Western Neurosurgical Society

The Hyatt Gainey Ranch, Scottsdale, Arizona

65th Annual Meeting
November 8 – 11, 2019

American Association of Neurological Surgeons

Jointly provided by the AANS

Calendar of Events
Friday, November 8th, 2019

12:00 PM – 04:00 PM	Executive Committee Meeting	Executive Boardroom
12:00 PM – 11:00 PM	Exhibits/Setup	Arizona I, II, III, IV
02:00 PM – 05:00 PM	Registration	Terrace Court Lobby
06:00 PM – 09:30 PM	Welcome Reception	Palm Grove
Saturday, November 9th, 2019		
06:30 AM – 07:25 AM	**Breakfast with Exhibitors**	Arizona I, II, III, IV
06:30 AM - 12:00 PM	Registration	Arizona Center Booth
07:25 AM – 08:30 AM	Spine Scientific Session	Arizona V
08:00 AM – 10:00 AM	Spouses Breakfast	South Foyer & Desert Garden
08:30 AM – 09:30 AM	Translational Neurosurgery Scientific Session	Arizona V
9:30 AM – 10:00 AM	**Coffee Break with Exhibitors**	Arizona I, II, III, IV
10:00 AM – 11:15 AM	Cranial Scientific Session	Arizona V
11:15 AM – 12:00 PM	Local Interest Lecture/ The Hohokam	Arizona V
Noon	**Adjourn for day**	
12:45 PM – 04:45 PM	Mountain Biking	West Curb Bus staging area, outside to right of lobby
12:45 PM – 04:45 PM	Cattle Drive	West Curb Bus staging area, outside to right of lobby
12:45 PM – 04:30 PM	Scottsdale Food Tour	West Curb Bus staging area, outside to right of lobby
12:45 PM – 05:00 PM	GOLF & TENNIS-arrange on own	Golf course/Tennis courts
06:00 PM – 09:30 PM	Local Night/Dinner	West Curb Bus staging area, outside to right of lobby
Sunday, November 10th 2019		
06:30 AM – 08:00 AM	Business Meeting (Members Breakfast)	Arizona VI, VII, VIII
06:30 AM – 08:00 AM	**Breakfast w/Exhibitors (nonmembers)**	Arizona I, II, III, IV
06:30 AM - 12:00 PM	Registration	Arizona Center Booth
08:00 AM – 10:00 AM	Spouses' Breakfast	South Foyer & Desert Garden
08:00 AM – 09:30 AM	Ensuring Ethical Neurosurgeons for the Future Scientific Session	Arizona V
09:30 AM 10:20 AM	Ablin Lecture/Regis Haid, MD	Arizona V
10:20 AM – 10:50 AM	**Coffee Break with Exhibitors**	Arizona I, II, III, IV
10:50 AM – 11:40 AM	Cloward Award Lecture/Robert Spetzler, MD	Arizona V
11:40 AM - 12:30 PM	Presidential Address	Arizona V
12:30 PM	**Adjourn for the Day**	
01:00 PM – 5:00 PM	Sonoran Desert Hike	West Curb Bus staging area, outside to right of lobby
12:45 PM – 05:00 PM	GOLF & TENNIS-arrange on own	Golf course/Tennis courts
12:45 PM – 04:45 PM	Tomkars	West Curb Bus staging area, outside to right of lobby
01:00 PM – 04:30 PM	Architecture Tour	West Curb Bus staging area, outside to right of lobby
05:45 PM – 06:00 PM	New Member w/Exec Committee Reception	South Foyer & Desert Garden
06:00 PM – 10:30 PM	Reception/Black Tie Dinner/Dancing	South Foyer & Desert Garden/AZ IV, V
Monday, November 11th 2019		
06:30 AM – 07:30 AM	**Breakfast with Exhibitors**	Arizona I, II, III, IV
06:30 AM – 12:00 PM	Registration	Arizona Center Booth
07:30 AM – 08:00 AM	Resident Award Presentations	Arizona V
08:00 AM – 10:00 AM	Spouses Breakfast	South Foyer & Desert Garden
08:00 AM - 09:40 AM	Mini Symposium-Spine	Arizona V
09:40 AM – 10:10 AM	**Coffee Break with Exhibitors**	Arizona I, II, III, IV
10:10 AM – 11:55 AM	General Interest Neurosurgery Scientific Session	Arizona V
12:00 PM	**Meeting Adjourns**	See you in San Diego!

Western Neurosurgical Society
65th Annual Meeting

2019 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:

Objective 1: Express the overall confidence in the surgical care of intracranial pathology.

Objective 2: Illustrate the overall confidence in the surgical care of spina disorders.

Objective 3: Discuss the challenges facing neurosurgeons regarding residency training competency, fellowship training and competency, and maintenance of certification.

Objective 4: Discuss difficult cases and trends in their own practices.

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EXHIBITORS

The Western Neurosurgical Society would like to thank the following exhibitors for their generous support in 2019

SILVER SUPPORT

Globus Medical

http://www.globusmedical.com/

Medtronic

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EXHIBITORS

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Hitachi https://www.hitachimed.com/

Insightec https://www.insightec.com

Integra Life https://www.integralife.com

KLS Martin http://www.klsmartinnorthamerica.com/

Leica Microsystems https://www.leica-microsystems.com/

Mag Mutual https://www.magmutual.com/

Natus Neuro www.natus.com

NICO Neuro http://www.niconeuro.com/

Oss Dsign https://www.ossdsign.com/

EXHIBITORS

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Orthofix https://www.orthofix.com

Providence Medical (Dtrax) https://providencemt.com/

RTI Surgical http://www.rtix.com/en_us/

Samsung Neuroloigca https://www.neurologica.com/

Southwest Surgical (Zeiss)
http://southwestsurgical.com/

Specialty Care https://specialtycareus.com/

Spine Source https://www.spinesource.com/

Spineology https://spineology.com/

Sutter USA https://www.sutter-usa.com/

Terumo BCT https://www.terumobct.com/

Tobra Medical https://tobramedical.com/

Xoran Technology https://xorantech.com/

2019 SOCIETY MEETING GUESTS

Robert Spetzler, MD	Cloward Medal	WNS
Regis Haid, MD	Ablin Lecture	WNS
Emily Early, PhD	Local Interest Speaker	WNS
Arjun Pendharkar, MD	Clinical Science Resident Award	WNS
Srinivas Chivukula, MD	Basic Science Resident Award	WNS
Estrada Bernard, MD	Member Nominee	Dr. J. Morgan
Scott Berta, MD	Member Nominee	Dr. Lee
Aria Fallah, MD	Member Nominee	Dr. Abou-Samra
Juan Fernandez-Miranda, MD	Member Nominee	Dr. Lee
Jason Hauptman, MD	Member Nominee	Dr. Lee
Andrew Ko, MD	Member Nominee	Dr. Pitkethly
Martin Mortazavi, MD	Member Nominee	Dr. Sekhar
Richard Perrin, MD	Member Nominee	Dr. Morgan
John Ratliff, MD	Member Nominee	Dr. Steinberg
Lee Tan, MD	Member Nominee	Dr. Li
Jay Turner, MD	Member Nominee	Dr. Little
Ray Chu, MD	Member Nominee	Dr. Scully
Kenneth De Los Reyes, MD	Member Candidate	Dr. Colohan
Farrokh Farrokhi, MD	Member Candidate	Dr. Nussbaum
Jamshid Ghajar, MD	Member Candidate	Dr. Steinberg
Omid Hariri, DO	Member Candidate	Dr. Lee
Jason Hauptman, MD	Member Candidate	Dr. Nussbaum
John Rolston, MD	Member Candidate	Dr. McDermott
Brian Toyota, MD	Member Candidate	Dr. McDermott
Anthony Wang, MD	Member Candidate	Dr. Bergsneider
Erica Bisson, MD	Guest	Dr. Snyder
Christopher Iannotti, MD	Guest	Dr. Little
Zachary Smith, MD	Guest	Dr. Liau
Juan Uribe, MD	Guest	Dr. Snyder
Dante Vacca , MD	Guest	Dr. Snyder

JOINT PROVIDERSHIP ACCREDIDATION 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 11 *AMA PRA Category 1 Credits™*. Physicians should claim only the credit commensurate with the extent of their participation in the activity."

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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, 65th 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.

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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
Erica Bisson, MD	Yes	Industry Grant (NREF, PCORI); Consultant fee (nView, MiRus); Stock or Shareholder (nView, MiRus)
Daniel Cleary, MD	Yes	Co-owner on company related to research (Surgical Simulations, LLC)
Richard Chua, MD	Yes	Consultant Fee (Medtronic)
Aria Fallah, MD	Yes	Consultant Fee (BrainLab); Honorarium (Medlink Neurology)
Jamshid Ghajar, MD	Yes	University Grant (Endowed Directorship, Stanford University); Stock or Shareholder (SyncThink); Employee (Stanford)
Mark Hamilton, MD	Yes	Honorarium (Integra Canada)
Michael Lawton, MD	Yes	University Grant (NIH U54 Grant); Consultant fee (Zeiss & Stryker); Other financial (Mizuho – Royalties)
G .Michael Lemole MD	Yes	Consultant fee (Sony-Olympus Medical); Fiduciary Position (Board Member - Yet2.com)
Gordon Li, MD*	Yes	University Grant (NIH); Industry Grant (Bristol Myers squibb); Consultant fee (Medtronic); Speaker's Bureau (Jandj)
Michael McDermott, MD	Yes	University Grant (UCSF); Consultant Fee (Stryker)
John Ratliff, MD	Yes	University Grant (AHRG); Consultant Fee (Stryker Spine, Nuvasive)
John Rolston, MD	Yes	University Grant (NIH, USTAR); Consultant fee (Medtronic, NeuroPace); Stock or shareholder (Axion Biosystems); Employee (University of Utah)
Laura Snyder, MD*	Yes	University Grant (Barrow Neurological Foundation); Consultant Fee (Globus)
Robert F. Spetzler, MD	Yes	Share or Stakeholder (Boston Scientific; Synergetics; Stereotaxis; Dicom Grid; EmergeMD; Neurovasc; RSB Spine; iCo Therapeutics; Katalyst/Kogent); Other financial (Royalties-Katalyst; Stryker)
Gary K. Steinberg, MD, PhD	Yes	Stock or Shareholder (Qool Therapeutics & NeuroSave); Employee (Stanford University); Other Financial (Peter Lazic US, Inc.)
Lee Tan, MD	Yes	Consultant Fee (Stryker); Other Financial (Nonr)
Jay Turner, MD	Yes	University Grant (Barrow Neurological Foundation); Industry Grant (Nuvasive, Medtronic, SeaSpine); Consultant Fee (NuVasive, SeaSpine); Speakers Bureau (NuVasive)
Juan Uribe, MD	Yes	Consultant Fee(sibone, misonix, nuvasive);Stock or Shareholder (Nuvasive);
Anand Veeravagu, MD*	Yes	Consultant Fee (Nuvasive, Medtronic, Stryker, Surgical Theater)
Amir Vookshoor, MD	Yes	University Grant (Aegis Spine, Orthofix, Stryker); Consultant Fee (Globus Medical)
Richard Wohns, MD	Yes	Consultant Fee (SeaSpine)
Isaac Yang, MD*	Yes	University Grant(UCLA); Industry grant support (Stryker, Brainlab); Consultant Fee (Baxter, Brainlab); Honorarium (GS Medical)

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**

Moustapha Abou-Samra, MD
Marvin Bergsneider, MD
Srinivas Chivukula, MD
Emily Early, PhD
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Juan Carlos Fernandez-Miranda, MD
Regis Haid, MD
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J. Adair Prall, MD *
Emily Schile*
Thomas Scully, MD
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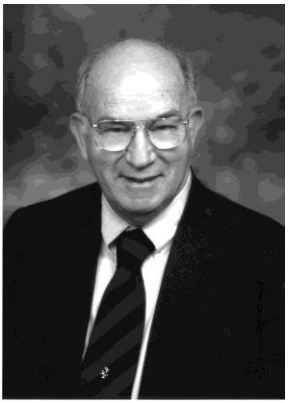
Brian Toyota, MD
Dante Vacca, MD
Anthony Wang, MD

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.

George Ablin Memorial Lecturer 2019 - Regis Haid, MD

The Ablin Lecture at each annual meeting affords the President the opportunity to present speakers on topics that he feels would interest meeting attendees. The lecture honors the memory of George Ablin and his contributions to neurosurgery in general and the Western in particular. The Western Neurosurgical Society is honored to have Regis W. Haid, Jr. M.D. deliver the 2019 George Ablin Memorial Lecture titled "Spinal Alignment: Keys to the Kingdom."

Dr. Haid grew up in Appalachia and Tennessee. At an early age, he developed a love for farming, hard work and fixing what needed fixing. He received his undergraduate degree in 1978 from the University of Notre Dame with majors in philosophy and theology, and a minor in classical literature. While at Notre Dame, he excelled at Rugby, being named All American and playing on the national team.

Dr. Haid received his MD at West Virginia University in 1982 where he was AOA and served as President of his class. He completed his neurosurgical residency in 1988 at West Virginia University and completed a Fellowship with Dr. Joseph Maroon in Pittsburgh. In 1988, he was on UF faculty in Neurosurgery and completed an orthopedic spine fellowship at the University of Florida. From 1989 to 1993 Dr. Haid served in the United States Air Force, leading the Spine Program at Wilford Hall Medical Center in San Antonio. Subsequently, he joined the faculty at Emory University and was promoted to Professor in 2001. During that time, he was Director of the Spinal Fellowship Program and trained many leaders in spine surgery. In 2003 he went into private practice and was a founding partner of Atlanta Brain and Spine Care.

A renowned surgeon and educator, Dr. Haid has been visiting professor at 30 universities worldwide. He has been a Course Director more than 280 times, lectured at over 200 Spinal Courses, and presented over 500 papers. As a widely published author, Dr. Haid has contributed over 135 scientific articles to peer-reviewed journals, has completed 13 textbooks, and has written more than 85 chapters on the treatment of spinal disorders. He is an American Board of Neurological Surgery Scholar.

Dr. Haid has served on the Editorial and Review Boards of several leading journals. His research interests include spinal reconstruction techniques. His research has resulted in over 20 patents and implants related to cervical lateral mass plating, anterior cervical plating, posterior, anterior, lateral and transforaminal lumbar interbody fusion techniques, cervical arthroplasty, lateral lumbar fusion and posterior cervical and thoraco-lumbar instrumentation. His patents include the first artificial cervical spine disc joint cleared by the FDA. His designed implants for spinal reconstruction are used worldwide.

Dr. Haid is an active member and leader within several professional neurosurgical and spinal societies, including the American Association of Neurological Surgeons, the Congress of Neurological Surgeons, the Neurosurgical Society of America and the Cervical Spine Research Society. He is a former Chairman of the Joint Section on Disorders of the Spine and Peripheral Nerve, having been given the Meritorious Service Award. He has served on the Board of Directors of the Think First Foundation, FIENS, the Neurosurgery Research & Education Foundation, the Neuropoint Alliance (NPA), and the Lumbar Spine Research Society. He is a former Board of Director of the AANS and currently serves as Vice President of the AANS. He is currently Chair of the NREF. He has given the Schneider Lecture at the AANS, as well as the Penfield Lecturer at the Canadian Neurosurgical Society.

Dr. Haid and his wife Mary Ellen have six children and six grandchildren, most of whom live "out west" in New Mexico and Colorado. Dr. Haid's hobbies include skiing with his children at their family cabin in Big Sky Montana, and trying to spend more time at his farms. He is very active in several philanthropic Boards, most notably the Art Institute of Chicago school.
Like Rugby, Reg considers neurosurgery to be a "full contact sport" and looks forward to exchanging ideas and experiences with members of the Western.

~J. Paul Elliot, MD

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*"

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.

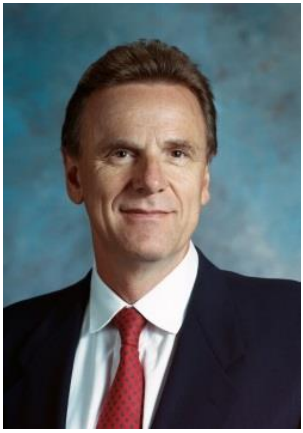
His academic accomplishments include Professor and Chair of Neurosurgery at the University of Chicago, 1954-55, and visiting professorships at the University of Oregon, University of Southern California, and Rush Medical School. He served long-term as Professor of Neurosurgery at the John A. Burns School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

2019 CLOWARD AWARD RECIPIENT - Robert Spetzler, MD



My Journey in Neurosurgery

The Society is most pleased to announce that Robert F. Spetzler, MD, has been chosen to receive the Ralph Cloward Award for 2019. He will receive the Cloward Medal and give a presentation on Sunday, November 10, entitled "My Journey in Neurosurgery". Robert F. Spetzler, M.D, attended Knox College in Galesburg, Illinois from 1963 to 1967 and graduated cum laude with a Bachelor of Science degree in Biology and Chemistry. Before graduating, he spent a year at the Free University of Berlin on a scholarship. In 1967, he entered medical school at Northwestern University, where he obtained his M.D. in 1971 and completed his internship in 1972.

In 1972 Dr. Spetzler moved to the University of California at San Francisco where he trained as a resident under Charles B. Wilson, M.D., Professor and Chairman, Department of Neurosurgery. It was there, under the expert tutelage of Dr. Wilson, that his interest in neurovascular surgery developed. His commitment to academic neurosurgery also was established at this time. Before finishing his residency, he had already published 15 articles in refereed journals, on 8 of which he was first author; had helped edit two books; and had made almost 20 presentations at national and international meetings. During the last year of his residency, he was awarded a Trauma Fellowship from the National Institutes of Health (NIH). He also received the Annual Resident Award at the 27th Annual Meeting of the Congress of Neurological Surgeons.

After completing his residency in 1977, Dr. Spetzler joined the Department of Neurosurgery at Case Western Reserve University School of Medicine in Cleveland, Ohio as an Assistant Professor. In 1980 he received his first major grant from NIH, developing a primate model of stroke that has since been used to test therapeutic treatments for stroke and cerebral ischemia. In 1981, he was promoted to an Associate Professor, holding that appointment until 1983.

In 1983 Dr. Spetzler was recruited by Dr. John R. Green to assume the J. N. Harber Chair of Neurological Surgery at the Barrow Neurological Institute (BNI) in Phoenix, Arizona. Two years later when Dr. Green retired, Dr. Spetzler became the Director of the BNI, and then its President and CEO, until his recent retirement in July 2017. Under Dr. Spetzler's leadership, the BNI has grown from primarily a regional center to an internationally recognized center of excellence that attracts both visiting healthcare professionals and patient referrals from around the world. The residency program has become one of the most highly sought programs because of the diversity of clinical experience and the emphasis on developing independent research projects. These accomplishments underscore why Dr. Spetzler was chosen as the Honored Guest of the Congress of Neurological Surgeons in 1994--the youngest member ever to receive this coveted honor.

Among just a few of Dr. Spetzler's contributions have been the development of theories on normal perfusion pressure breakthrough and how the size of arteriovenous malformations (AVMs) is related to their rupture; the development of a heuristic grading system for AVMs; advances in the surgical treatment of complex cerebrovascular lesions based on hypothermia, barbiturates, and cardiac arrest; and the development of innovative surgical approaches for skull base surgery. Since the start of his career, Dr. Spetzler has treated more than 6000 aneurysms and published more than 600 articles in refereed journals, more than 200 book chapters, and edited or coauthored numerous books and neurosurgical atlases.

In recognition of his outstanding commitment to the education of medical professionals; neurosurgeons in particular, he was named Mentor of the Millennium in 2000, Teacher of the Year in 1986, 1987,1992-97 and in 2010. He was named Professor of the Year in 1983 and 1984.

It probably comes as a surprise to most of us that Dr Spetzler is both a very competitive and adventurous person! He enjoys hiking, mountain biking, skiing, sailing and horseback riding. He competes in many extreme endurance challenges. He instituted the traditional Barrow Department of Neurosurgery rim-to-rim Grand Canyon hike each spring and the rumor is that he has never let a resident beat him out of the canyon! He believes that it is important to balance the rigors of a neurosurgical practice with extreme physical activity. This philosophy is a trademark of the Barrow Neurosurgery training program. Needless to say Dr. Spetzler has not slowed down since retiring.

In his home state of Arizona, Dr Spetzler was inducted into the Historical League as a "Historymaker" in 2017. He also received the Arizona Florence Crittenton Hope Award in 2012 and the Healthcare Leadership Award by the Arizona Business Magazine in 2009. He is the recipient of the Ellis Island Medal of Honor in 2015.

Dr Spetzler currently is President and CEO Emeritus of the Barrow Neurological Institute and Saint Joseph's Hospital as well as the Professor and Chair Emeritus of the Barrow Department of Neurological Surgery. He lives in Paradise Valley, AZ with his wife of 45 years, Nancy Baxley. He has two children, David, age 44, and Christina, age 42.

--William Ganz WNS Communications Committee

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"*

INVITED SPECIAL LECTURER

Emily Early, PhD

Emily Goble Early is Curator of Anthropology at the Arizona Museum of Natural History in Mesa, Arizona. There she oversees anthropology collections, exhibit design and cultural resource management activities. She was formerly Associate Curator and ran educational programming at Mesa Grande Cultural Park, a Hohokam tempe mound site affiliated with the museum. She has BAs in anthropology and history from the Barrett Honors College at Arizona State University, and a MA and PhD in Anthropology from Yale University. Emily is a former Peter Buck Postdoctoral Fellow (2011-2013) in the Smithsonian's Human Origins Program. Her research focuses on mammalian shifts in taxonomy and abundance that correspond with known global climate change in the Pliocene. She has done fieldwork in South Africa, but her primary research has been in Kenya, particularly the Tugen Hills. She has been involved in Southwest archaeology for the last six years with the City of Mesa and works extensively with other cities, tribal governments, cultural resource managers and other museums to protect and promote local heritage.

Her presentation is:

The Hohokam: Archaeology of a Culture that Made Desert Village Life Possible

2019 RESIDENT AWARD RECIPIENTS

Clinical Science Award – *Functional Mapping for Glioma Surgery: A Propensity-Matched Analysis of Outcomes and Cost*

Arjun Pendharkar, MD Stanford

Arjun was born and raised in the Bay Area to Indian immigrant parents. He completed his undergraduate training at Cal Poly San Luis Obispo and earned his MD at Georgetown University. During residency, Arjun completed an NIH R25 and NREF funded postdoctoral fellowship in Dr. Steinberg's lab studying motor circuit plasticity after stroke and using optogenetic stimulation to promote recovery in a mouse model of stroke. Following residency he plans to complete a two year Neurointerventional Radiology fellowship at Stanford. Outside of neurosurgery, Arjun enjoys spending time with his wife Ruhi and their families, as well as playing golf and traveling.

Basic Science Award

Srinivas Chivukula, MD UCLA

Somatosensory Processing within the Posterior Parietal Cortex

My interest in research is practical, patient-centric, and multidisciplinary. My goals lie in studying neuroanatomical structures on a basic level and in understanding the role for integrating machine learning strategies in their modulation. As a resident in neurosurgery I have witnessed firsthand the devastation that patients experience with paralysis from spinal cord lesions, neurodegenerative disorders, stroke, and traumatic brain injury. Deep brain stimulation, spinal cord stimulation and neural prosthetics represent only a few of the numerous areas of research that have been translated from bench side to operating rooms to help such patients. I am fortunate to have been a part of such efforts, both on the research side, for instance recently publishing on optimizing targets for central neuromodulation in patients with refractory pain post-injury, as well as on the surgical side as a resident in neurosurgery. I have extensive clinical research experience, having published several articles on the treatment of central pain pathologies such as trigeminal neuralgia, as well as skull base pathologies. Extensively exploring the various aspects of neurosurgery helped me discover that my interests lie in neurosurgical applications to improve quality of life through implants or modulation. To this end, I plan to pursue an academic career in functional neurosurgery, particularly in the area of neural prostheses. Identifying the ideal types of neural signals to extract from the brain, the optimal analytic and signal extractions techniques, and locations from which to extract them, is critical to developing the next generation of prosthetics. Through this project I will expand my knowledge of neuraoanatomy and neuroscience, and will begin to learn the basics of neural signal acquisition and analysis, single neuron electrical recording as well as signal processing, and their applications in brain machine interfacing. I hope to carry forward this research by pursuing a doctoral degree in Dr. Richard Andersen's lab at Caltech. The R25 award will uniquely situate me to engage in this project, which will form a basis for future work, enabling me to apply for further scholarships such as the National Research Service Award (NRSA), and prepare me for an eventual academic neurosurgical career.

WNS 2019 SCIENTIFIC PROGRAM
The Hyatt Gainey Ranch, Scottsdale, Arizona, November 9 – 11, 2019

Saturday November 9th, 2019

6:30-7:25 Breakfast with Exhibitors

7:25-7:30 Welcome, Thomas Scully, MD WNS President

7:30-8:30 **Spine Scientific Session** (10 min talks, 5 min discussion)

Moderator: Adair Prall, MD and Thomas Scully, MD

1. Amir Vokshoor, MD (Member) "Two-Year Retrospective Bayesian Assessment of Cervical Artificial Disc Replacement Failure Factors"
2. Omid Hariri, DO (Member Candidate) "Clinical Efficacy of Frameless Stereotactic Radiosurgery in the Management of Spinal Metastases from Thyroid Carcinoma"
3. Lee Tan, MD (Member Nominee) "Safety and Efficacy of Anterior Cervical Foraminotomy with Uncinate Process Resection in Conjunction with Anterior Discectomy and Fusion for Treatment of Cervical Radiculopathy"
4. Zachary Smith, MD (Guest)"Atlas-based Mapping of Gray Matter Loss in Patients with Cervical Spondylotic Myelopathy"

8:30-9:30 **Translational Neurosurgery Scientific Session** (10 min talks, 5 min discussion)

Moderator: Ciara Harraher, MD and Jay Morgan, MD

1. Gary Steinberg, MD (Member) "Safety and Efficacy of Intracerebral Implantation of Modified Bone Marrow-Derived Mesenchymal Stem Cell (SB623) in Patients with Chronic Motor Deficit from Traumatic Brain Injury"
2. Jamshid Ghajar, MD (Member Candidate) "Baseline Oculomotor Performance is Associated with Increased Risk of Symptomatic Concussion"
3. John Wanebo, MD (Member) "C6 Ceramide as a Single Agent and as an Adjuvant to Temazolamide and Radiation Inhibits Growth of Glioblastomas In Vitro but not In Vivo"
4. Anthony Wang, MD (Member Candidate) "Activating Adaptive Immunity to Target H3.3G34 Mutant Glioblastoma"

9:30-10:00 Break with Exhibitors

10:00-11:15 **Cranial Scientific Session** (10 min talks, 5 min discussion)

Moderator: Michael Lemole, MD and Marco Lee, MD

1. Aria Fallah, MD (Member Nominee) “Hemispherectomy Outcome Prediction Scale: Development and Validation of a Tool to Predict Seizure Outcomes”
2. Mark Hamilton, MD (Member) “Reducing the Risks of Proximal and Distal Shunt Failure in Adult Hydrocephalus”
3. Martin Mortazavi, MD (Member Nominee) “Tuberculum Sellae Meningiomas: Role of Posterolateral Orbitotomy, Optic Canal Decompression and Proposal of a New Classification System”
4. Juan Fernandez-Miranda, (Member Nominee) “Endoscopic Endonasal Surgery for “Inoperable” Craniopharyngiomas: Intraoperative Challenges and Management of Complications”
5. Phil Taussky, MD (Member) ”Flow Diversion for Posterior Circulation Aneurysms”

11:15-12:00 **Local Interest Lecture** by Dr. Emily Early of the Arizona Museum of Natural History, “The Hohokam: Archaeology of a Culture that Made Desert Village Life Possible”

Sunday November 10th, 2019

6:30-8:00 Member Business Meeting

8:00-9:30 **Ensuring Ethical Neurosurgeons for the Future**

1. Introduction and Moderator, Moustapha Abou-Samra, MD (Member) 5 min
2. Marvin Bergsneider, MD (Member) "Evaluating Medical Students as Potential Neurosurgeons" 15 min talk, 5 min discussion
3. Michael McDermott, MD (Member) "Remediation during Residency" 15 min talk, 5 min discussion
4. Richard Wohns, MD (Member) "Teaching Residents to Develop Ethical Relationships with Industry and Corporate America" 20 min talk, 5 min discussion
5. Ciara Harraher, MD (Member) "How Do We Monitor Ethical Behavior of Newly Graduated Neurosurgeons?" 15 min talk, 5 min discussion

9:30-9:35 Introduction to Albin Lecture, Thomas Scully, MD

9:35-10:20 Albin Lecture, Regis Haid, MD "Spinal Alignment: Keys to the Kingdom"

10:20-10:50 Break with Exhibitors

10:50-10:55 Introduction to Cloward Award Winner, Marvin Bergsneider, MD

10:55-11:40 Cloward Award Winner, Robert Spetzler, MD "My Journey in Neurosurgery"

11:40-11:45 Introduction to Presidential Address, Richard Chua, MD

11:45-12:30 Presidential Address, Thomas Scully, MD

Monday November 11th, 2019

6:30-7:30 Breakfast with Exhibitors

7:30-8:00 **Resident Award Presentations** (10 min talks, 5 min discussion)

Moderator: Laura Snyder, MD

1. **Clinical Science Award**, Arjun Pendharkar, MD "Functional Mapping for Glioma Surgery: A Propensity-Matched Analysis of Outcomes and Cost"
2. **Basic Science Award**, Srinivas Chivukula, MD "Somatosensory Processing within the Posterior Parietal Cortex"

8:00-9:40 **Mini-Spine Symposium** (15 min talks, 5 min discussion)

Moderator: Richard Chua, MD

1. Juan Uribe, MD (Guest) "Lateral Approach Can Obviate Three Column Osteotomy"
2. Erica Bisson, MD (Guest) "Improving Outcomes with Registry Data"
3. Jay Turner, MD (Member Nominee) "Improving outcomes with long segment constructs: a biomechanical approach"
4. Jay Morgan, MD (Member) "Robotics in Spine Surgery"
5. John Ratliff, MD (Member Nominee) "Use of Data Analytics to Improve Spine Surgery Outcomes"

9:40-10:10 Break with Exhibitors

10:10-11:55 **General Interest Neurosurgery Scientific Session** (10 min talks, 5 min discussion) *Moderator: Laura Snyder, MD*

1. Michael Lawton, MD (Member) "Anterior Cerebral Artery Bypass for Complex Aneurysms: Advances in Intracranial-Intracranial Bypass Techniques"
2. John Rolston, (Member Candidate) "Human Interictal Epileptiform Discharges Recorded from Microelectrode Arrays are Traveling Waves with Distinct Propagation Directions"
3. Brian Toyota, (Member Candidate) "Impact of Technology on Surgical Education"
4. Farrokh Fakkokhi, MD (Member Candidate) "Risk Reduction in DBS Surgery: Lean Methodology, Logistic Regression, Artificial Intelligence and the Kitchen Sink"

5. Jay Morgan, MD (Member) “Management of Giant Extradural Arachnoid Cyst”
6. Dante Vacca, MD (Guest) “Case of a Career”
7. Moustapha Abou-Samra, MD (Member) “When Life Throws you a Curve Ball”

11:55-12:00 Wrap-up and Adjourn

ABSTRACTS – SATURDAY

Scientific Session I Spine

1) Amir Vokshoor, MD

Two-Year Retrospective Bayesian Assessment of Cervical Artificial Disc Replacement Failure Factors

Introduction

Previous research on Cervical Artificial Disc Replacement (C-ADR) failure has primarily focused on anatomical and intraoperative factors and not yet thoroughly explored how perioperative features work in conjunction to contribute to the chance of C-ADR failure.[1,2] The objective of the current study was to apply a Bayesian logistic regression model to measure the strength of the association between demographic and perioperative variables and C-ADR failure.

Methods

C-ADR failure was defined as a reoperation on or adjacent to the C-ADR's index within two years. Pertinent variables were selected through a literature review and scrutinized with neurosurgical experience of C-ADR. Retrospective data of a single neurosurgeon's C-ADR patients were garnered through various electronic health records. A Bayesian logistic regression was conducted and validated using Markov Chain Monte Carlo methods.

Results

Fifty patients were identified as having either a C-ADR (28/50, 56%) or hybrid (C-ADR and fusion) (22/50, 44%) surgery; 18% (9/50) were C-ADR failures. The strongest negatively associated factors with C-ADR failure were number of implanted C-ADRs and depression; 90% credible intervals (CI) were (−5.35 to −1.06) and (−4.86 to −0.50), respectively. The strongest positively associated factor with C-ADR failure was current smoking (90% CI, 0.61-4.82). Hybrid surgery (90% CI, −0.40 to 3.07), former smoking (90% CI, −0.13 to 4.07), and single marital status (90% CI, −0.06 to 5.70) trended toward positive associations with C-ADR failure.

Conclusions

Demographic and perioperative factors play important roles in C-ADR failure; however, this model, emphasized by the single surgeon sample, also captures how these factors may bias patient selection for reoperation. Future research will investigate how effects of other perioperative factors and patient selection bias for reoperation account for the directionality of the associations in this model.

1. Chen, C, Zhang X, Ma X. Durability of cervical disc arthroplasties and its influence factors: A systematic review and network meta-analysis. *Medicine (Baltimore)*. 2017;96(6):e5947.
2. Park JB, Chang H, Yeom JS, Suk KS, Lee DH, Lee JC. Revision surgeries following artificial disc replacement of cervical spine. *Acta orthopaedica et traumatologica turcica.* 2016;50(6):610-8.

2) Omid Hariri, DO, MSc, Ariel Takayanagi2 DO, Jonathan Lischalk MD3, Kaniksha4, Desai MD, TJ Florence5 MD PhD, Pouria Yazdian6, Steven D. Chang1 MD, Frank Vrionis7 MD, John R. Adler1 MD, Atman1 Desai MD

Clinical efficacy of frameless stereotactic radiosurgery in the management of spinal metastases from thyroid carcinoma

Introduction: Thyroid carcinoma is an infrequent cause of spinal metastasis (SM). The absolute efficacy of stereotactic radiosurgery (SRS) generally and CyberKnife in particular remains poorly characterized for thyroid SMs. The current study is the first to specifically evaluate the efficacy of CyberKnife (CK) SRS for thyroid SMs.

Methods: A retrospective chart review of patients with thyroid carcinoma SMs who underwent CK SRS at our institution between 2003 and 2013 was done after IRB approval. Details about tumor location, radiographic findings before and after CK SRS, tumor recurrence, prescription isodose level, total and maximum dose, number of fractions, and gross tumor volume coverage were similarly collected. Each patient was assessed for survival and local disease control from the time of the first CK session and survival analysis was carried out using the Kaplan-Meier method. Risk factors for local failure were assessed using multivariate logistic regression.

Results: A total of 12 patients with 32 spinal metastases from thyroid carcinoma that were treated with CK SRS were identified. At the time of treatment of 12 (58%) of the lesions, patients had Karnofsky performance score (KPS) of greater than 70, while 13 lesions (52%) were treated while KPS when less than 70. Follicular thyroid carcinoma was the most common histology (50%, n=6) and thoracic lesions were the most common location (76%, n=19). Survival for 1, 2, and 3 years was 55%, 44%, and 33%, and local control was 67%, 56%, and 34% respectively. No complications such as signs of radiation-induced neuropathy or myelopathy occurred in the immediate or late follow-up period.

Discussion/Conclusion: This was the first study to specifically investigate the efficacy of CK for treatment of thyroid SMs. Our findings suggest that CK can be safely used to treat spinal SMs from thyroid cancer and is associated with a high rate of local control.

3) Lee A. Tan MD

Safety and Efficacy of Anterior Cervical Foraminotomy with Uncinate Process Resection in Conjunction with Anterior Discectomy and Fusion for Treatment of Cervical Radiculopathy

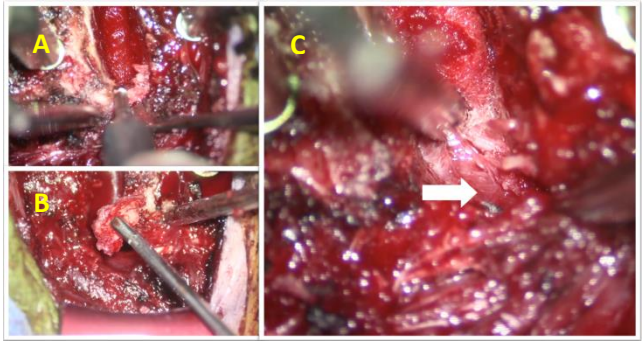
Introduction: Cervical radiculopathy is common in patients with degenerative cervical spine pathology. ACDF relies on indirect nerve root decompression via distraction of the disc space by the intervertebral bone graft or spacer, which then increases the foraminal height. However, the outcome of direct anterior nerve root decompression via resection of uncovertebral joint in conjunction with ACDF is not well documented. We aim to investigate the safety and efficacy of anterior cervical foraminotomy via direct nerve root decompression with uncinate process resection in patients undergoing ACDF.

Methods: Electronic medical records were screened from November 2017 to January 2019. Patients who underwent direct nerve root decompression with uncinate process resection by a single surgeon were identified and patients with at least 6-week follow-up data were included. Pre- and post-operative motor and sensory examination findings, as well as NDI, EQ5D, and VAS scores were compared.

Results: Fifty-two consecutive patients were identified and 152 anterior cervical foraminotomies were performed. Sixty-six foraminotomies were associated with numbness in the corresponding dermatome pre-operatively, with 86.4% of patients experiencing complete or significant resolution in numbness post-operatively. A total of 89 foraminotomies were associated with pre-operative motor weakness, and 88.8% of patients had improvement in at least one corresponding myotome post-operatively. One patient experienced post-operative C5 palsy which recovered at the 6-months follow-up. The mean NDI and EQ5D scores improved from 0.43 and 0.49 preoperatively to 0.34 and 0.66 post-operatively. The mean VASneck and VASarm scores improved from 5.8 and 4.05 preoperatively to 3.8 and 3.32 post-operatively. There was zero intraoperative vertebral artery injury.

Conclusions: Anterior cervical foraminotomy with uncinate process resection is a safe and effective method to treat patients with cervical radiculopathy. It is a powerful technique that can be used in conjunction with routine ACDF to ensure complete nerve root decompression and facilitate optimal surgical outcome.

Intraoperative Photographs of Anterior Cervical foraminotomy with Uncinate Resection



Intraoperative photographs of anterior cervical foraminotomy with uncinate resection (A-C). A) Resection of uncinate process was accomplished using high-speed burr while a Penfield #2 was placed laterally to protect the vertebral artery. B) Uncinate process removed. C) Complete nerve root decompression after uncinate resection with white arrow indicating nerve root free of pressure. D) Preoperative plain films demonstrated left C4-5 foraminal stenosis with osteophytes on oblique view. E) Six-week postoperative cervical films demonstrated a patent C4-5 left neural foramen following direct nerve root decompression.

4) Zachary Smith, MD

Altas-based mapping of gray matter loss in patients with cervical spondylotic myelopathy.

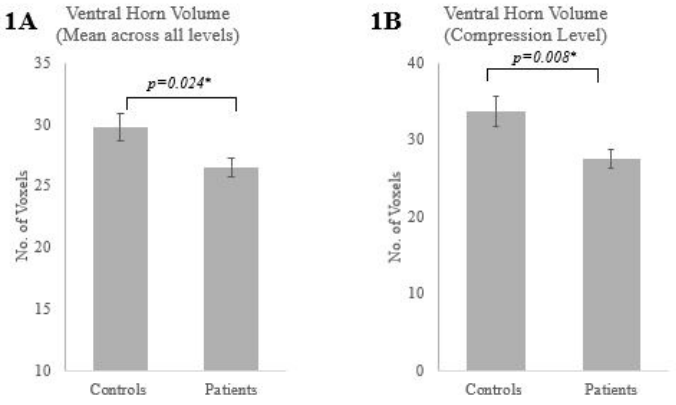
Introduction: Cervical spondylotic myelopathy (CSM) is a common cause of disability with symptoms such as increased reflexes, poor coordination and strength. Spinal cord compression can injure both white and gray matter regions of the cord. Recent advancement in neuroimaging have allowed atlas- based volumetric mapping of the spinal cord areas. The purpose of this study is to examine gray matter volume loss in patients with CSM and its association with disability.

Methods: Fifteen patients and 14 healthy controls participated. Subjects with major neurodegenerative diseases, spinal tumors or trauma, diabetes, and a history of spinal trauma/ surgery were excluded. Modified Japanese Orthopedic Association (mJOA) and Nurick scores were evaluated for all subjects. 3T high-resolution axial MRI images were analyzed with an open source atlas-based processing application (Spinal Cord Toolbox) and cervical spinal cord gray matter volumes were extracted. Statistical differences were analyzed at $p<0.05$ (SPSS).

Results: Spinal gray matter, both ventral and dorsal horn volumes, were significantly lower in patients as compared to controls. In patients, mean ventral volume (26.55±2.99 vs 29.76±4.19, p=0.024) and ventral volume at compressed region (27.55±4.38 vs 33.390±6.50, p=0.008) were significantly decreased in patients (*Figure 1*). Similarly, mean dorsal volume at compression region (17.0±2.97 vs 20.56±4.0, p=0.015) and mean across all levels of cervical spine (16.83±2.58 vs 19.06 ±3.35, p=0.054) were lower in patients. Lower mean ventral horn volumes predicted worse mJOA score (ρ = 0.469, p= 0.016) and Nurick (ρ = -0.448, p= 0.022). Similarly, decreasing dorsal horn volumes were significantly related to worse mJOA and Nurick scores.

Conclusion: Patients with CSM show decreased gray matter volumes and this decline is negatively associated with clinical scores of functions. Advanced spinal neuroimaging and volumetric mapping has the potential to identify specific areas of spinal cord injury and can greatly enhance our understanding of cord diseases.

Supplementary Figure 1:



Scientific Session II Translational Neurosurgery

1) Gary Steinberg, MD, PhD

Safety and Efficacy of Intracerebral Implantation of Modified Bone Marrow-Derived Mesenchymal Stem Cells (SB623) in Patients with Chronic Motor Deficit from Traumatic Brain Injury

Background: Traumatic brain injury (TBI) is a major cause of neurologic disability with no effective treatments.

Methods: This double-blind, randomized, sham-controlled, Phase 2 trial evaluated efficacy and safety of stereotactic intracerebral implantation of allogeneic modified bone marrow-derived mesenchymal stem cells (SB623) in patients with chronic motor deficits secondary to TBI. Sixty-one subjects (mean age 34 years) from 18 sites (US, Japan, and Ukraine) received $2.5x10^6$, $5.0x10^6$, or $10x10^6$ SB623 cells or sham procedure (1:1:1:1 ratio; n=46 SB623, 15 controls). Primary outcome was mean change from baseline in the Fugl-Meyer Motor Scale (FMMS) of pooled SB623 subjects c/w controls at 24 weeks. MR at 8 days post-implant was evaluated for new FLAIR signal changes.

Results: Mean (SE) change from baseline in FMMS (Week 24) was 8.3 (1.4) for SB623 versus 2.3 (2.5) in the control group (p=0.04). Eight (17.4%) serious adverse events (SAEs) in five (10.9%) SB623-treated subjects occurred versus three (20%) SAEs in three (20%) controls. No abnormal MR FLAIR signal changes were observed in any patients at post-implant Day 8.

Conclusion: The primary efficacy endpoint of improved motor function at 6 months was achieved. SB623 cell implantation was well tolerated. Unlike a prior Phase 1/2a study of patients with chronic ischemic stroke undergoing intracerebral implantation of SB623 cells, where a new transient premotor cortex MR FLAIR signal at 1 week post-implantation was highly correlated with neurologic recovery at 6, 12 and 24 months post-implantation, no new MR FLAIR signal was detected at 1 week post-implant in any of the patients.

2) Jam Ghajar MD PhD

Baseline Ocular-motor Performance is Associated with Increased Risk of Symptomatic Concussion

Little is known about how objective baseline testing, including oculomotor assessments, informs prediction of post-concussive symptoms. Identifying at-risk athletes allows for prognostic counseling and may allow for proactive injury prevention via targeted training approaches.

We aimed to determine whether baseline assessments identify the risk of post-concussive symptoms in athletes following head injury. Athletes, 12-30 years of age participating in organized sports, were eligible for enrollment if they were English-speaking and had normal or corrected-to-normal vision, regardless of a history of concussion, neurologic disorder, psychiatric disorder, or learning disability. Athletes were baseline-assessed with the expectation that some would experience a head injury during the study period, and were reassessed within two weeks of their injuries. Baseline and post-injury assessments included demographics; head injury history; post-concussion symptom scale; neurocognitive testing; depression, anxiety, and attention deficit disorder questionnaires; and oculomotor assessments.

A total of 3,091 volunteers were enrolled for baseline testing. Concussion occurred in 2.9% of the athletes, and 39% of those concussed (1.1% of the total cohort) had post-concussive symptoms at the time of post-injury testing. There were baseline characteristics that were associated with the presence of post-concussion symptoms, namely increased variability in pursuit eye movement, prior history of head injury, attention deficit hyperactivity disorder, sensitivity to noise, sleep complaints, and younger age.

Comprehensive baseline testing including oculomotor assessments may identify athletes who are at higher risk of post-concussive symptoms following head injury. Understanding the risk of concussion in athletes, related to baseline testing including pursuit eye movement impairments, is relevant to clinical sports medicine and injury prevention strategies.

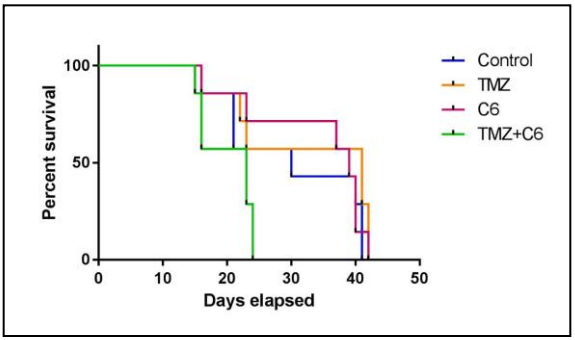
3) John E Wanebo, MD

C6 Ceramide as a single agent and as an adjuvant to temazolamide and radiation inhibits growth of glioblastomas in vitro but not in vivo

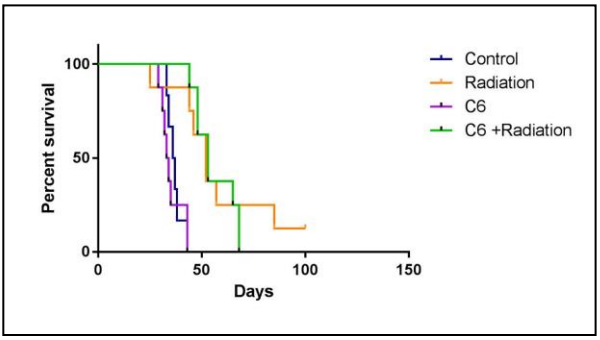
C6 ceramide is a membrane sphingolipid which has shown in vivo chemotherapy-mediated anti-tumor effects against pancreatic cancer which has many pro survival tumor signaling pathways that overlap with glioblastoma such as Pk13/AKT/mTOR pathways. We tested the anti-glioma effects of C6 ceramide in vitro and in vivo murine models. Using in vitro techniques we assayed three independent patient-derived glioma stem-like cell lines and immortalized U87 glioma cell lines and found that C6 ceramide had an antitumor effect against all four glioma cell lines tested .

We performed further pre-clinical treatment studies using either TMZ or radiation in combination with C6 ceramide in immunocompromised mice bearing tumors induced with intracranial injection of the human GBM cell line (ATCC-U87).

For the first study, mice were treated for two weeks with 50 mg/kg of TMZ and 10 mg/kg of C6 ceramide five days/week. Control cohort included vehicle alone treatment, TMZ alone and C6 alone treatments. The mice were imaged every week and sacrificed once they started showing neurological symptoms and/or lost more than 10% of their body weight. C6 treatment alone did not have any effect on tumor growth or survival of mice, however, C6+TMZ combination treatment resulted in significant weight loss in mice and this group had to be sacrificed early (~25 days). There was no significant difference in survival between C6 alone, TMZ alone or control mice. There seemed to be toxicity associated with the drug combination.



Next, we asked if C6 would enhance the effect of radiation on tumor growth. We induced tumors using the same ATCC-U87 cell line. Once the tumor burden was reached, we separated the mice in 4 cohorts – vehicle control, C6 alone, radiation alone and radiation + C6 ceramide. Since C6 by itself was not toxic we increased the dose to 20 mg/kg. The mice were treated five days/week with C6 and twice/week with 4 Gy radiation for two weeks. We followed tumor growth until the mice started showing neurological symptoms. There was a significant increase in survival after radiation treatment, however, there was no difference between the radiation alone and radiation + C6 cohort. These data suggest that C6 is not enhancing the effect of radiation in intracranial tumors. A recent paper has shown that C6 penetrates the BBB but has a short half-life in the brain providing one of the reasons behind the discrepancy between the effect of C6 in pancreatic cancer models and GBM model.



4) Anthony C. Wang, MD

Activating adaptive immunity to target H3.3G34 mutant glioblastoma

Introduction

The two main subtypes of pediatric glioblastoma (GBM) are marked by highly conserved somatic *H3F3A* gene mutations. The H3.3G34R/V GBM subtype displays distinct characteristics that differentiate it from the better-characterized diffuse midline glioma, H3 K27M mutant. The H3.3G34R/V GBM occurs in children and young adults, is typically lobar in location, and frequently harbor concurrent *TP53*, *ATRX/DAXX*, and *PDGFRA* alterations. H3.3G34 alterations prevent K36 residue tri-methylation by altering BS69 binding, which appears to regulate alternative splicing events, and potentially synchronizes the regulation of a subgroup of genes through the intron retention mechanism. We have utilized statistical prediction algorithms to identify splice variant-derived neoantigens in H3.3G34R/V GBM, and have confirmed clonal T cell expansion and strong T cell binding affinity to these neoantigens.

Methods

A patient-derived xenograft and cultured cell line from an HLA-A*02:01 patient harboring an H3.3G34R GBM was generated by Dr. David Nathanson. RNA-Seq generated data were analyzed using IRIS (Isoform peptides from RNA splicing for Immunotherapy target Screening), a neoantigen prediction algorithm developed by Dr. Yi Xing. This platform yields a consensus MCH binding prediction for unique cancer-specific junction peptides. Co-immunoprecipitation for tandem mass spectrometry was then performed to confirm HLA-specific presentation of high-value predicted neoantigens. In addition, two candidate neoantigens were identified using NetMHC, an antigen binding prediction tool. Finally, targeted exome sequencing was paired with germline exome sequencing and analyzed using MuTect2, a somatic mutation-derived neoantigen prediction algorithm that identifies high-value candidates called from single nucleotide variants and from insertion and deletion variants.

Using peripheral blood mononuclear cells obtained from the same patient, CD3+ T cells were expanded in the presence of synthetic long peptides encompassing high-value predicted splice variant-derived neoantigens, and sorted for CD8+ populations. Custom oligomeric major histocompatibility complex class I molecules were then designed for high-value predicted neoantigens, and HLA-specific CD8+ T cell binding was tested to confirm clonal expansion of T cells binding the identified neoantigen candidates. T cell receptor (TCR) sequencing was then used to synthesize cDNA to clone neoantigen-specific TCR$\alpha\beta$ via single-cell multiplex polymerase chain reaction techniques, in a retroviral expression vector.

Results

Two high-value splice variant-derived neoantigen targets were identified using IRIS. Two strong-binding peptide sequences were predicted using NetMHC, though for HLA-A*03:01. Somatic mutation-derived neoantigen targets are still pending confirmatory analysis. Clonal expansion of a few populations of antigen-specific T cells was observed peripheral blood mononuclear cell re-stimulation. These T cells demonstrated high binding affinity for the two splice variant-derived neoantigen targets, and activation in response to patient-derived H3.3G34R GBM cells *in vitro*. These TCRs were then cloned in a retroviral expression vector.

Conclusion

IRIS, a neoantigen prediction algorithm based on alternative splice variants, identified two high-value candidate peptide sequences which were confirmed to be present within H3.3G34R GBM. Re-stimulated T cells expanded against these peptides demonstrated high binding affinity for the two splice variant-derived neoantigen targets, and activation in response to patient-derived H3.3G34R GBM cells *in vitro*. Future studies will include adoptive transfer of TCR-engineered T cells targeting these high-value candidate peptides *in vivo*, using our patient-derived xenograft avatar models.

SCIENTIFIC SESSION III CRANIAL

1) Aria Fallah, MD, MSc University of California Los Angeles Los Angeles, California, USA

Hemispherectomy Outcome Prediction Scale: Development and validation of a tool to predict seizure outcomes.

Objective: To develop and validate a model to predict the probability of seizure freedom in children undergoing a cerebral hemispherectomy for the treatment of drug-resistant epilepsy.

Methods: We analyzed 1267 hemispheric surgeries performed consecutively on children (<19 years of age) across 30 centers and 12 countries to identify predictors of seizure freedom at 6 months following the operation. A multivariate logistic regression model was developed on 70% of the dataset (training set) and validated on 30% of the dataset (validation set). Missing data was handled using multiple imputation techniques.

Results: Overall, 817/1267 (64%) hemispherectomies led to seizure freedom. The regression model (containing age at seizure onset, presence of generalized seizures, etiology, age at surgery and previous non-hemispheric respective surgery) demonstrated were predictive of seizure freedom (Training set AUC 0.755, Testing set AUC 0.689). A simplified HOPS score was devised that closely approximates the predicted probability of hemispherectomy success.

Conclusions: Children most likely to benefit from a hemispherectomy can now be appropriately selected and counselled.

Importantly, some children can be spared from the complications and deficits associated with this surgery who are unlikely to experience seizure control.

Abstract Title: Tuberculum Sellae Meningiomas: Role of Posterolateral Orbitotomy, Optic Canal Decompression and Proposal of a New Classification System

2) Mark G. Hamilton, MDCM, FRCSC
Reducing the risks of proximal and distal shunt failure in adult hydrocephalus (the ShOut-QI initiative)

Introduction: Shunt failures are common and subject patients to multiple surgeries and decreased quality of life. A Shunt Outcomes Quality Improvement (**S**h**O**ut-**QI**) initiative was implemented to reduce shunt failure incidence (**SFI**) through: 1) neuronavigation-assisted proximal catheter insertion; and 2) laparoscopy-guided distal catheter anchoring over the liver dome to drain into the right upper quadrant (RUQ), away from omentum and common shunt obstruction-prone debris. A prospective cohort study tested the hypothesis *neuronavigation and laparoscopy-guided VP shunt insertion (VPSI) will reduce incidence of shunt failure.*

Methods: "Pr**e-**S**hOut**" and "Post**-S**h**O**ut" groups of patients were assessed, which included those who had their initial VPSIs done before or after the **S**h**O**ut-QI initiative, and without or with neuronavigation/laparoscopy, respectively. A 3-point CT index assessed proximal catheter placement, postop X-rays confirmed distal catheter placement, and a standardized protocol determined the primary outcome (SFI) as any return to surgery for shunt revision.

Results: 244 patients (97 Pre**-S**h**O**ut, 147 Post**-S**h**O**ut), mean age 73 years, were observed for ~4 years. Neuronavigation improved proximal catheter placement accuracy by 20% (p<.001), and 90% of laparoscopy-guided distal catheters drained into the RUQ. SFI occurred in 57% vs 23%, with a mean duration of 380 vs 283 days to revision surgery, in the Pre**-S**h**O**ut and Post**-S**h**O**ut groups, respectively (p=.008).

Conclusions: Adult SFI may be reduced by improving the accuracy of proximal catheter placement with neuronavigation and reducing the risk of distal catheter failure with neuronavigation-guided placement. Further studies are necessary to assess the effect of these interventions on long-term patient outcomes.

3) Martin M. Mortazavi, MD,

Introduction: Tuberculum Sellae Meningiomas comprise a small portion of skull base meningiomas. Due to their location, they tend to grow into the optic canals and cause visual decline. Successful restoration of vision and prevention of recurrence is based on proper exposure of the optic canal through posterolateral orbitotomy, anterior clinoidectomy and both extradural and intramural decompression of the optic canal to remove tumor residing in the optic canal.

Methods: Retrospective review of resected tuberculum sell meningiomas were performed since 2005.

Results: With the proposed surgical technique, a majority of lost vision was restored with no recurrence except in 1 case with grade II meningioma and 1 case with a small residual firmly attached to ICA that underwent stereotactic radiation and stayed free of recurrence. Important parameters dictating surgical approach and outcome include tumor size, degree of optic canal invasion, extent of ICA/ACA encasement, brain invasion, sphenoid sinus invasion, previous surgery, and previous radiation. Based on these parameters a 3-class classification system was proposed in 2016.

Conclusion: A 3-class classification system for Tuberculum Sellae Meningiomas was proposed in 2016 outlining important factors in the treatment of these tumors and simplifying communication in between treating neurosurgeons for this kind of meningiomas. Class 1 tumors were also validated by an independent group in 2018. Key to successful resection of these tumors and restitution of vision is in opening the optic canal and near total resection of these tumors.

4) Juan C. Fernandez-Miranda, MD, FACS
Endoscopic Endonasal Surgery for "Inoperable" Craniopharyngiomas: Intraoperative Challenges and Management of Complications

Introduction: Craniopharyngiomas are among the most challenging intracranial tumors. Compared with well-established transcranial approaches, endoscopic endonasal surgery combines the virtues of the caudocranial and midline approaches, allowing for appropriate infrachiasmatic exposure without the need for manipulation of surrounding neurovascular structures to access the tumor

Methods: Here we present several highly complex craniopharyngioma cases operated by the author at Stanford University Medical Center and Lucile-Packard Children's Hospital, that had been previously labeled as "inoperable" or "unresectable" based on imaging characteristics (size, calcification), behavior (multiple recurrence), or patient's age.

Results: Five patients were included in the study, 3 adults and 2 children. Two of the adults had undergone a total of 12 previous operations and 4 radiation treatments, while the remaining adult patient was left untouched based on the presence of a large calcification in spite of progressive growth. The 2 pediatric patients had giant tumors and had undergone transfrontal cyst drainage without attempted resection secondary to huge size and/or very young age (2-year-old).
In 4 out of 5 patients, gross-total resection was achieved, with near-total resection (+95%) in the remaining case. There were 2 intraoperative vascular injuries involving the posterior circulation that were successfully managed with bipolar coagulation or aneurysm clip placement, with vessel preservation in both cases. One patient had evidence of a small stroke on postoperative MRI (anterior thalamus) with no obvious neurological deficits. One patient had postoperative CSF leakage secondary to necrotic nasoseptal flap that required a temporo-parietal fascia flap reconstruction.

Conclusions: Here we emphasize the importance of new surgical planning platforms, "live-cadaver" vascular injury exercises, virtual reality simulation and 3D printed models, as adjuncts to training in the surgical neuroanatomy lab in preparation for these challenging cases. There is an absolute need for advanced expertise and dedication for safe, effective and live-changing treatment of complex adult and pediatric craniopharyngiomas.

5) Philipp Taussky, MD

OBJECTIVE:
Flow diversion has been an important addition to endovascular neurosurgery, but its use in the posterior circulation remains controversial. Our goal is to describe the safety and efficacy of m flow diversion for posterior circulation lesions (aneurysms or dissecting pseudoaneurysms).

METHODS:
The authors retrospectively reviewed the medical records of all patients who underwent placement of a Pipeline embolization device for a posterior circulation lesion using moderate sedation at a single institution from August 2012 through November 2017. Clinical data and outcomes were evaluated.

RESULTS:
32 consecutive patients were identified: 20 female, 12 male (mean age 52.2 ± 16.3 years, range 15-81). Tenwty-two lesions were located in the vertebral artery, 2 in the posterior inferior cerebellar artery, 2 in the superior cerebellar artery, 3 in the posterior cerebral artery, and 3 in the basilar artery. All patients underwent flow diversion with Pipeline embolization devices. One patient experienced an acute occlusion of the basilar artery during the procedure that required revascularization. Mean fluoroscopy time was 35.6 ± 16.5 minutes (range 15.5-75). Mean follow-up time was 12.7 ± 8.8 months (range 3-36). No patient had new neurologic deficits in the perioperative or postoperative period. Conversion to general anesthesia was not required in any case.

CONCLUSIONS:
Flow diversion, particularly under moderate sedation is safe and feasible in patients undergoing flow diversion for posterior circulation lesions. In addition, its use may allow for more rapid identification of procedural complications, facilitating emergent treatment and decreasing procedure-related morbidity.

SCIENTIFIC SESSION IV
Ensuring Ethical Neurosurgeons for the future

SCIENTIFIC SESSION V

Ablin Lecture, Regis Haid, MD
"Spinal Alignment: Keys to the Kingdom"

Cloward Award winner, Robert Spetzler, MD
"My Journey in Neurosurgery"

Presidential Address
Thomas Scully, MD

SCIENTIFIC SESSION VI Resident Abstracts

1) Arjun Vivek Pendharkar, MD Clinical Science Award

Functional mapping for glioma surgery: A propensity-matched analysis of outcomes and cost

Introduction
Intraoperative functional mapping, as a technical adjunct, has been shown to produce lower postoperative complications and longer postoperative survival in several clinical series, but larger multi-institutional database studies are lacking. We sought to compare clinical outcomes and payment differences between glioma resections with and without functional mapping.

Methods
A national longitudinal database was used to identify patients undergoing resection of supratentorial primary malignant glioma with or without functional mapping between 2007-2016. Patients were stratified into mapped and unmapped (conventional) groups, and subsequently propensity-matched based on demographics, clinical comorbidities, and surgical characteristics (i.e., use of stereotactic navigation, microscope, intratumoral chemotherapy). Outcomes and charges were compared between matched groups using bivariate analyses.

Results
A total of 14,037 patients were identified, of which 796 (6.0%) received functional mapping. Propensity-matching resulted in a total of 1,592 well-matched patients for subsequent analyses, of which half received functional mapping. Thirty-day postoperative rates of new-onset seizures, cerebral edema, hemorrhage, and neurological deficits were significantly lower for the functional mapping group (all $p<.05$). Functional mapping was also associated with shorter hospital length of stay ($p=.0144$), lower 30-day rates of emergency department visits ($p=.0001$) and fewer reoperations ($p=.0068$). Total costs of initial admission were not significantly different between groups.

Conclusion
Intraoperative functional mapping during glioma resection resulted in decreased complications, reoperations, emergency department visits, and shorter length of stay. Furthermore, total charges of mapped resections were not significantly different from those of conventional resections. These findings support the utility of functional mapping for resection of supratentorial primary malignant gliomas.

2) Srinivas Chivukula, MD UCLA Basic Science Award

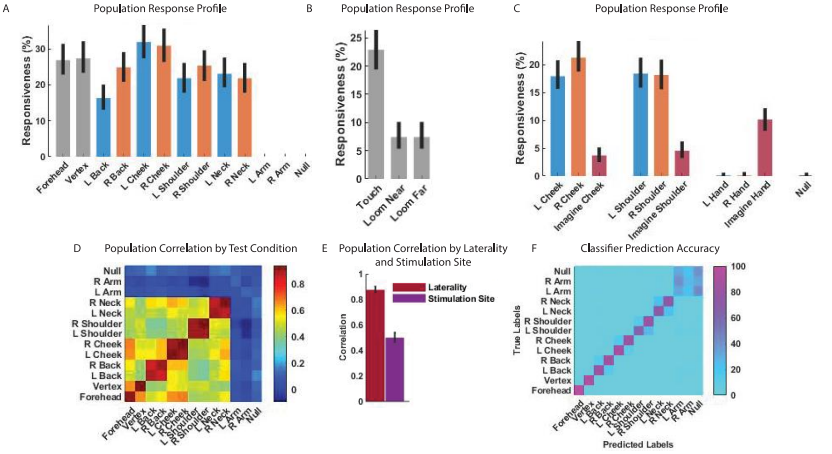
Somatosensory Processing within the Posterior Parietal Cortex

Introduction: The posterior parietal cortex (PPC) integrates convergent multisensory information for a unified representation of the world around us. Although a body of literature has grown around elucidating multisensory integration, a fundamental question remains: at the single neuron level, what are the basic somatosensory properties of the human PPC that enable more complex cognition and perception?

Methods: We recorded from 1423 single neurons at the junction of the postcentral and intraparietal sulci (PC-IP) within the PPC of a high cervical, spinal cord injured human subject during the presentation of tactile (or visual looming) stimuli to sensate dermatomes above the level of the subject's injury.

Results: We found that PC-IP neurons robustly encode touch to distributed receptive fields on the head, face, neck and bilateral shoulders (Figure 1A). A fraction of the PC-IP population demonstrated bimodal visual-tactile responsiveness, which may underlie the region's involvement in multisensory integration (Figure 1B). A small fraction of neurons also encoded imagined touch to bilateral receptive fields (Figure 1C). These representations are organized by body parts (right shoulder similar in representation to the left shoulder, for example) and are complex and variable, are bilaterally robust yet retain significant singularity in their neural structure to be classified with greater than 85% accuracy by a trained decoder (Figures 1D,E and F).

Conclusion: Our results together provide the first ever single unit evidence of somatosensory processing within the human PPC, suggesting a preferential encoding of touch within a partially bimodal population, and identify coding for imagined touch. The latter represents a novel finding, thus far untestable in NHP models. The identification of cells within the PPC that respond preferentially to touch, against a background of visuo-tactile bimodal responsiveness, have far reaching implications in brain machine interfacing, such as in providing sensory capabilities to neural prosthetics.



SCIENTIFIC SESSION VII Mini-Spine Symposium

SCIENTIFIC SESSION VIII General Interest Neurosurgery

1) Michael Lawton, MD

Objective: Previous experience with anterior cerebral artery (ACA) bypasses for complex aneurysms demonstrates how infrequent this alternative treatment strategy is implemented, and how important intracranial-intracranial (IC-IC) bypass techniques are, relative to extracranial-intracranial (EC-IC) techniques. Our experience with ACA bypass has grown and bypass construction has evolved. These technical advances and their clinical results were reviewed.

Methods: 23 patients with 23 complex aneurysms requiring an ACA bypass were reviewed retrospectively. Ten patients were treated in the 16-year period between 1997 and 2013 (Period 1), and 13 patients were treated in the 5-year period between 2014 and 2018 (Period 2).

Results: There were 3 pre-communicating ACA (13%), 8 communicating ACA (ACoA, 35%), and 8 post-communicating ACA aneurysms (35%), plus 4 middle cerebral artery (MCA) aneurysms (17%). ACA in situ bypass was the most common bypass (9 patients, 39%). The classic L A3 ACA-R A3 ACA in situ bypass was performed in 5 patients, but 3 new in situ variations were performed in Period 2: L PcaA-R PcaA (n=1), L CmaA-R CmaA (n=2), and L CmaA-R A3 ACA (n=1). The sole reimplantation in Period 1 was the ipsilateral and vertical PcaA CmaA reimplantation, whereas reimplantations in Period 2 were contralateral and horizontal (L PcaA-R PcaA and R A3 ACA-L AlFA). A1 ACA was not used as a donor for any bypasses in Period 1, but was used in 4 patients with MCA bifurcation aneurysms in Period 2 (17% of all ACA bypasses). Bypass patency was 91%, and 21 patients (91%) improved or remained unchanged neurologically (mean follow-
up duration, 26 months).

Conclusions: The frequency of ACA bypass is increasing and ACA bypass technique is evolving dynamically. Despite using all 5 of the IC-IC bypasses in Period 1, 9 additional variations of ACA bypass were performed in Period 2. The variations displayed in this experience push bypass technique beyond the standard constructs and add important alternatives to our bypass arsenal. Impact of Technology on Neurosurgical Education

2) John D. Rolston, MD, PhD

Human interictal epileptiform discharges recorded from microelectrode arrays are traveling waves with distinct propagation directions

Introduction: Interictal epileptiform discharges (IEDs), also known as interictal spikes, are intermittent, large-amplitude electrographic events recorded from epilepsy patients. Despite the relative prevalence of IEDs compared to seizures, little is known about how IEDs relate to the seizure onset zone in human epilepsy. Our recent theoretical work predicted that robust, spatially directed propagation of intense synaptic activity during seizures will cause IEDs to propagate in the same direction as ictal discharges. Critically, the geometry of focal seizure expansion dictates that direction leads to the center of the seizure onset zone.

Methods: To test this hypothesis, we studied microelectrode array recordings from human subjects with medically refractory epilepsy. We detected IEDs by filtering in the beta range and retaining excursions >8 standard deviations that occurred across ≥10 microelectrodes within a window of 250 milliseconds. We then measured IED traveling wave speeds and directions using a previously validated multilinear regression framework. IEDs with model slopes that were significantly different from zero, based on a permutation test (500 permutations), were operationally defined as interictal traveling waves. The Hermans-Rasson tests of circular non-uniformity was used to verify directional consistency.

Results: We detected 1749.4 ± 1019.8 IEDs across 5 subjects, 1194.8 ± 648.7 (68.3 %) of which were interictal traveling waves (permutation tests, FDR-corrected $p < 0.05$). Distributions of IED traveling waves were significantly non-uniform in every subject (Hermans-Rasson tests, all $p < 0.05$), indicating that interictal traveling waves generally have consistent directions. However, several IED direction distributions exhibited secondary modes.

Conclusions: These results show that IEDs are traveling waves with consistent directions. We are currently examining whether IEDs travel in the same direction as ictal discharges, as predicted by our computational model. This work shows that abundant IEDs can predict the spatial properties of rare seizures, a finding potentially useful in epilepsy surgery.

3) Brian D. Toyota, UBC

With the tenet that post-graduate medical education always lags the practice of medicine, technology in the surgical fields emphasizes the point.

The introduction of several technologies and innovations into neurosurgery over the past 1-2 decades has unequivocally changed how neurosurgery is practiced. The adoption of these technologies is rapid and ubiquitous, although the depth and sophistication of usage varies greatly. The integration of these technologies is totally dependent on the local cohort of practicing surgeons, which are not necessarily within teaching environments.

The construct for changing formal educational templates, e.g. CanMeds, Competency based curriculums, is work-heavy, time-consuming and by its nature, latent. On this basis, neurosurgical training programs carry a great burden in tryin to match educational goals to the reality of practice.

Using several neurosurgical technologies as examples, along with a recent survey of Canadian Neurosurgical graduate competencies in vascular surgery as evidence, this presentation will highlight the lag between education and practice.

A recent trend in neurosurgical practice is to treat ruptured cerebral aneurysms via endovascular routes, rather than open micro-surgery. However current educational curriculums do not adequately address this change in practice, at least not to the extent that a graduating neurosurgeon is enabled to manage ruptured aneurysms with the primary modality of intervention. A recent survey of Canadian neurosurgical graduates highlights an extremely varied and heterogeneous competency level in the field of subarachnoid hemorrhage and ruptured cerebral aneurysms.

This presentation will discuss the need for more agile and objective orchestration of educational goals with the reality of clinical service delivery.

4) Farrokh Farrokhi, MD

"Risk reduction in DBS Surgery: Lean Methodology, Logistic Regression, Artificial Intelligence and the Kitchen Sink!"

There is an increasing application of deep brain stimulation (DBS) therapy in patients experiencing medically resistant neurological disease. DBS complications rates are declining, but remain as a primary reason for those who defer treatment. Multimodality approaches have been applied to risk reduction in this population. This presentation outlines a decade long pursuit of efforts at complication reduction through application of lean methodology, traditional statistical analysis of modifiable patient characteristics, and recent advances in artificial intelligence and machine learning methodologies all directed at getting closer to zero risk DBS.

5) Jay K. Morgan, MD

Management of Giant Extradural Arachnoid Cyst

The authors present a case of a giant extradural arachnoid cyst in a young woman presenting with myelopathy. This large compressive lesion extended from T10 through L3 with marked enlargement of the associated spinal foramina. The spinal cord and cauda were both markedly compressed. The attending surgeon considered this an intra-dural arachnoid cyst but at surgery found it to be extradural. Attempted fenestration and later shunting failed to treat the lesion. The patient had extensive testing with multiple CT/myelograms using dynamic positioning and subsequently digital subtraction techniques at UCSF to localize the communication between the intra-thecal subarachnoid space and the arachnoid cyst . A discrete connection was not found with these conventional studies. MRI with intrathecal gadolinium proved to be an accurate technique to localize the dural defect to the right L1 nerve root exit zone. An L1 hemi- laminectomy with microsurgical closure of the communication eliminated the lesion. Post-operative MRI studies done over the last 2 years have shown sustained and dramatic resolution of this giant extradural arachnoid cyst with normal spinal cord and cauda equina anatomy. Patient's myelopathy resolved but she has persistent non-positional headaches.

ORGANIZATIONAL COMMITTEE

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Edwin B. Boldrey*
Howard A. Brown*
Herbert G. Crockett*
John Raaf*
Rupert B. Raney*
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C. Hunter Sheldon*

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**deceased*

DECEASED SOCIETY MEMBERS
(Expired while a member, non-Officers or founder)

Kenneth H. Abbott, Eben Alexander, Jr., James R. Atkinson, Thomas S. Bennett, Irvin H. Betts Jr., David Brown, John D. Camp, Norman L. Chater, Cyril B. Courville, John B. Doyle, Charles W. Elkins, Hal Pittman, John C. Oakley, Carl W. Rand, Aidan Raney, Nat, D. Reid, Ted Roberts, Adolf Rosenauer, Alan W. Rosenberg, Robert L. Scanlon, Harry F. Steelman, A. Earl Walker, W. Keasley Welch, William Wright, Eric Yuhl, Edward Zapanta, Michael Robbins, Peter Allen, Deane B. "Skip" Jacques, William Hyman, Lester B. Lawrence, Grant Levin, Frank W. Lusignan, John S. Marsh, Robert Morelli, Richard Newquist, Charles Needham, Michael Mason, Sam Assam, Benjamin L. Crue, Jr., Justin Renaudin, O. W. Jones, Alexander Johnson, Ralph Kamm, John C. Kennady, Peter A. Lake, James Lansche, Attilla Felsoory, Robert D. Fiskin, Anthony Gallo, Leslie Geiger, John W. Hanbery, Hale A. Haven, William A Newsom, Shokei Yamada, Robert Florin, Homer McClintock, John Bonner, Alan Hunstock, Edward Reifel, Bruce Sorensen, Ralph Kamm, W. Eugene Stern, Burton Wise

PAST SECRETARY-TREASURERS

Herbert Crockett*	1955, 1956, 1957
Ernest W. Mack*	1958, 1959, 1960
Samuel W. Weaver*	1961, 1962, 1963
James R. St. John*	1964, 1965, 1966
Robert W. Porter	1967, 1968, 1969
William A. Kelly	1970, 1971, 1972
John S. Tytus	1973, 1974, 1975
Theodore S. Roberts*	1976, 1977, 1978

Ulrich Batzdorf	1979, 1980, 1981
John A. Kusske	1982, 1983, 1984
W. Ben Blackett	1985, 1986, 1987
Francis E. LeBlanc	1988, 1989, 1990
Melvin L. Cheatham	1991, 1992, 1993
Grant E. Gauger	1994, 1995, 1996
Randall W. Smith	1997, 1998, 1999
Moustapha Abou-Samra	2000, 2001, 2002
Hector E. James	2003
Austin R. T. Colohan	2004, 2005, 2006
Jeffery L. Rush	2007, 2008, 2009
Charles E. Nussbaum	2010, 2011, 2012, 2013
Deborah C. Henry	2014, 2015
Marc Vanefsky	2016, 2017, 2018

PAST HISTORIANS

Henry M. Cuneo*	1962-1966
Ernest W. Mack*	1967-1971
Donald B. Freshwater*	1972-1976
George Ablin*	1977-1982
Gale C. Clark*	1983-1984
Robert Rand*	1985-1990
Frank P. Smith*	1991-1995
John C. Oakley*	1996-1999
John P. Slater	1999-2002
John T. Bonner *	2002-2008
Randall Smith	2009-2013
Moustapha Abou-Samra	2014-2016
Moustapha Abou-Samra	2016-2019

**deceased*

PAST MEETINGS OF THE SOCIETY

1. Biltmore Hotel, Santa Barbara, CA	Nov 25-26, 1955
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
56. Eldorado Hotel, Santa Fe, NM *In Memory of L. Philip Carter* Oct. 8-11, 2010
57. The Grand Hyatt Kauai Resort & Spa, Island of Kauai, HI Sept. 10-13, 2011
58. Broadmoor Hotel, Colorado Springs, CO Sept. 7-10, 2012
59. Ritz Carlton Half Moon Bay, Half Moon Bay, CA Sept. 15-18, 2013
60. The Lodge, Sun Valley, ID Aug. 16-19, 2014
61. Grand Hyatt Kauai Hotel, Kauai, HI Sept. 10-13, 2015
62. Park Hyatt Aviara, Carlsbad, CA Sept. 9-12, 2016
63. Fairmont Banff Springs Hotel, Banff, Alberta, Canada Sept. 8-11, 2017
64. The Fairmont Orchid, Kona, Hawaii Sept. 14-17, 2018

FUTURE MEETINGS

Fairmont Grand Del Mar, San Diego, CA	August 28-31, 2020
Hyatt Regency Tamaya, Santa Ana Pueblo, NM	September 10-13, 2021

PAST VICE-PRESIDENT

John Raaf*	1955	Robert Florin*	1987
Frank Turnbull*	1956	John A. Kusske	1988
Howard A. Brown*	1957	Basil Harris*	1989
Rupert R. Raney*	1958	W. Ben Blackett	1990
Edmund J. Morrissey*	1959	Ronald F. Young	1991
C. Hunter Sheldon*	1960	Edward Reifel *	1992
Ernest W. Mack*	1961	Grant E. Gauger	1993
Hale A. Haven*	1962	Ralph F. Kamm*	1994
Frank M. Anderson*	1963	Steven L. Giannotta	1995
Edwin B. Boldrey*	1964	Randall W. Smith	1996
Herbert C. Crockett*	1965	Gail A. Magid	1997
Karl O. Von Hagen*	1966	Donald Prolo	1998
Samuel W. Weaver*	1967	Lawrence Shuer	1999
Chester B. Powell*	1968	John C. Oakley*	2000
Peter O. Lehman*	1969	L. Philip Carter*	2001, 2002
Charles W. Elkins*	1970	William L. Caton III	2003
Nathan C. Norcross*	1971	Gerald Silverberg	2004
James R. St. John*	1972	Kim Burchiel	2005
Edward K. Kloos*	1973	John Adler	2006
Ralph B. Cloward*	1974	Philip Weinstein	2007
Thomas K. Craigmile*	1975	Betty MacRae	2008
Lyman Maass*	1976	Linda Liau	2009
Gale C. Clark*	1977	David W. Newell	2010
William A. Kelley	1978	J. Paul Muizelaar	2011
Byron C. Pevehouse*	1979	Richard Wohns	2012
Robert W. Rand*	1980	Marc Vanefsky	2013
Theodore S. Roberts*	1981	Marvin Bergsneider	2014
Ulrich Batzdorf	1982	Thomas Scully	2015
George Ablin*	1983	David Pitkethly	2016
George A. Ojemann	1984	Odette Harris	2017
Gale C. Clark*	1985	John McVicker	2018
Robert Weyand	1986		

**deceased*

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John Raaf*	1956
Frank Turnbull*	1957
Howard A. Brown*	1958
Rupert R. Raney*	1959
Edmund G. Morrissey*	1960
C. Hunter Sheldon*	1961
Ernest W. Mack*	1962
Hale A. Haven*	1963
Frank M. Anderson*	1964
Edwin B. Boldrey*	1965
John R. Green*	1966
Arthur A. Ward, Jr.*	1967
Lester B. Lawrence*	1968
John D. French*	1969
Chester B. Powell*	1970
Robert W. Porter	1971
Henry M. Cuneo*	1972
Charles W. Elkins*	1973
Edward K. Kloos*	1973
W. Eugene Stern *	1974
Ralph B. Cloward*	1975
James R. St. John*	1976
Eldon L. Foltz*	1977
John Tytus*	1978
Donald B. Freshwater*	1979
William A. Kelly	1980
Byron C. Pevehouse*	1981
Robert W. Rand*	1982
Theodore S. Roberts*	1983
Thomas K. Craigmile*	1984
Ulrich Batzdorf	1985
Gale C. Clark*	1986
Lyman Maass*	1987
Gordon B. Thompson	1988
George Ablin*	1989
Robert Weyand	1990
Basil Harris*	1991W.
Ben Blackett	1992
Francis E. LeBlanc	1993
Ronald F. Young	1994
John A. Kusske	1995
Melvin L. Cheatham	1996
Robert Florin*	1997
Frank P. Smith*	1998
Ralph F. Kamm *	1999
Steven L. Giannotta	2000
Donald J. Prolo	2001,2002
Grant E. Gauger	2003
Randall W. Smith	2004
John P. Slater	2005
Moustapha Abou-Samra	2006
Kim Burchiel	2007
Gerald Silverberg	2008
Lawrence Shuer	2009
L. Philip Carter*	2010
David W. Newell	2010
Austin R.T. Colohan	2011
John T. Bonner *	2012
Jeffery L. Rush	2013
Richard Wohns	2014
Gary Steinberg	2015
Linda Liau	2016
Charles Nussbaum	2017
Martin Weinand	2018

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Ralph Kamm, OHSU**	1966
Jerry Greenhoot, UW	1968
L. Philip Carter, BNI**	1971
Ronald J. Ignelzi, U. of Colorado	1972
Henry G. Fieger, Jr., U. of Colorado	1973
Peter F. Schlossberger, UCLA	1974
Paul Steinbok, UBC	1975
Arden F. Reynolds, Jr., UW	1976
John W. Hutchison, UCI	1977
Kim J. Burchiel, UW**	1978
Roy A.E. Bakay, UW	1979
Herbert Fried, UCLA	1980
Linda M. Liau, UCLA **	1997
Sean D. Lavine, USC	1998
Soohoo Choi, USC	1999
Michael Y. Wang, USC	2000
Odette Harris, Stanford**	2001
Raymond Tien, OHSU	2002
Michael Sandquist, OHSU	2003
Iman Feiz-Erfan, BNI**	2004
Johnathan Carlson, OHSU	2005
Mathew Hunt, OHSU	2005
Kiarash Golshani, OHSU	2006
Edward Chang, UCSF	2006
Jonathan Miller, OHSU	2007
Kenneth Liu, OHSU	2007
Justin Cetas, OSHU	2008
Edward Chang, UCSF	2008
Zachary Litvack, OHSU	2009
Kiran Rajneesh, UCI	2009
Justin Dye, UCLA **	2010
Isaac Yang, UCSF **	2010
Terry Burns, Stanford	2011
Gabriel Zada, USC	2011
Walavan Sivakumar, U. of Utah	2012
David Stidd, U. of Arizona	2012
Allyson Alexander, Stanford	2013
Anand Veeravagu, Stanford	2013
Terry Burns, Stanford	2014
Karam Moon, BNI	2014
Achal Achral, Stanford	2015
Jesse Skoch, Tucson	2015
Nicholas Au Yong, UCLA	2016
Priscilla Pang, OHSU	2016
Kevin Kwong-Hon Chow	2017
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