M.D.

(310) 248-6693. 127 S. San Vicente
Blvd, 6th floor. Los Angeles, CA 90048
Uyen Chu.
ray.chu@cshs.org Active-2019

Richard Chua M.D.

O: (520) 742-7890 F: (520) 742-7894
5860 N. LaCholla Blvd., Ste 100
Tucson, AZ 85714 H: (520) 544-5714
Tess
6229 N. Camino DE Michael Tucson,
AZ 85718
rchua@nwneuro.com Active-2011

Austin R.T. Colohan M.D.

H: (951) 699-5431
Murrieta, CA 92563
Darla
44970 Via Renaissance Temecula,
CA 92590
acolohan@yahoo.com Active-2000

Andrew Dailey, M.D.

O: (801) 585-7575 175 South Medical
Dr. East 5th floor 94123 Salt Lake City,
UT 84123
Julie
adailey89@me.com Active-2016

William N. Dawson Jr. M.D.

H: (775) 329-7281 F: (775) 329-4124
130 Southridge Drive Reno, NV
89509
Gail
billgailnv@aol.com Senior-1994

Justin Dye, M.D.

O: 909-800-0003
1533 Pamela Cres, Redlands CA
92373
Richelin
justindye16@gmail.com Active – 2017

Fredric Edelman M.D.

O: (818) 781-3350 F: (818) 781-7237
4835 Van Nuys Blvd, Suite 114
Sherman Oaks, CA 91403 H: 818-990-
3008
Emily
5161 Amestoy Ave. Encino, CA 91316
edelmanmd@sbcglobal.net
Active-2007

Michael S.B. Edwards M.D.

O: (650) 497-8775 F: (650) 725-5086
300 Pasteur Dr., Room R211
Stanford, CA 94305-5327 H: (650) 473-
9374
Linda
edwards9@stanford.edu Active-1989

Allen Efron M.D.

O: (650) 299-2290 F: (650) 299-2677
1150 Veterans Blvd
Redwood City, CA 94063 H: (650)
559-9963
Yvette Amos
461 San Domingo Way, Los Altos, CA
94022
allen.d.efron@kp.org Active-2006

Eldan Eichbaum M.D.

O: (707) 523-1873 F: (707) 523-0119
525 Doyle Park Dr. # 102 Santa Rosa,
CA 95405 H: (707) 568-2188
Rosy Chattha
3640 Fir Ridge, Santa Rosa, CA 95403
eeichbaum@gmail.com Active-2005

Richard G. Ellenbogen M.D.

O: (206) 744-9321 F: (206) 744-9942
325 9th Ave Box 359924
Seattle, WA 98105-3901
Sandy
5616 N.E. 55th, Seattle, WA 98105
rge@uw.edu Active-1999

J. Paul Elliott M.D.

O: (303) 783-8844 F: (303) 783-2002
Colorado Brain & Spine
499 E. Hampden Ave. #220 H(303)
756-3114 Engelwood, CO 80113
Jennifer
4850 S. Albion St. Cherry Hills Village,
CO 80121
pelliott@cbsi.md Active-2003

Aria Fallah M.D.

AFallah@mednet.ucla.edu
Active-2019

Iman Feiz-Erfan M.D.

O: (602) 344-5056
2601 E Roosevelt F: (602) 344-5048
Phoenix, AZ 85008
Leah
294895 N. 107th Way Scottsdale, AZ
iman_feiz-erfan@dmagaz.org
Active-2011

Edmund H. Frank M.D.

O: (503) 789-1714
2850 SW Cedar Hills Blvd. #254 F:
(503) 494-8160
Beaverton, OR 97201 H: (503)
297-8524
Eustacia Su
1500 SW 11th Ave Portland, OR 97201
edmundf@earthlink.net Active-1996

John G. Frazee M.D.

O: (310) 206-1231 F: (310) 267-2208
UCLA Medical Center Neurosurgery
Box 957039 H: (818) 704-8803
Los Angeles, CA 90095-7039 Jennifer
30075 Triunfo Dr., Agoura Hills, CA
91301 jfrazee@mednet.ucla.edu
Active-1985

William F. Ganz, MD

O: (208) 664-6964
Neurosurgery and Spine Northwest
2236 N Merrit Creek Loop, Ste A
Coure D Alene, ID 83814-4960 Luann
1140 Harborview Drive
Coure D Alene, ID 83814
wfganz@gmail.com Active-2014

John T. Garner M.D.

O: (702)243-3592 F: (702)243-3593
2834 Dove Run Creek
Las Vegas, NV 89135
Candace
jtgrex@aol.com Senior-1968

Grant E. Gauger M.D.

O: (415)750-2059 F: (415)750-2181
University of California
Box 0112 San Francisco, CA 94143-0112
Austra H: (510)531-1095
13300 Clairepointe Way Oakland, CA 94619
grant.gauger@va.gov Active-1983

Rosemaria Gennuso-Kyle M.D.

O: (210)643-3387
20952 Great Navajo, San Antonio, Texas, 78229 H: (210)366-0669
Texal Kyle
8 Wolfwood San Antonio, TX 78248
rgkyle@sbcglobal.net
Corresponding-1999

Gregory Gerras M.D.

O: (619)528-0501
5670 Calle Miramar F: (619)528-7237
La Jolla, CA 92037 H: (858)459-1718
Robin Kaanana-Gerras
gggerras@hotmail.com Active-1998

Steven L. Giannotta M.D.

O: (323)226-7421 F: (323)226-7833
LAC/USC Medical Center
1200 North State Street #5046
Los Angeles, CA 90033
3644 Lombardy Road
Pasadena, CA 91107 H:626 577-4892
giannott@usc.edu Senior-1984

DeWitt B. Gifford M.D.

O: (831)622-9547
PO Box 6027 F: (510)865-7010
Carmel, CA 93921 H: (831)622-9547
Mary
giff@dewittgifford.com Senior-1983

Gerald A. Grant, M.D.

O: (650)497-8775
Stanford Department of
Neurosurgery F: (650)725-5086 300
Pasteur Dr., Rm R211/MC 5327
Stanford, CA 94305-2200
Laura
ggrant2@stanford.edu Active-2014

Mark Hamilton M.D. O: (403)

944-1626 F: (403)283-2270 Foothills
Hospital Division of Neurosurgery,
12th Floor
1403 29th St NW Calgary, AB T2N 2T9
Canada
Heather Graham
5028 Vanstone Cr NW Calgary, AB
T3A 0V9 H: (403)288-3790
mghamilton.hydro@gmail.com
Active-2011

Ciara Harragher M.D.

O: (831)475-5232 F: (831)475-5733
1595 Soquel Drive, Ste 360 Santa
Cruz, CA 95065 H: (831)431-6328
Michael McDonnell
121 Greystone Way Soquel, CA
95073
Harragher@stanford.edu Active-2013

Odette Harris M.D., M.P.H.

O: (650)723-5574 F: (650)852-3380
300 Pasteur Drive R205 Stanford, CA
94305
Edward Sharp
26958 DeZahara Way
Los Altos Hills, CA 94022
oharris@stanford.edu Active-2013

Jason Hauptman M.D.

4800 Sand Point Way NE, OA.9.220
Seattle, WA 98105. 1-206-987-4240
Jason.Hauptman@Seattlechildrens.org
Active-2019

Melanie Hayden Gephart, M.D.

O: 650-498-4548
1201 Welch Rd MSLS Bldg, Room
P307, Stanford, CA 94305
Matthew Hayden
mghayden@gmail.com Active-2016

Jaimie Henderson M.D.

O: (650) 723-5574 F:(650) 725-8279
300 Pasteur Dr R227 Stanford, CA
94305
241 Santa Teresa Lane Stanford, CA
94305
henderj@stanford.edu Active-2011

Deborah C. Henry M.D.

O: (626) 390-3125
P.O. Box 3545
Newport Beach, CA 92659
dchenry.md@sbcglobal.net
Active-2002

Christopher Honey M.D.

O: (604) 875-5894 F: (604) 875-4882
8105-2775 Laurel St. Vancouver, BC
V5Z 1M9 Canada
Karla
6312 Angus Drive Vancouver, BC
V6M 3P5 Canada
chris.honey@telus.net Active-2011

Robert S. Hood M.D.

O: (801) 581-6908 F: (801) 581-4385
175 N Medical Dr E, 5th Floor
Salt Lake City, UT 84123-2313 H: (801)
531-6740
Kim
1336 East Perrys Hollow Drive
Salt Lake City, UT 84103
robert.hood@hsc.utah.edu
Active-1991

Thomas E. Hoyt M.D.

O: (559) 739-1300
720 West Main Street, Suite B H: (559)
798-1072 Visalia, CA 93291
Diann
hoytmdinc@yahoo.com Active-1997

Frank Hsu M.D., PhD.

O: (714) 456-6966 F: (714) 456-8212
University of California Irvine 200 S.
Manchester Ave. #210 H: (949)
444-9381
Orange, CA 92868
Wenwei
38 Mistral Lane Irvine, CA
fpkhsu@uci.edu Active-2008

Hector Edward James M.D.

O: (904) 633-0793 F: (904) 633-0781
836 Prudential Dr. Pavillion 1005, Ste
1205 Jacksonville, FL 32207 Christina
pedneurosurgery@aol.com
Corresponding-1985

J. Patrick Johnson M.D.

O: (310) 423-9900 F: (310) 423-9767
Institute of Spinal Disorders
Cedars Sinai Medical Center H: (310)
471-7144
444 South San Vicente, Suite 800
Mark Goodson Bldg. Los Angeles, CA
90048
Bridget
32107 Lindero Canyon Rd #235 West
Lake Village, CA 91361
johnsonjp@cshs.org Active-1998

Stephen D. Johnson M.D.

O: (303) 861-2266 F: (303) 830-7054
Western Neurological Group, P.C.
1601 East 19th Avenue, Suite 4400
Denver, CO 80218-1253
Judi Gervasini
2417 Daisy Lane Golden, CO 80401
speedjohnsonwng@yahoo.com
Active-1993

Theodore Kaczmar Jr. M.D.

O: (831) 424-0807 F: (831) 424-3408
220 San Jose Street Salinas, CA
93901-3975 H: (821) 372-1214
Debra
11143 Saddle Rd Monterey, CA
93940
tedkazz@aol.com Active-1991

Michael M. Kendrick M.D.

O: (541) 389-7340 F: (541) 389-0882
2874 NW Three Sisters Drive
Bend, OR 97701
Paula
MKendrick@bendcable.com
Lifetime Senior-1989

Glenn W. Kindt M.D.

O: (303) 724-2305 F: (303) 724-2300
12631 E. 17th Avenue, MS C-307
Aurora, CO 80045 H: (303) 740-8560
Charlotte
4991 Emporia Court Englewood, CO
80111
glenn.kindt@ucdenver.edu
Lifetime Senior-1983

Douglas B. Kirkpatrick M.D.

H: (541) 772-2232
330 Harvard Place Medford, OR
97504
Terrie
Kirkpat@charter.net Senior-2004

Phillip Kissel M.D.

O: (805) 544-4455 F: (805) 544-5815
699 California Blvd., Suite A
San Luis Obispo, CA 93401 H: (805)
545-8314
Janice
1610 Calle Crotalo San Luis Obispo,
CA 93401
pkissel@pkisselneurosurgery.com
Active-1997

George H. Koenig M.D.

H: (760) 771-4141 F: (760) 771-4443
79963 Rancho La Quinta
La Quinta, CA 92253
Beth
ghkmd@mac.com Senior-1987

John A. Kusske M.D.

H: (541) 306-6804
18160 Cottonwood Road, PMB 558
Cell (949) 300-5111 Bend, OR
97707-9317
jkusske@bendbroadband.com
Senior-1975

Roderick G. Lamond M.D.

O: (303) 403-7300 F: (303) 403-7310
3455 Lutheran Pkwy, Ste. 280
Wheatridge, CO 80033 H: (303)
697-0984
rglamondmd@yahoo.com
Active-1988

Barton Lane M.D.

H: (650) 948-2492648
Distel Drive Los Altos, CA 94022
blane@stanford.edu Senior-1996
Aleksandyr Lavery M.D.
O: (650) 299-3695 F: (650) 299-2677
1150 Veterans Blvd.
Redwood City, CA 94063
Desiree LaBeaud
aleksandyr.w.lavery@kp.org
Active-2013

Michael T. Lawton M.D.

O: (602) 406-3489
2910 N. 3rd Avenue Phoenix, AZ
85013
C: 415-699-668
6502 Lost Dutchman Drive Paradise
Valley, AZ 85253
Michael.Lawton@BarrowBrainandSpine.com
Active-2002

Marco B. Lee M.D. Ph.D.

O: (408) 885-6062 F: (408) 885-6195
Department of Neurosurgery 300
Pasteur Drive H(408) 338-9001,
Stanford, CA 94305
Vanessa
1252 Cherry Avenue San Jose, CA
95125
vanessaleefamily@gmail.com
marcolee@stanford.edu
Active-2011

G. Michael Lemole, Jr., M.D.
O: (520) 626-2164 F: (520) 626-8313
University of Arizona
1501 N. Campbell Ave., Room 4310
(520) 395-2085
PO Box 245070 Tucson, AZ 85724-7880
Ruthie
1783 Sahuaro Blossom Pl Tucson, AZ
85718
mlemole@surgery.arizona.edu
Corresponding-2010

Lewis Leng, M.D.
O: 415-885-8628
2100 Webster St #115, San Francisco,
CA 94115 C: 917-558-7193
Susanne Marie Kasper
10 Oak Ridge Rd., Berkeley, CA
94705
lzleng@gmail.com Active - 2017

Jay M. Levy M.D.
O: (707) 255-7900 F: (707) 224-0445
1370 Tranca Street #164 Napa, CA
94558 H: (707) 224-3023
Jodi
2477 Old Soda Springs Rd. Napa, CA
94558
jbird94558@yahoo.com Senior-1998

Gordon Li, M.D.
1201 Welch Rd, MSLS Bldg, Room P
309, Stanford, CA 94305
gordonli@stanford.edu Active-2016

Linda Liau M.D., PhD., MBA
O: (310) 267-2621 F: (310) 825-9388
UCLA Neurosurgery
10833 Le Conte Avenue Los
Angeles, CA 90095-6901
Marvin Bergsneider, M.D.
10418 Windtree Drive
Los Angeles, CA 90077
H: (310) 474-1640
lliau@mednet.ucla.edu Active-2003

Jason Lifshutz M.D.
O: (503) 786-8435
286 D Ave, Lake Osuego, OR 97034
Julie
jason.lifshutz@kp.org Active-2011

Mark E. Linskey M.D.
O: (714) 456-6966 F: (714) 456-8212
101 The City Drive South Bldg. 56, Ste
400 Orange, CA 92868
JoAnne
1429 High Bluff Drive Newport
Beach, CA 92660
mlinskey@uci.edu Active-2004

Andrew Little M.D.
O: (602) 406-2596 F: (602) 294-4492
Barrow Neurosurgical Associates
2910 N. 3rd Avenue H(602) 625-9068
Phoenix, AZ 85013
Susan Lin, MD
216 W. Flynn Lane Phoenix, AZ 85013
Andrew.Little@bnaneuro.net
Active-2013

John D. Loeser M.D.
O: (206) 543-3570 F: (206) 543-8315
1959 N.E. Pacific St., Campus Box
356470 Dept. of Neurological
Surgery (425) 450-1798
Seattle, WA 98195
Karen
4228 91st Avenue N.E. Yarrowpoint,
WA 98004-1210
jcloeser@uw.edu Senior-2006

William Loudon M.D., PhD.
O: (714) 835-2724
1010 West La Veta, Suite 710 F: (714)
835-2752
Orange, CA 92867 H: (949) 498-6068
Ruth
4020 Calle Madera San Clemente,
CA 92672
wgloudon@gmail.com Active-2011

Andres M. Lozano, MD, PhD
Toronto Western Hospital
399 Bathurst St. WW4-447
Toronto ON M5T-2S8 Canada
O:(416) 603-6200
lozano@uhnres.utoronto.ca
Honorary 2015

Joel MacDonald M.D.
O: (801) 581-6908 F: (801) 581-4385
175 N. Medical Dr. East Salt Lake
City, UT 84132
4172 S. Mathew Way Salt Lake City,
UT 84124
joel.macdonald@hsc.utah.edu
Active-2004

Luke Macyszyn, M.D.

O: 727-742-429 C 727-742-4292
300 Stein Plaza, Suite 540 Los
Angeles, CA, 90095
Felicia
4764 La Villa Marina Unit D Marina
del Rey, CA, 90292
lmacyszyn@mednet.ucla.edu
Active-2017

Gail A. Magid M.D.

O: (307) 699-2345
475 North Fall Creek Rd H(307)
733-4731 Wilson, WY 83014-0066
Roseanne
magid@onewest.net Senior-1971

Claudia Martin, M.D.

O: 503-715-6776 F: 540-772-3830 710
SW Skyline Blvd, Portland, OR 97221
cmartin_md@live.com Active-2017

Duncan McBride M.D.

O: (310) 319-4268 F: (310) 618-8157
1000 West Carson Street Torrance,
CA 90509
Michelle
1 Runningbrand Road
Rolling Hills, CA 90274
dmcbride@mednet.ucla.edu
Active-1993

Bruce M. McCormack M.D.

O: (415) 923-9222 F: (415) 923-9255
2320 Sutter Street #202 San
Francisco, CA 94115
Dede
3948 Clay Street San Francisco, CA
94118
bmccormack@neurospine.org
Active-1998

Michael W. McDermott M.D.

8900 N Kendall Drive
Miami, FL 33176
mwmc57@comcast.net
Corresponding-1999

John H. McVicker M.D.

O: (719) 365-6300 F: (719) 365-6094
28 W. Monument, Suite 502
Colorado Springs, CO 80903 H: (303)
589-8313
Debra
1304 E. Saint Vrain St Colorado
Springs, CO 80909
acns.mhs@gmail.com Active-1997

Alim Mitha, M.D.

Foothills Medical Centre
1403-29th Street NW
Calgary, Alberta T2N-2T9 Canada
O:403-944-4550
403 Riverdale Avenue SW Calgary,
Alberta T2S-0X7 Canada
T: 403- 852-6158
amitha@ucalgary.ca Active-2018
Billie

David F. Morgan M.D.

O: (310) 540-0965 176 F: (310) 540-
6721
21350 Hawthorne Blvd., Suite
Torrance, CA 90503 H: (310) 545-4300
Marsha
17 Chatham
Manhattan Beach, CA 90813
davidmorgan530@yahoo.com
Active-1988

Jay K. Morgan M.D.

O: (775) 323-2080 F: (775) 829-8354
5590 Kietzhe Lane Reno, NV 89511 H:
(775) 829-2286
Sherry
2336 Manzanita Lane Reno, NV
89509 C: 775-250-3879
Jmorgan48@sierraneurosurgery.com
Active-1998

Martin Mortazavi M.D.

(805) 795 - 7656
martin.mortazavi@cinero.org
Active-2019

J. Paul Muizelaar, M.D.

dutchmaster@yahoo.com
Corresponding-2016

Praveen Mummaneni M.D.
O: (415) 353-3998
505 Parnassus Ave., M780 F: (415)
353-3907 San Francisco, CA 94143
Valli
387 Darrell Road Hillsborough, CA
94010
praveen.mummaneni@ucsf.edu
Active-2009

Wallace Nelson M.D.
H: (360) 482-4387
10238 Matlock Brady Road
Elma, WA 98514
suekorvell@gmail.com Senior-1967

David Newell M.D.
550 17th Avenue
Seattle Neuroscience Institute-
Shirley
1126 38th Ave East Seattle, WA 98112
snewell@seanet.com
davidwnewell@gmail.com
Active-2004

Charles E. Nussbaum M.D.
O: (206) 223-7525 F: (206) 341-0443
PO Box 900, X7-NS Seattle, WA 98111
H: (425) 957-0255
Debbie
16481 SE 59th Street
Bellevue, WA 98006
ce.nuss18@outlook.com Active-1998

George Ojemann M.D.
O: (206) 543-3570 F: (206) 543-8315
University of Washington
Dept. of Neurosurgery
1959 NE Pacific St., Box 356470
Seattle, WA 98195
Linda
lgojemann@gmail.com Senior-1995

Donald R. Olson M.D.
O: (503) 885-1188
18325 NE Fairview Drive F: (503)
538-2239 Dundee, OR 97115
dotmvw@gmail.com Senior-1971

Kimberly A. Page M.D.
O: 208-625-3800
3326 N. Merritt Creek Loop
Coeur d'Alene, ID 83814
kpage2@mac.com
Active-2005

Richard Perrin M.D.
rperrin@sierraneurosurgery.com
Active-2019

John P. Phillips M.D.
O: (831) 484-1253 P.O. Box 379 Tahoe
Vista, CA 96148
June H. Dunbar, M.D. Senior-1981

David T. Pitkethly M.D.
H: (425) 882-3315 F: (425) 861-3809
9821 Hilltop Road Bellevue, WA
98004
Mara
dtpit@uw.edu Active-1989

Nader Pouratian, M.D.
300 Stein Plaza, Ste. 562
Los Angeles, CA 90095
O: 310-206-2189
NPouratian@mednet.ucla.edu
801 Devon Ave. Los Angeles, CA
90024 C: 310-6999137

J. Adair Prall M.D.
O: (720) 638-7500 F:(303) 586-2292
Littleton Adventist Hospital
7780 S. Broadway, Ste. 350 (303)
797-3633 Littleton, CO 80122
Kellie
5265 Skyline Trail Littleton, CO 80123
ap1964@comcast.net Active-2010

Donald J. Prolo M.D.
O: (408) 295-4022 F: (408) 295-2562
203 Di Salvo Avenue San Jose, CA
95128 H: (408) 354-8333 H: F: (408)
354-1532 Joanne
19841 Glen Una Drive Saratoga, CA
95070
don@donaldprolo.com
Lifetime Senior-1974

Richard Rapport M.D.

O: (206) 744-9306 F: (206) 744-9944
UW Dept of Neurologic Surgery
325 Ninth Ave., Box 359924 Seattle,
WA 98014
Valerie Trueblood
141 39th Ave. East Seattle, WA 98112
rappor@uw.edu Lifetime Senior-2006

John Ratliff M.D.

1924 Edgewood, Palo Alto, CA94303
Carla
jratliff@stanford.edu Active-2019

R.L. Patrick Rhoten MD

O: (310) 385-8030
444 S. San Vicente Blvd. #901 F: (310)
385-8035 Los Angeles, CA 90048 Mae
prhotenmd@gmail.com Active-2011

J. Charles Rich M.D.

H: (760) 799-2484
25 Columbia Dr. Rancho Mirage, CA
92270
Jasmine
jcrichnsur@aol.com Senior-1975

Steven Ritland M.D.

O: (928) 779-7880 F: (928) 779-7895
1150 N. San Francisco Street Flagstaff,
AZ 86001
Wendy Lamb
stephenritland@gmail.com
Active-2011

Cavett M. Robert Jr. M.D.

H: (925) 980-5908
3959 Canyon Road F: (925) 283-1474
Lafayette, CA 94549-2701
Sande
cavett@mac.com
Lifetime Senior-1996

Marshal Rosario M.D.

O: (408) 358-0838 F: (408) 358-2160
15899 Los Gatos-Almada Rd., Suite 1
Los Gatos, CA 95032 H: (650) 940-1596
Christine
951 Berry Avenue Los Altos, CA 94024
mdrosariomd@comcast.net
Active-1992

Ian Ross M.D.

O: (626) 793-8194 F: 626 793-3664
630 S Raymond Ave, Suite 330
Pasadena, CA 91105 H: 626 396-9454
Cathy Pitfield
1605 Pegfair Estates Drive
Pasadena, CA 91103
ianrossmd@gmail.com Active-2011

Jeffery L. Rush M.D.

H: (970) 453-5631 F: (970) 453-8093
P.O. Box 7399 PMB 326
Breckenridge, CO 80424
Pamela
jefferyleerush@msn.com Senior-1981

Madjid Samii, M.D

International Neuroscience Institute
Rudolf Pichlmayr Str. 4
30625 Hannover Honorary -1997

Charles J. Scibetta M.D.

O: (831) 476-8900 F: (831) 476-8819
1661 Soquel Drive, Bldg. F Santa
Cruz, CA 95065-1709 H: (408)
475-9508

Joan

390 Rancho Soquel Drive
Soquel, CA 95073

santacruzdoc@aol.com Senior-1975

Thomas Scully M.D.

O: (520) 742-7890 F: (520) 742-2894
5860 North La Cholla Ste. 100
Tucson, AZ 85741
Dawn
6006 East West Miramar Dr Tucson,
AZ. 85715
Tom.scullymd@gmail.com
Active-2005

Mark Sedrak, M.D

C: 650.400.5647
1150 Veterans blvd., 3rd floor Dept
of Neurosurgery Tower, Redwood
City CA 94063
Maureen
mark.f.sedrak@gmail.com
Active-2018

John Seelig M.D.

O: (858) 453-9950
8929 University Center Lane #203
C: (858) 395-2300 H: 858-756-2192
San Diego, CA 92122
Trippi
PO Box 9204 Rancho Santa Fe, CA
92067 johnny1vc@cox.net
Lifetime Senior-1988

Laligam N. Sekhar M.D.

O: (206) 744-9330 F(206) 744-9942
Harborview Medical Center
325 Ninth Ave.- NS Box 359766 H:
(206) 524-3803 Seattle, WA
98104-2499
Gordana Jurik-Sekhar
6819 54th Ave. N.E. Seattle, WA
98115
lsekhar@u.washington.edu
Active-2006

William Sheridan M.D.

O: (650) 299-2283 F(206) 744-9942
Kaiser Redwood City
1150 Veterans Blvd. Redwood City,
CA 94063
Martha
4348 Silva Court Palo Alto, CA 94306
william.sheridan@kp.org Active-2004

Peter Shin M.D.

O: (253) 383-5288 F: (253) 383-5288
South Sound Neurosurgery
1519 3rd Street SE
Puyallup, WA 98372
Hea Won
4512 Layman Terrace, NE Tacoma,
WA 98422
pshin@unm.edu Active-2010

Lawrence Shuer M.D.

O: (650) 723-6093 F: (650) 723-7813
Stanford University Medical Center
Department of Neurosurgery H: (650)
967-1420 300 Pasteur, R229 Cell (650)
222-5433 Stanford, CA 94305-5327
Paula
3413 Ridgmont Mountain View, CA
94040
lshuer@stanford.edu Active-1988

Javed Siddiqi M.D., PhD.

O: (951) 486-4460 F: (951) 486-6510
Department of Neurosurgery 400 N.
Pepper Avenue H: (951) 366-3645
Colton, CA 92324
31150 Sutherland Dr. Redlands, CA
92373 Active-2004
siddiqij@armc.sbcounty.gov

H. Jack Siefert M.D.

H: (260) 432-5216
5316 Arrowhead Pass
Fort Wayne, IN 46804
Alice
aj.siefert@frontier.com Senior-1959

Gerald Silverberg M.D.

H: (650) 325-6730
710 Frenchman's Road
Stanford, CA 94305
Donna
geralds@stanford.edu Active-1981

John P. Slater M.D.

H: (559) 439-8084
5043 North Van Ness Blvd.
Fresno, CA 93711-2851
Arlene Motz
slaterjpm@comcast.net Senior-1985

Roger A. Slater M.D.

H: (360) 779-7057
P.O. Box 1650 Indianola, WA 98342
Karen
raskls@comcast.net Senior-1974

Christine Smith, PhD

2142 Cardinal Dr. San Diego, CA
92123 O 858-552-8585 x 7128
C: 858-220-6759
Chad Prey
cnsmith@ucsd.edu
Associate-2018

Maurice C. Smith M.D.

H: (979) 279-3620 7821 N. Hwy 77
Lexington, TX 78947-9320
Carolyn
drmaurysmith@gmail.com
Senior-1972

Randall W. Smith M.D.
H: (858)-270-3722
4490 Champlain Way, San Diego,
CA 92117
Florence
rw-savopro@sbcglobal.net
Active-1974

Laura Snyder, M.D.
O: 602-406-7868
2910 N. 3rd Ave, Phoenix, AZ 85016
Robert Fintelmann
laura.snyder@barrowbrainandspine.com
Active 2016

Volkar Sonntag, MD
Barrow Neurosurgical Associates 2910 N. 3rd
Avenue H(602) 625-9068 Phoenix, AZ 85013
volker.sonntag@barrowbrainandspine.com
Honorary – 2017

Robert Spetzler, MD
Barrow Neurosurgical Associates 2910 N. 3rd
Avenue H(602) 625-9068 Phoenix, AZ 85013
Nancy
robert.spetzler@barrowbrainandspine.com
Honorary – 2019

Timothy Steege M.D.
O: (206) 623-0922
801 Broadway, Room 617 F: (206)
623-1588 Seattle, WA 98122 H: (206) 232-4787
Esther
4600 Forest Ave. SE Mercer Island, WA 98040
timothy.steege@swedish.org Active-1999

Gary K. Steinberg M.D., PhD
O: (650) 725-5562 F: (650) 723-2815 Stanford
University Medical Center Department of
Neurosurgery H: (650) 365-2778 300 Pasteur
Drive R281 Stanford, CA 94305-5327
Sandra Garritano
21 Bennet Road Redwood City, CA 94062
gsteinberg@stanford.edu
Active-1990

Lee Tan, M.D.
(419) 236-8831
1631 Pierce St, SF, CA 94115
laytan43@gmail.com
Active-2019

Philipp Taussky, M.D. Active-2018 Dept. of
Neurosurgery, Univ of Utah 175 E. Medical
Dr. Salt Lake City, UT 84132 O: 801-581-6908
74 E. Columbus Ct, Salt Lake City, UT 84103
C: 801-688-2668
Racheel
philipp.taussky@gmail.com

Chris Taylor, M.D.
UT Southwestern Neurosurgery
8230 Walnut Hill Lane
Professional Building 3, Suite 514
Christopher.Taylor@utsouthwestern.edu
Corresponding-2016

Gordon B. Thompson M.D.
O: (250) 248-2125
1358 Gabriola Drive F: (250) 248-2134
Parksville, B.C. V9P 2T8 Canada Sally
salgord@shaw.ca Senior-1970

Larry D. Tice, M.D.
O: (970) 858-2580 F: (970) 858-3211 551
Kokopelli Blvd., Suite 1 Fruita, CO 81521 H:
(970) 241-7261 C: (970) 261-0496
Sharon
775 26th Road Grand Junction, CO 81506
larry.d.tice@gmail.com Active-1983

Victor Chun-Kee Tse, M.D.
O: (650) 299-3536
1150 Veterans Blvd Redwood City, CA
94363
Mimi Callanan
1017 Newell Road Palo Alto, CA 94303
tsevictor@gmail.com Active-2005

Ian M. Turnbull, M.D.

O: (604) 879-1925
888 W. 8th Avenue F: (604) 872-7394
Vancouver, B.C. V5Z 3Y1 H: (604)
922-4993 Canada
Patricia
5369 Brookside Ave. West Vancouver,
B.C. V7W 1N2 ianmartt@shaw.ca
Senior-1982

Jay D. Turner, M.D.

(408) 708-3763
turnerjayd@gmail.com
Active 2019

Paul T. Turner, M.D.

H: (505) 286-4994
73 Via Entrada Sandia Park, NM 87047
Annette
pturner@salud.unm.edu Senior-1983

Hoi-Sang U, M.D.

O: (619) 543-5540 F: (619) 543-2769
UCSD Medical Center
200 West Arbor Drive #8893
San Diego, CA 92103-8893
Vivian
hoisang@ucsd.edu Active-1996

Marc Vanefsky, M.D.

O: (714) 279-4958
3460 E. La Palma Ave F: (714) 279-4890
Anaheim, CA 92806 H: (949) 640-0994
Helen
416 DeSola Terrace
Corona Del Mar, CA 92625
marcvanefsky@me.com Active-2005

Anand Veeravagu, MD

300 Pasteur Drive, R-292
Stanford, CA 94305
Sangeeta Das
veeravagu@gmail.com Active-2018

Amir Vokshoor M.D.

O: (310) 574-0415 F: (310) 574-0485
13160 Mindanao Way Suite 300
Marina Del Rey, CA 90292 H: (310)
749-1349
3548 Stonewood Dr.
Sherman Oaks, CA 91403
Sila
vokshoor@yahoo.com Active-2012

Patrick J. Wade, M.D.

O: (818) 547-9478 F: (818) 247-4574 1916 E.
Broadway, Ste. 100 Glendale, CA 91205 H: (818)
247-0888
Pjw7@earthlink.net.com Senior-2014

Joseph R. Walker M.D.

O: (775) 323-2080
5590 Kietzke Ln F: (775) 323-5296 Reno, NV 89511
H: (775) 825-7508 Cynthia
4840 Buckhaven Rd. Reno, NV 89519-0961
jwalkerns@mac.com Senior-1984

John E. Wanebo, M.D., FACS Barrow Brain and Spine

7301 E. 2nd Street, Suite 106 Scottsdale, AZ 85253
O 480-425-8009 C 480-415-6527
Sonja M Wanebo, MD
john.wanebo@barrowbrainandspine.com
Active -2018

Martin E. Weinand M.D.

O: (520) 626-5003 F: (520) 626-8313
Arizona Health Sciences Center Division of
Neurosurgery H:520 577-9363 PO Box 245070
1501 N. Campbell Ave.
Tucson, AZ 85724-5070
Shauna
6100 N. Tucson Mountain Dr. Tucson, AZ 85743
mweinand@surgery.arizona.edu Active-1997

Philip R. Weinstein M.D.

O: (415) 353-3998
505 Parnassus Ave., M780 F: (415) 353-3596
San Francisco, CA 94143-0112
H:(415) 681-3407
Jill
974 Ashbury Street
San Francisco, CA 94117
weinsteinp@neurosurg.ucsf.edu
Senior-1978

Martin H. Weiss M.D.

O: (323) 226-7421
LAC/USC Medical Center F(323)
226-7833
1520 San Pablo St H(818) 790-7467
Los Angeles, CA 90033
Debby
357 Georgian Road Flintridge, CA
91011
weiss@hsc.usc.edu
Senior-1997

David Westra, M.D.
Ventura Neurosurgery
168 North Brent Street, Suite 408
Ventura, CA, 93003
O: 805-643-2179
Reimee
2947 Seahorse Ave. Ventura,
CA 93001
C: 805-701-8687
dlwestra@hotmail.com
Active 2018

Robert D. Weyand M.D.
H: (925) 254-1760
26 El Toyonal F: (925) 258-0958
Orinda, CA 94563-2227
Carole
rdweyand@prodigy.net
Senior-1967

William O. Wild M.D.
H: (562) 598-3192
850 North Hillside Drive
Long Beach, CA 90815
Shirley
wowild54@gmail.com
Senior-1971

Richard Wohns M.D.
O: (253) 841-8939 F: (253) 841-5944
1519 3rd St. S.E., #101 Puyallup, WA
98372 H: (253) 927-7187
Marie Lauritano
Browns Point, WA 98422
7410 East Side Drive NE
rwohns@neospine.net
Active-1988

Isaac Yang, M.D.
O: 650 Charles Young Wasserman
#562, Los Angeles, CA 90095
iyang@mednet.ucla.edu
Active-2016

Kenneth S. Yonemura M.D.
O: (855) 806-7846
Heiden Davidson Orthopedics F:
(435) 635-8823
6360 S 300 E, Suite 210 H: (801) 583-
0933
Salt Lake City, UT 84121
Grace Noda
5529 E. Pioneer Fork Rd.
Salt Lake City, UT 84108
neuropod@surgical.net
Active-1996

Ronald F. Young M.D.
O: (805) 306-9218 F: (805) 306-9210
2200 Lynar Road
Thousand Oaks, CA 91360
rfy127@hotmail.com
Lifetime Senior-1980

John Zhang M.D., PhD.
O: (909) 558-4723
Loma Linda University Medical
Center F: (909) 558-0119
11234 Anderson St., #2562B H: (909)
825-2417
Loma Linda, CA 92354
Jiping Tang, M.D.
24630 Keissel Road Colton, CA 92324
johnzhang3910@yahoo.com
Honorary-2008

MEMBER GEOGRAPHICAL LISTING

CANADA

Calgary

Mark Hamilton, M.D.
Alim Mitha, M.D.

Parksville

Gordon B. Thompson, M.D.

Ontario

Andres M. Lozano, M.D., PhD

Vancouver

Christopher Honey, M.D. Ian
M. Turnbull, M.D.

ALASKA

Anchorage

Estrada Bernard, MD

ARIZONA

Flagstaff

Stephen Ritland, M.D.

Phoenix

Iman Feiz-Erfan, M.D.
Michael T. Lawton, M.D.
Andrew Little M.D.
Laura Snyder, M.D.
Volkar Sonntag, M.D.
Robert Spetzler, M.D.
Jay Turner, M.D.
John Wanebo, M.D.

Tucson

Hillel Baldwin, M.D.
Richard Chua, M.D.
Thomas Scully, M.D.
Marfin E. Weinand, M.D.

NORTHERN CALIFORNIA

Berkeley

Lewis Leng, M.D.

Carmel

Dewitt Gifford, M.D.

Fresno

Henry Aryan, M.D.
John P. Slater, M.D.

Lafayette

Cavett M. Robert, Jr., M.D.

Los Gatos

Marshal Rosario, M.D.

Napa

Jay M. Levy, M.D..

Orinda

Robert D. Weyand, M.D.

Redwood City

Allen Efron, M.D.
Aleksandyr Lavery, M.D.
Mark Sedrak, M.D.
William Sheridan, M.D.
Victor Tse., M.D.

Roseville

Barry Chehrazi, M.D.

Sacramento

Michael S.B. Edwards, M.D

Salinas

Theodore Kaczmar Jr., M.D.

San Francisco

Brian T. Andrews, M.D.
Mitchel S. Berger, M.D.
Grant E. Gauger, M.D.
Bruce M. McCormack, M.D.
Praveen Mummaneni, M.D.
Lee Tan, M.D.
Philip R. Weinstein, M.D.

San Jose

Kenneth Blumenfeld, M.D.
Donald J. Prolo, M.D.

San Luis Obispo

Phillip Kissel, M.D.

Santa Cruz

Charles J. Scibetta, M.D.
Ciara Harraher, M.D.

Santa Rosa

Eldan Eichbaum, M.D.

Stanford / Los Altos

John R. Adler, M.D..
Gerald A. Grant, M.D.
Melanie Hayden-Gephart, M.D.
Jaimie Henderson, M.D.
Barton Lane, M.D.
Marco Lee, M.D. Ph.D
Gordon Li, M.D.
Odette Harris, M.D.
John Ratliff, MD
Lawrence M. Shuer, M.D.
Gerald Silverberg, M.D.
Gary K. Steinberg, M.D., PhD.
Anand Veeravagu, M.D.

Tahoe

John P. Phillips, M.D.

Visalia

Thomas E. Hoyt, M.D.

SOUTHERN CALIFORNIA

Anaheim

Marc Vanefsky, M.D.

Irvine / Orange County

Deborah C. Henry, M.D.
Frank Hsu, M.D., PhD.
Mark Linskey, M.D.
William Loudon, M.D.

El Segundo / Long Beach / Marina Del Rey / Torrance

Duncan McBride, M.D.
David F. Morgan, M.D.
Amir Vokshoor, M.D.
William O. Wild, M.D.

Los Angeles.

Ulrich Batzdorf, M.D.

Marvin Bergsneider, M.D.
Keith L. Black, M.D.
Harismran Brara, M.D.
Jeff Chen, M.D., PhD.
Thomas C. Chen, M.D., PhD.
Ray Chu, M.D.
Aria Fallah, M.D.
John G. Frazee, M.D.
Steven L. Giannotta, M.D.
J. Patrick Johnson, M.D.
Linda Liau, M.D., PhD., MBA
Luke Macyszyn, M.D.
Nader Pouratian, M.D.
R.L. Patrick Rhoten, M.D.
Martin H. Weiss, M.D.
Isaac Yang, M.D.

Pasadena / Duarte / Glendale

Joseph C.T. Chen, M.D., PhD.
Ian Ross, M.D.
Patrick J. Wade, M.D.

San Bernardino / Riverside / Palm Desert / Redlands

Farbod Asgarzadie, M.D.
James Ausman, M.D.
Blake Berman, M.D.
Justin Dye, M.D.
George H. Koenig, M.D.
J. Charles Rich, M.D.
Javed Siddiqi, M.D., PhD.
John Zhang, M.D., PhD.

San Diego / La Jolla / La Mesa

M. Samy Abdou, M.D.
Sharona Ben-Haim, M.D.
Gregory G. Gerras, M.D.
John Seelig, M.D.
Christine Smith, Ph-D
Randall W. Smith, M.D.
Hoi-Sang U, M.D.

Sherman Oaks

Fred Edelman, M.D.

Thousand Oaks

Martin Mortazavi, M.D.
Ronald F. Young, M.D.

Temecula / Murrieta

Bret Abshire, M.D.
Austin R.T. Colohan, M.D.

Ventura

Moustapha Abou-Samra, M.D.
Melvin L. Cheatham, M.D.
David Westra, M.D.

COLORADO

Aurora

Glenn W. Kindt, M.D.

Breckenridge

Jeffery L. Rush, M.D.

Colorado Springs

John H. McVicker, M.D.

Englewood

J. Paul Elliott, M.D.

Golden

Stephen D. Johnson, M.D.

Fruita

Larry D. Tice, M.D.
Littleton
J. Adair Prall, M.D.
Wheatridge
Roderick G. Lamond, M.D.
FLORIDA
Jacksonville
Hector Edward James, M.D.
Miami
Michael McDermott.
IDAHO
Coure D Alene
William F. Ganz, M.D.
Kimberly Page, M.D.
INDIANA
Fort Wayne
H. Jack Siefert, M.D.
MINNESOTA
Rochester
Terry Burns, M.D. **MONTANA**
Missoula
Carter E. Beck, M.D.
NEVADA
Las Vegas
John T. Garner, M.D.
Reno
William N. Dawson, Jr., M.D.
Jay K. Morgan, M.D.
Richard Perrin, M.D.
Joseph R. Walker, M.D.
NEW MEXICO Albuquerque
Paul T. Turner, M.D.
OREGON
Bend
Mark G. Belza, M.D.
Michael M. Kendrick, M.D.
John A. Kusske, M.D.
Beaverton
Edmund Frank, M.D.
Dundee
Donald R. Olson, M.D.
Medford
Douglas B. Kirkpatrick, M.D.
Portland
David Adler, M.D.
Kim J. Burchiel, M.D.
Jason Lifshutz, M.D.
Claudia Martin, M.D.
TEXAS
Dallas
Christopher Taylor, M.D.
Lexington
Maurice C. Smith, M.D.
San Antonio
Rosemaria Gennuso, M.D.

UTAH

Salt Lake City

Sam Cheshier, M.D.
Andrew Dailey, M.D.
Robert S. Hood, M.D.
Joel D. MacDonald, M.D.
Philipp Tausky, M.D.
Kenneth Yonemura, M.D.

WASHINGTON

Elma

Wallace Nelson, M.D.

Indianola

Roger A. Slater, M.D.

Seattle

Richard G. Ellenbogen, M.D.
Jason Hauptman, MD.
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