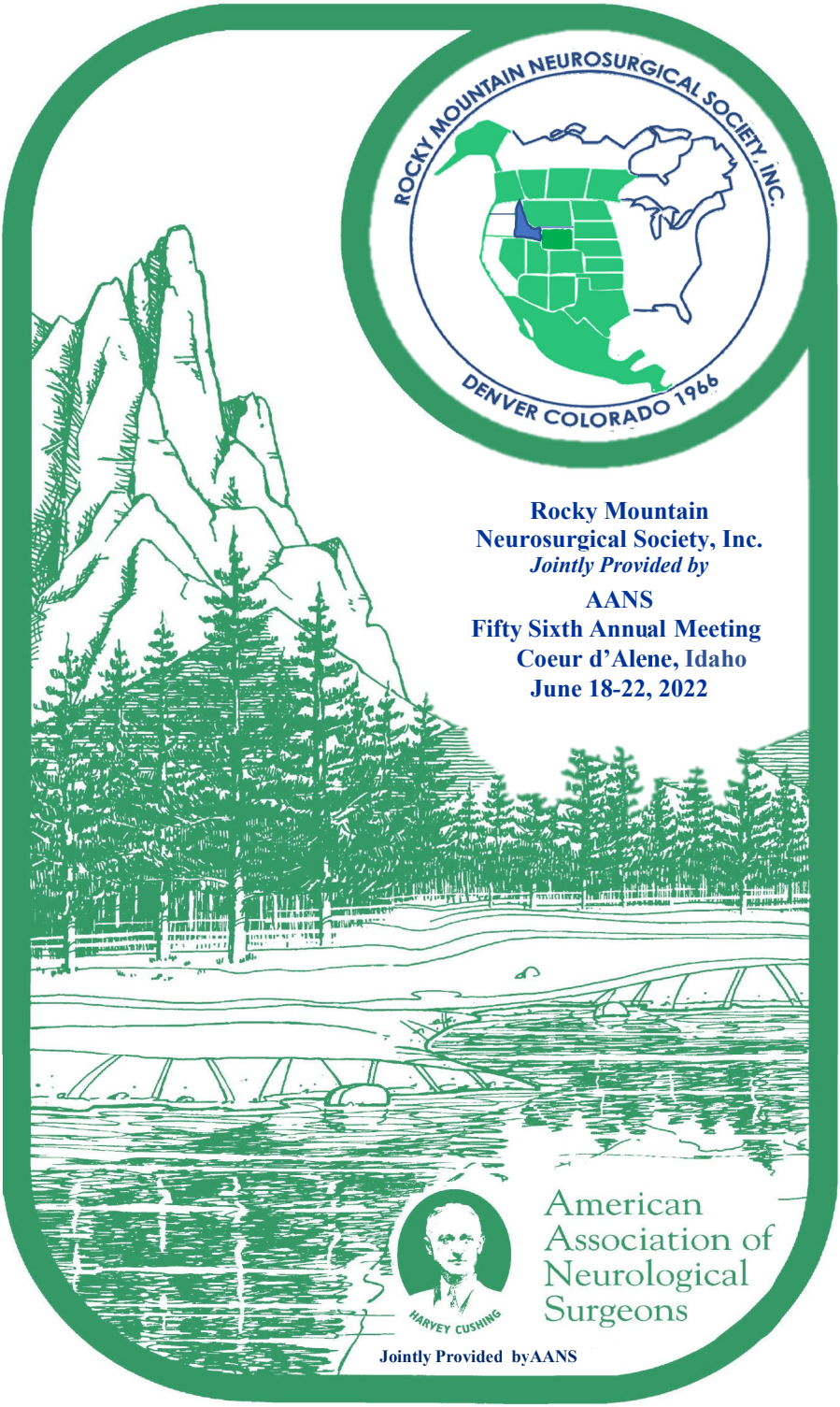

Rocky Mountain Neurosurgical Society, Inc.
Jointly Provided by
AANS
Fifty Sixth Annual Meeting
Coeur d'Alene, Idaho
June 18-22, 2022

American Association of Neurological Surgeons

Jointly Provided byAANS

www.rmns.org

PROGRAM

FIFTY SIXTH ANNUAL MEETING

OF

THE ROCKY MOUNTAIN NEUROSURGICAL SOCIETY, LLC

American Association of Neurological Surgeons

Jointly Provided by the AANS

Honored Guests:

Dr. Linda Liau, MD, PhD, MBA

Dr. Richard Byrne, MD

June 18-22nd, 2022

Coeur d'Alene Resort

Coeur d'Alene, Idaho

THE ROCKY MOUNTAIN NEUROSURGICAL SOCIETY, INC.

www.rmns.org

Founded 30 April, 1966, in Denver, Colorado
Incorporated 1974 in Houston, Texas

SURGICALLY TARGETED RADIATION THERAPY | STaRT

5 minutes at resection can improve patient outcomes[1–3]

Give patients with gliomas, brain metastases, and meningiomas a head STaRT on fighting tumor cell proliferation. Surgery plus GammaTile Therapy extends local recurrence-free survival and eases patient burden.

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DON'T LEAVE BRAIN TUMOR RECURRENCE TO CHANCE

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REFERENCES

1. Brachman D, Youssef E, Dardis C, et al. Resection and permanent intracranial brachytherapy using modular, biocompatible cesium-131 implants: results in 20 recurrent, previously irradiated meningiomas. *J Neurosurgery*. 2019;131(6):1819-1828. 2. Gessler DJ, Neil EC, Renah S, et al. GammaTile® brachytherapy in the treatment of recurrent glioblastomas [published online ahead of print December 27, 2021]. *Neuro-Oncology Advances*. 2022;4(1). 3. Nakaji P, Smith K, Youssef E, et al. Resection and surgically targeted radiation therapy for the treatment of larger recurrent or newly diagnosed brain metastasis: results from a prospective trial. *Cureus*. 2020;12(11):1-12.

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Officers and Executive Committee 2021-2022

President:	Joseph Sramek, MD
President Elect:	Brad Duhon, MD
Vice President:	John Clough, MD
Secretary:	Justin Davis, MD
Treasurer:	Erik Parker, MD
Historian:	Paul Elliott, MD
Past President:	Michael Seiff, MD
Member at Large:	Kalil Abdullah, MD

Committees 2017-2018

Scientific Program Committee:	Brad Lega, MD
CME Chairman:	Mark Mahan, MD
Local Arrangements:	Brad Duhon, MD
Nominating Committee:	Brett Dietze, MD (2022) Kris Smith, MD (2023) Michael Seiff, MD (2024)
Membership Committee:	Brad Duhon, MD Joseph Sramek, MD Michael Seiff, MD
Website Administrator:	Joel MacDonald, MD

MEETING AT A GLANCE

SATURDAY, JUNE 18, 2022

1:00-5:00 p.m.	**Registration**
1:00-4:00 p.m.	**Executive Committee Meeting**
6:30-10:00 p.m.	**Opening Reception and Kid's Party**

SUNDAY, JUNE 19, 2022

7:00-7:55 a.m.	**Physician and Exhibitor Breakfast**
7:00-9:00 a.m.	**Spouse and Children's Breakfast**
8:00 a.m.-12:00 p.m.	**Scientific Session**
6:00-10:00 p.m.	**Lake Cruise Dinner**

MONDAY, JUNE 20, 2022

7:00-7:55 a.m.	**Physician and Exhibitor Breakfast**
7:00-9:00 a.m.	**Spouse and Children's Breakfast**
8:00-12:00 p.m.	**Scientific Session**
1:00 p.m.-?	**Golf Tournament**
7:00-10:00 p.m.	**President's Dinner (executive board and guest speakers)**

TUESDAY, JUNE 21, 2022

7:00-7:55 a.m.	**Physician and Exhibitors Breakfast**
7:00-9:00 a.m.	**Spouse and Children's Breakfast**
7:30-8:00 a.m.	**Annual Business Meeting**
8:00 a.m.-12:00 p.m.	**Scientific Session**
1:00 p.m.-?	**Tennis Tournament**
6:30-10:00 p.m.	**Annual Award Banquet and Dance Kids' Party**

WEDNESDAY, JUNE 22, 2022

7:00-7:30 a.m.	**Physician and Exhibitors Breakfast**
7:00-9:00 a.m.	**Spouse and Children's Breakfast**
8:00 a.m.-12:00 p.m.	**Scientific Session**
12:00 p.m.	**Meeting Adjournment**

Resident Award

First place award for the best resident paper presented at the meeting now includes a $750 cash award. There will also be awards for second place ($500) and third place ($250) resident papers. Each of the first 10 residents to register will receive $500 travel reimbursement.

Academy Cup

Best paper from a practicing neurosurgeon (Active or Associate member).

Coeur d'Alene Resort
115 S. 2nd Street
Coeur d'Alene, Idaho
1-855-280-4398

The 2022 Rocky Mountain Neurosurgical Society Meeting will be held from June 18th through June 22nd at The Coeur d'Alene Resort, in Coeur d'Alene, Idaho. Dr. Brad Duhon is serving as the local arrangements chairman and is putting together an exciting array of activities for members, guests, and their families.

The venue for the 56th annual meeting is located at the Coeur d'Alene Resort which is on the shores of Lake Coeur d'Alene. This wonderful resort promises to offer the usual relaxing yet fun-filled experience that our membership and their families have come to expect. The usual robust scientific program will take place during the mornings, with the afternoons open to participate in one of our planned activities, or just relax and enjoy spending time with family or reconnecting with old friends. Social activities include a dinner lake cruise with spectacular views, our annual golf and tennis tournaments, and the closing night awards banquet and dance!

Coeur d'Alene is the largest city in northern Idaho, renowned for its scenery and lake activities during the summer. The Coeur d'Alene area is known as the playground of the Northwest and has numerous summer activities. The surrounding area is in the Bitterroot range with access to hiking, fly fishing, river rafting and numerous other activities!

Social Highlights - All attendees, including exhibitors, are invited to our social program
Opening Reception –6:30-10:00 p.m. – *Coeur d'Alene Resort* - **Saturday**
Lake Cruise Dinner- 6:00-10:00 p.m. – Hagodone Event Center- **Sunday**
Golf Tournament-1:00 p.m. – Coeur d'Alene Resort **- Monday**
Tennis Tournament –1:00 p.m. - Coeur d'Alene Resort **-Tuesday**
Annual Banquet- 6:30-10:00 p.m. – *Coeur d'Alene Resort* **-Tuesday**

Enjoy dinner, dancing, with awards and prizes for outstanding categories in our Golf and Tennis tournaments.

Dr. Linda Liau

Linda Liau, MD, PhD, MBA is Chair of the Department of Neurosurgery at UCLA, where she also serves as Director of the Brain Tumor Program at UCLA David Geffen School of Medicine. She is board certified by the American Board of Neurological Surgery.

Dr. Liau's clinical expertise is in intra-operative functional brain mapping and use of intra-operative imaging for resection of brain tumors (gliomas, meningiomas, and metastatic tumors). Her research efforts are focused on the molecular biology of brain tumors, gene therapy, immunotherapy, and brain cancer vaccines. She is the former Editor-in-Chief of the Journal of Neuro-Oncology.

Dr. Liau received two bachelor's degrees from Brown University. She received her medical degree from Stanford University and completed residency training in neurosurgery at UCLA. Dr. Liau also received a doctoral degree in Neuroscience at UCLA and an M.B.A. from the UCLA Anderson School of Management.

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Dr. Richard Byrne

Richard Byrne, MD, is Chairman of the Department of Neurosurgery at Rush University and the Roger C. Bone Professor of Neurosurgery at Rush Medical College. He is board certified by the American Board of Neurological Surgery.

Dr. Byrne specializes in surgical treatment for epilepsy, skull base and brain tumor surgery, pituitary surgery, trigeminal neuralgia and radiosurgery. He has been actively involved in man epilepsy and brain tumor surgery trials, and has authored more than 150 manuscripts, book chapters and two textbooks on these subjects. He is co-PI on an FDA approved and NIH-funded, intracortical visual prosthesis phase 1 clinical trial for the treatment of blindness.

Dr. Byrne earned his undergraduate degree from the University of Illinois and his medical degree from Northwestern University Medical School. He completed his neurosurgical residency at Rush University.

Learning Objectives

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

1. Understand current surgical management of limbic system gliomas
2. Understand current immunotherapies for gliomas
3. Discuss protocols for interpreting intra-operative monitoring
4. Describe the features of ultrasound in SCI, post-operatively
5. Discuss the epidemiology of gunshot wounds to the spinal cord
6. Understand the diagnosis and management of peripheral nerve entrapment
7. Describe vaccination strategies for glioblastoma
8. Discuss the lasting impact of Covid-19 on the practice of neurosurgery
9. Describe the use of MMA embolization in management of chronic subdural hematomas
10. Identify transfusion requirements in TBI
11. Describe robotic cervical traction
12. Describe laser ablation of subcortical cavernomas
13. Describe the activation of the amygdala during facial recognition
14. Discuss the usefulness of 3D printing for hardware planning in complex spinal deformity surgery
15. Describe pediatric TBI epidemiology
16. Discuss emerging strategies for spinopelvic fixation in deformity surgery
17. Discuss patient selection in neuromodulation for intractable epilepsy
18. Outline factors affecting meningioma recurrence

SCIENTIFIC PROGRAM - JUNE 19th– 22nd
Rocky Mountain Neurosurgical Society
56th Annual Meeting
Coeur d'Alene Resort, Coeur d'Alene, Idaho

SUNDAY JUNE 19th, 2022

08:00-12:00	**SCIENTIFIC SESSION I:** **Moderator: John Clough, MD**
08:00-08:10	**Introductory Remarks and Welcome to Coeur d'Alene** **President Joseph Sramek, MD** *Vendors Welcome*
08:10-08:55	**SPECIAL GUEST LECTURE – Richard Byrne, MD** **Professor and Chair of Neurosurgery, Rush University** Glioma Surgery in the Limbic System
08:55-09:35	**SPECIAL GUEST LECTURE – Linda Liau, MD, PhD, MBA** **Professor and Chair of Neurosurgery, UCLA** Current State of Immunotherapeutic Strategies for Gliomas
09:35-10:15	**Dr. John Burke** Development of an Automated Protocol for Interpretation of Intraoperative Monitoring Signals During PSO
10:15-10:35	**Break**
10:35-11:00	**Dr. Sivakanthan Sinanthan *** Postoperative Ultrasound Imaging of Spinal Cord Injury in Humans
11:00-11:20	**Dr. Brandon Sherrod *** Epidemiology of gunshot wounds to the spinal cord
11:20-12:00	**Dr. Kathryn Hoes** Peripheral Nerve Entrapment: Update on Diagnosis and Management
12:00	**ANNOUNCEMENTS & ADJOURN**

MONDAY JUNE 20th, 2022

08:00-12:00	**SCIENTIFIC SESSION II:** **Moderator: Kelly Schmidt, MD**
08:00-08:55	**SPECIAL GUEST LECTURE – Linda Liau, MD, PhD, MBA** Autologous Tumor Lysate-loaded Dendritic Cell Vaccination for Glioblastoma
08:55-09:35	**SPECIAL GUEST LECTURE - Richard Byrne, MD** Lasting Impacts of the Covid-19 Pandemic in Neurosurgery
09:35-10:00	**Dr. Luke Tomycz** Organization of Ukrainian Healthcare Resources in a Time of War
10:00-10:20	**Break**
10:20-10:45	**Dr. Jon White** The Application of MMA Embolization in the Management of Subdural Hematoma
10:45-11:20	**Dr. Salah Aoun** Transfusion Requirements in Traumatic Brain Injury
11:20-11:40	**Dr. Brandon Sherrod *** Motorized Robotic-Assisted Cervial Traction
11:40-12:00	**Dr. Christian Ogasawara * (Virtual)** Laser Ablation for Subcortical Cavernomas
12:00	**ANNOUNCEMENTS & ADJOURN**

TUESDAY JUNE 21st, 2022

07:30-07:55	**ANNUAL BUSINESS MEETING FOR ALL RMNS MEMBERS**
08:00-12:00	**SCIENTIFIC SESSION III:** **Moderator: Justin Davis, MD**
08:00-08:35	**SPECIAL GUEST LECTURE – Richard Byrne, MD** Neurosurgical Education - A Chair's Perspective
08:35-09:00	**Dr. Marvin Bergsneider** Neurosurgical Education: A Program Director's Perspective
09:00-09:35	**Dr. Jon White** Neurosurgical Education: Boomers to Gen Z
09:35-10:00	**Dr. Raphael Sillero** Treatment Strategies for Recurrent Posterior Communicating Artery Aneurysms
10:00-10:30	**Break**
10:30-10:45	**Introduction to RMNS 57th Annual Meeting in Girdwood, Alaska: Kelly Schmidt, MD**
10:45-11:00	**Dr. Nicolas Gamboa** High-grade Glioma Imaging Volumes and Survival: A Single Institution Analysis of 101 Patients After Resection Using Intraoperative MRI
11:00-12:00	**Jeff Meldrum** Sasquatch: Legend Meets Science
12:00	**ANNOUNCEMENTS & ADJOURN**

WEDNESDAY JUNE 22nd, 2022

08:00-12:00	**SCIENTIFIC SESSION IV**
MODERATOR:	**Joel MacDonald, MD**
08:00-08:35	**Dr. Shaquia Idletti-Ali** Activation of the Human Amygdala During Processing of Affective Facial Information
08:35-09:20	**Dr. Richard Westmark** Financial Models for Neurosurgical Practice
09:20-09:40	**Dr. James Caruso *** The Applicability of 3D Printing and Modeling for Preoperative Reconstruction and Hardware Placement Planning in Complex Deformity Surgery
09:40-10:00	**Dr. Cordell Baker *** Pediatric Traumatic Brain Injury in a Geographically Dispersed Population
10:00-10:30	**Break**
10:50-11:10	**Dr. Roland Kent** Spinopelvic Fixation with the Bedrock Technique Following Deformity Surgery
11:10-11:30	**Dr. Brad Lega** Patient Selection for Neuromodulation Approaches for the Treatment of Intractable Epilepsy
11:30-11:50	**Dr. Jeffrey Traylor * (Virtual Presentation)** Impact of Site of Origin on Meningioma Recurrence
11:50-12:00	**Difficult Case Presentation** **Dr. Joel MacDonald**
12:00	**Closing Remarks and Meeting Adjourn** **Joseph Sramek, MD**

*** Resident Award Candidate**

Vendor Participants

This year we have the pleasure of welcoming the following exhibitors to the Rocky Mountain Neurosurgical Society's Annual Meeting. Please stop by their booths to thank your representatives for their company's support.

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Medtronic

Silver Sponsor

Globus Medical

Depuy Synthes

Bronze Sponsors

Abbott

Azurity Pharmaceuticals

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GT Medical Technologies, Inc.

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SI-BONE

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Invenio Imaging

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Kuros Biosciences

Stryker Spine

Omniscient Neurotechnology

OssDsign USA, Inc

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Opening Reception Sponsor

SI-BONE

Name Badge/Lanyard/Portfolio Sponsor

GT Medical Technologies

COVID Sponsor
Donohoe & Associates

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

Name	Disclosure	Type of relationship*
Roland Kent	Globus Medical	Surgeon education, research support, product development
	SI-Bone	Surgeon education, research support
	Premia Spine	Research support
Linda Liau	Clearpoint Neuro, Inc.	Board of Directors
	Insightec, Inc.	Advisor
	Northwest Biotherapeutics, Inc.	Research Support
Nader Pouratian	Boston Scientific	Consultant
	Abbott Laboratories	Consultant
	Sensoria Therapeutics	Consultant
	Second Sight Medical Products	Consultant

*Relationship refers to receipt of royalties, consultantship, funding by research grants, receiving honoraria for educational services elsewhere, or any other relationship to a commercial interest that provides sufficient reason for disclosure.

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

Rafael Sillero
Christian Ogasawara
Bradley Lega **
James Caruso
Erik Parker **
John Clough **
Kelly Schmidt **
Justin Davis **
Brandon Sherrod
Nicholas Gamboa
Joseph Sramek **
Marvin Bergsneider
Richard Byrne
Jessica Tarnow **
Jeffrey Traylor
Joel Macdonald **
Salah Aoun
Cordell Baker
Shaquia Idlett-Ali
John Burke
Richard Westmark
Allison Whipple **
Kathryn Hoes

** Educational content planner of this meeting

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The AANS designates this live activity for a maximum of 14.25 *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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Historical Notes

Eight neurological surgeons from the Rocky Mountain States met informally in Denver, CO on April 30, 1966, and a Founders meeting was held which established The Rocky Mountain Neurosurgical Society.

Harry Boyd, MD	Denver, CO
Thomas Craigmile, MD	Denver, CO
Charles Elkins, MD	Tucson, AZ
Robert Imler, MD	Tulsa, OK
Alexander Johnson, MD	Great Falls, MT
Homer McClintock	Denver, CO
Chester Powell, MD	Salt Lake City, UT
William McKinney, MD	Fort Worth, TX

Because of the growth and complexity of the society in which we now live, Articles of Incorporation were approved in December 1974, in the State of Texas as a non-profit organization and The Rocky Mountain Neurosurgical Society, Inc. was established and obtained a tax exempt status.

RMNS Constitution - Revised June 1999

Article I - Name

The organization shall be known as The Rocky Mountain Neurosurgical Society, Inc.

Article II - Purpose

The corporation is organized for exclusively educational and other charitable purposes, and is a nonprofit corporation and the period of its duration is perpetual. The purpose of the Society shall be (1) to promote knowledge within the fields of neurological surgery and allied branches of medicine. It shall be within the purposes of the corporation to use any means to such end as may from time to time seem expedient to its members or trustees, including study, investigation, research, publication, publicity, instruction, the organization of educational or other charitable activities, agencies and institutions and the aid of any such educational or other charitable activities, agencies and institutions already established; (2) the promotion of fellowship and the exchange of ideas among its members.

Article III - Membership

Section 1 - The membership of Society shall consist of five categories: ACTIVE, ASSOCIATE, SENIOR, INACTIVE, and HONORARY.

(A) ACTIVE MEMBERS shall consist of neurological surgeons who have been certified by the American or Mexican Board of Neurological Surgery, or Fellowship in the Royal College of Surgeons (Canada), and also members of allied fields who have been certified by their appropriate board in that allied specialty. Active members in allied fields shall not exceed twenty per cent (20%) of the total membership of the Society.

(B) ASSOCIATE MEMBERS will include physicians and doctors of philosophy qualifying in one of the following categories:

1) Neurological surgeons living in the geographic confines of the Society who have completed their training and have met all the requirement for Board Certification but who have not been certified by the American or Mexican Board of Neurological

Surgery, or Fellowship in the Royal College of Surgeons (Canada). Following certification an Associate Member shall become eligible for Active Membership and may apply to the Membership Committee for change in classification.

2) Neurological surgeons who have an outstanding record in the field over a period of years due to high standard and quality of work.

3) Members in the Neurosciences who have had acceptable academic training equivalent to the requirements for board certification in that field.

(C) SENIOR MEMBERSHIP shall be accorded to those members over the age of sixty who have been active dues-paying members for ten (10) years or greater. Senior members will be relieved of the payment of dues and rules of attendance. They may not hold office but will retain all other privileges of membership.

(D) INACTIVE MEMBERSHIP shall be accorded to members who no longer practice in the geographic domain of the Society or members who are physically disabled or retired from practice. Inactive members shall be relieved of payment of dues. They may attend meetings of the Society but shall not vote or hold office.

(E) HONORARY MEMBERS shall be chosen from recognized leaders in the field of neurological surgery and allied fields who are neither active nor associate members. They shall not be required to pay initiation fees or dues and shall enjoy all of the privileges of active membership except those of voting or holding office. There shall be no limitation on their selection.

Section 2- Membership, except for Honorary and Inactive Members, shall consist of those physicians residing in Alaska, Arizona, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, South Dakota, Texas, Utah, Wyoming, adjacent provinces of Canada, and The Republic of Mexico.

Article IV Founders Group - Executive Committee

The Founders Group shall act as an Executive Committee until the time of the First Annual Meeting. They will assume all the duties of the Executive Committee, including those of the Nominating Committee, the Program Committee, and any other duties being deemed necessary. This committee will submit a nomination slate, which will be voted upon by all the Active Members. This committee has the power to accept as members of the Society any that they feel meet the requirements as outlined by the By-Laws. The power is given to the committee until the First Annual Meeting, after which time all membership applications will be acted upon as outlined in the ByLaws.

Article V - Officers

Section 1 - The officers of the Society shall consist of a President, President-Elect, Vice-President, Secretary, Treasurer and Historian. The President and Vice-President shall be elected for a period of one year and neither may succeed himself. The President-Elect shall succeed to the office of President one year following his election. The Secretary and Treasurer shall be elected for a period of three years and the Historian shall be elected for a period of five years.

Section 2 - The Executive Committee (9) shall be comprised of the President, Immediate PastPresident, the President-Elect, Vice-President, Secretary, Treasurer, Historian and one Member-atLarge appointed by the President and a Continuing Medical Education (CME) liaison also appointed by the President.

Article VI - Duties of Officers

Section 1 - The President shall preside at all meetings of the Society and of the Executive Committee. He shall appoint all committees. He shall cast the deciding vote in any ties resulting from balloting of the members of the Society.

Section 2 - The Vice-President shall preside in the absence of the President and be the Society Parliamentarian.
Section 3 - The Secretary shall record the proceedings and attendance of each meeting and shall report this record at the succeeding meetings. He shall collect and preserve all records, including the membership roll, and shall forward to the Historian all paper which are of documentary or historical value to the Society. He shall send notice to the membership of all meetings two months in advance and shall notify all members of appointments and assigned duties. He shall carry on all other correspondence and business essential for the proper function of the Society. The Secretary shall forward to the Membership Committee all completed applications for membership within three months prior to the date of the Annual Meeting.
Section 4 - The Treasurer shall collect the dues and assessments and carry out the fiscal transactions of the Society. The Treasurer shall keep an accurate record of these transactions and render an annual report. The Treasurer shall submit records annually to a certified public accountant for report to the President. The Treasurer shall notify all members who are delinquent in payment of dues or assessments.
Section 5 - The Historian shall compile and retain all pertinent data relative to the founding, programs and functioning of the Society.
Section 6 - The Executive Committee shall have general supervision over the affairs of the Society. They shall:
(A) Make recommendations as to the time and place of the Annual Meeting.
(B) Review all applications from the Membership Committee and make their recommendations at the Annual Meeting.
(C) Have the power of decision in the consideration of each candidate's personal and professional qualifications.
(D) Upon request make a careful investigation as to a candidate's personal and professional qualifications.
(E) Call special meetings when deemed necessary.
(F) Invite official guests and, in consideration with the host for said meeting, limit their number.

(G) Review all matters concerning fiscal delinquency and absence of members and make appropriate recommendations to the Society regarding these matters.

Article VII - The Constitution
The Constitution shall be in effect from the time of its adoption. It shall be amended only by written resolution at an annual Meeting. Such resolutions must be circularized to the membership by the Secretary two months before the Annual Meeting at which time a vote will be taken. Approval by three-fourths of the voting members present will be necessary for acceptance.

RMNS By-Laws - Revised June 1999

Article I - Application and Election to Membership
Section 1 - The President shall appoint a Membership Committee of three members whose duties shall be to review all applications for membership and to conduct careful investigations as to personal and professional qualifications of all applicants. The recommendations of this Committee shall be presented to the Executive Committee at the Annual Meeting.
Section 2 - Every candidate for active, associate, senior, inactive or honorary membership shall be proposed by at least two active, associate or senior members of the Society on the required application form furnished by the Society. Appropriately completed membership applications shall be in the hands of the Secretary at least four months before the date of the Annual Meeting. Two months before the Annual Meeting the Secretary shall send to each member of the Society a list of

all candidates for membership. Members are urged to submit to the Executive Committee written comments on the candidate's qualifications for membership.

Section 3 - The Executive Committee shall have power of decision in the consideration of each candidate's eligibility and its judgment upon each eligibility shall be final. No candidate for membership shall be voted upon at the Executive Session of the Society unless recommended by the Executive Committee.

Section 4 - Election to the membership shall be at the Executive Session of each Annual Meeting and if three-fourths of the votes are favorable, the candidate shall be declared elected.

Section 5 -The names of all candidates who have not been recommended for membership by the Executive Committee three years after nomination shall be withdrawn and their sponsor notified. A subsequent application of such candidate can be made after a period of two years. Any candidate for membership who has been recommended by the Executive Committee but not elected by the Society cannot be proposed again for a period of two years.

Section 6 - Any Active or Senior member in good-standing may prefer charges alleging that a member is failing to maintain good professional conduct. Such charges may be made against any class of member. All charges shall be in writing and shall specify the basis thereof. These charges shall be delivered to the Secretary who shall immediately forward a copy to the accused, by registered mail sent to his last known address, a copy to the Executive Committee, and retain the original copy. The Executive Committee shall investigate the charges and shall call on the members who file the charges for such information, witnesses, evidence etc. as may be necessary for a full investigation. Both the accused and accuser or accusers shall be given a full hearing by the Executive Committee at its next regularly scheduled meeting. The accused may conduct his own defense or shall be entitled to counsel of his own selection, but counsel for the accused shall also be allowed to secure, at the Society's expense, through the use of a competent stenographer, a verbatim report of the hearing of his case by the Executive Committee in the absence of the accused at the hearing, unless he expressly waives participation therein, the Presiding Officer shall appoint a member to represent him and the hearing shall proceed as though he were present. The hearing shall be closed to all except members of the Society and the counselors chosen for the purpose of this hearing.

Provided the investigation is satisfactorily completed and the accused has been given a hearing, if he so desires, the Executive Committee shall within ten days of the completion of the hearing, determine:

(A) That the charges are not sustained, and that no further action be taken; or (B) That the charges are sustained and that the accused be:

1) censured, or
2) suspended for a definite time, or 3) expelled from the society.

The accused shall be notified by the President in writing, by registered mail sent to his last known address, the date of the meeting in which the recommendation of the Executive Committee will be made. At that meeting the accused shall be given an opportunity to make any statement that he desires before action is taken on the recommendations of the Executive Committee. The President may also make a statement and explain and define findings of the Executive Committee, but there shall be no examination of witnesses or introduction of further evidence before the Executive Committee. Censure or supervision shall require an affirmative vote of at least 2/3 of the voting members of the Executive Committee present. Expulsion shall require an affirmative vote of at least 3/4 of the voting members of the Executive Committee. Any members of this Society who may feel aggrieved by the action of the Executive Committee in censuring, suspending, or expelling him shall have the right to appeal to the entire membership at the time of the next annual meeting. At this time, the accused shall be given the opportunity to make any statements he desires and may have counsel present if he so desires. The President of the Rocky Mountain Neurosurgical

Society may also make a statement and explain and define the findings of the Executive Committee, but here shall be no examination of witnesses or introduction of further evidence before the membership. At the conclusion of the meeting, the Membership shall, by secret ballot, determine whether it will sustain or change the action of the Executive Committee. An affirmative vote of at least a majority of the voting members present shall sustain or change the action of the Executive committee.

Article II - Election of Officers

Section 1 - The officers of the Society shall be elected from the Active Membership at each Annual Meeting and shall take office at the close of that meeting. The President shall not be eligible for re-election at any time. The Vice-President, as well, may not be re-elected to the Vice-Presidency but may be eligible for any other office in the Society. The nominating committee shall notify the membership of a proposed slate of officers before the Annual Meeting. Additional nominations may be made from the floor. The election shall be by ballot and the member receiving the greatest number of votes shall be declared elected to the office for which he was a candidate.

Section 2 - In the case of a vacancy in an office, it shall be filled by appointment by the Executive Committee.

Article III - Initiation Fees and Dues

Section 1 - Every Active and Associate Member on his election to membership shall pay an initiation fee of twenty-five dollars ($25.00) by which act he acknowledges and accepts the Constitution and By-Laws. Honorary members shall not pay an initiation fee.

Section 2 - Every Active and Associate member shall pay annual dues. The amount of the dues shall be determined by the vote of the Executive Committee, so as to maintain the Society in a financially stable condition. Payment of dues shall be received by January 1 and if unpaid by March 1, shall become delinquent.

Section 3 - Any member in arrears for two years shall be notified by the Treasurer in writing, and if he fails to pay his dues within two months thereafter shall forfeit his membership. It shall be the duty of the Treasurer to notify the Executive Committee of this forfeiture.

Section 4 -The expenses of the Annual Meeting shall be paid principally from funds received as registration fees for that meeting. The amount of the registration fee for each Annual Meeting will be set by the Executive Committee.

Section 5 - The prorated expense of an invited guest shall be borne by his host.

Section 6 - While on temporary duty with the Armed Forces, any Active or Associate Member shall be exempt from paying dues.

Article IV - Guests

Section 1 - Any member may invite a guest to attend the annual meeting. The fees for non-member guests are set by the Executive Committee.

Section 2 - The Executive Committee shall be empowered to select official guests. These shall be local physicians and surgeons at the place of the meeting or especially invited guests to participate in the program.

Section 3 - The prorate share of the officially invited guests will be borne by the Society and determined/limited at the time of the invitation.

Section 4 - The limitation of the number of guests to attend any given meeting shall be at the discretion of the Executive Committee and the host for said meeting.

Section 5 - Invited guests shall be entitled to all the privileges of the Society during the annual session except attendance at business or Executive Sessions.

Article V - Meetings

Section 1 - The Rocky Mountain Neurosurgical Society, Inc. shall meet annually at such time and place as may be designated by the Executive Committee.

Section 2 - There shall be at least one annual Executive Session of Active Members of the Society at which the order of business shall be as follows:

1. Reading of the minutes of the last meeting.
2. Report of the Secretary.
3. Report of the Treasurer.
4. Report of the Executive Committee.
5. Report of the Historian.
6. Report of the review of the Treasurer's Account
7. Reports of Special Committees.
8. Unfinished Business.
9. New Business.
10. Election of Members.
11. Report of the Nominating Committee.
12. Election of Officers.

Section 3 - Members shall sign the permanent register of the Society as a record of their attendance. A special register shall be provided for guests.

Section 4 - Special meetings of the Society may be called on the advice of the Executive Committee. Every member shall be notified of the place and time of the meeting at least two weeks in advance.

Article VI - Quorum

Only Active Members shall attend any Business Session and shall constitute a quorum for business.

Article VII Parliamentary Authority

"Robert's Rules of Order - Revised Edition" shall be parliamentary authority in all matters not specified by the Constitution or By-Laws.

Article VIII - Committees

Section 1- The President shall appoint with the approval of the Executive Committee, the following committees:

(A) Program Committee, of which the Secretary is a member ex officio.

(B) Committee on Arrangements for the Annual Meeting.

(C) Membership Committee, consisting of three members.

(D) Nominating Committee, consisting of the immediate three Past Presidents.

Section 2 - The President shall appoint such other committees as indicated.

Article IX - Forfeiture of Membership

Membership may be forfeited for reasons deemed sufficient by the Society, which may be effected by a three-fourths majority vote.

Article X - Scientific Papers

Section 1 - An abstract of all papers to be read must be submitted to the Program Committee three months before the meeting, excluding those presented by invited guests of the Society. The Committee shall exercise the right of accepting or rejecting papers.

Section 2 -The time allotted for the presentation and discussion of a paper shall be at the discretion of the Program Committee subject to approval of the Executive Committee. A tentative program shall be sent to each member by the Secretary two weeks prior to the stated meeting.

Section 3 - A Resident award paper will be selected for presentation t the Annual Meeting by the Program Committee and an award will be given.

Article XI - Amendments

These By-Laws may be amended at the Annual Meeting by approval of three-fourths of the voting members present, provided due notice of the proposed changes has been given to the membership at least two months before said meeting.

Past Meetings of the Society

1966	Colorado Springs, CO	1993	Bigfork, MT
1967	Tucson, AZ	1994	Snowmass, CO
1968	Banff, AB	1995	Sun Valley, ID
1969	McAllen, TX	1996	Telluride, CO
1970	Sun Valley, ID	1997	Jasper Park Lodge, AB
1971	Colorado Springs, CO	1998	Vail, CO
1972	Guadalajara, Mexico	1999	Coeur D'Alene, ID
1973	Scottsdale, AZ	2000	Alyeska, AK
1974	Victoria, BC	2001	Steamboat Springs, CO
1975	Cozumel, Mexico	2002	Santa Ana Pueblo, NM
1976	Las Vegas, NV	2003	Big Sky, MT
1977	Lake Tahoe, NV	2004	Squaw Creek, CA
1978	Colorado Springs, CO	2005	Whistler, BC
1979	Jackson Hole, WY	2006	Sedona, AZ
1980	Park City, UT	2007	Jackson Hole, WY
1981	Durango, CO	2008	Park City, UT
1982	Big Sky, MT	2009	Girdwood, AK
1983	Mescalero, NM	2010	Telluride, CO
1984	Colorado Springs, CO	2011	Taos, NM
1985	Banff, AB	2012	Maui, HI
1986	Keystone, CO	2013	Sun Valley, ID
1987	Deer Valley, UT	2014	Victoria, BC
1988	Lake Tahoe, NV	2015	Colorado Springs, CO
1989	Durango, CO	2016	Whitefish, MT
1990	Vail, CO	2017	Lake Tahoe, CA
1991	Jackson Hole, WY	2018	Banff, AB
1992	Sedona, AZ	2019	Durango, CO
		2021	Jackson Hole, WY

Past Presidents

1966	**Homer G. McClintock**	**Denver, CO**
1967	**Charles Elkins**	**Tucson, AZ**
1968	**William McKinney**	**Ft. Worth, TX**
1969	**Chester Powell**	**Salt Lake City, UT**
1970	**Thomas K. Craigmile**	**Denver, CO**
1971	**Alexander C. Johnson**	**Great Falls, MT**
1972	**Joseph W. Robertson**	**Houston, TX**
1973	**Robert G. Fisher**	**Oklahoma City, OK**
1974	**Michael Pollay**	**Albuquerque, NM**
1975	**Robert L. Imler, Jr.**	**Tulsa, OK**
1976	**Javier Verdura**	**Mexico City, Mexico**
1977	**George T. Hoffman**	**Phoenix, AZ**
1978	**Michael McNally**	**Colorado Springs, CO**
1979	**Richard Moiel**	**Houston, TX**
1980	**R. Barton Carl**	**Oklahoma City, OK**
1981	**Ralph J. Kaplan**	**Oklahoma City, OK**
1982	**Paul Turner**	**Roswell, NM**
1983	**Charles Clough**	**Kansas City, MO**
1984	**Robert Partain, III**	**San Antonio, TX**
1985	**Ronald D. Clark**	**Greeley, CO**
1986	**Richard F. Tenney**	**Tulsa, OK**
1987	**Robert S. Hood**	**Salt Lake City, UT**
1988	**Henry Fieger**	**Denver, CO**
1989	**Franco Erculei**	**Las Vegas, NV**
1990	**Harry B. Tate**	**Oklahoma City, OK**
1991	**David Fell**	**Tulsa, OK**
1992	**Wayne Paullus**	**Amarillo, TX**
1993	**Kenyon Kugler**	**Tulsa, OK**
1994	**Volker Sonntag**	**Phoenix, AZ**
1995	**Lee Krauth**	**Denver, CO**
1996	**Robert Morelli**	**Reno, NV**
1997	**Larry Tice**	**Grand Junction, CO**
1998	**Ronald Apfelbaum**	**Salt Lake City, UT**
1999	**Charles Fullenwider**	**Muskogee, OK**
2000	**Kevin Lillihei**	**Denver, CO**
2001	**Howard Morgan**	**Dallas, TX**
2002	**Al Capanna**	**Las Vegas, NV**
2003	**Vance MacDonald**	**Las Vegas, NV**
2004	**Richard Schmidt**	**Salt Lake City, UT**
2005	**John McVicker**	**Englewood, CO**
2006	**Mary Kay Gumerlock**	**Oklahoma City, OK**
2007	**Robert Beatty**	**Kansas City, KS**
2008	**Joel MacDonald**	**Salt Lake City, UT**
2009	**Jonathan White**	**Dallas, TX**
2010	**Michael Brown**	**Colorado Springs, CO**
2011	**Randy Jensen**	**Salt Lake City, UT**
2012	**Stewart Levy**	**Denver, CO**
2013	**Paul Elliott**	**Denver, CO**
2014	**Paul House**	**Salt Lake, UT**
2015	**Richard Day**	**Missoula, MT**
2016	**Kelly Schmidt**	**Kalispell, MT**
2017	**Brett Dietze**	**Texarkana, TX**

2018	**Kris Smith**	**Phoenix, AZ**
2019	**Michael Seiff**	**Las Vegas, NV**

Past Honored Guest Speakers

1966: Dr. Dwight Parkinson
Dr. Howard Barrows
Dr. Theodore Kurze
Dr. Edwin M. Todd
Dr. Lyle A. French

1967: Dr. R. Eustace Semmes
Dr. Harold A. Sofield
Dr. L. Cashion
Dr. Merlin K. DuVal
Dr. Paul M. Lin
Dr. Mark Kartchner
Dr. Robert L. Scanlan

1968: Dr. Burton Wise
Dr. Morley Singer

1969: Dr. Philip Dodge
Dr. Miguel Ramos-Murgia Dr.

1970: Richard Bergland
Dr. John C. Stears Dr.
James Bor
Dr. Donald Nelson

1971: Dr. Thomas Acers
Dr. Philip Ellis
Dr. Henry VanDyk
Dr. Eugene Wiggs

1972: Dr. Temple W. Williams
Dr. Robert Barnard Couch
Dr. Daniel Gonzalez-Gonzalez Dr.

1973: Eduardo Eidelberg
Dr. Robert E. Flynn
Dr. John A. Hodak
Dr. Robert Scanlon
Dr. James R. Nelson
Dr. John D. Waggener

1974: Dr. Arthur R. Dick
Dr. Stanley R. Nelson

1975: Dr. Keasley Welch
Dr. Ken Winston
Dr. Russell Snyder

1976: Dr. Rubin Bressler
Dr. David Norman
Dr. Charles B. Wilson

1977: Dr. John J. Caronna
Dr. Joel B. Kirkpatrick
Dr. David G. Kline
Dr. Martin H. Weiss

1978: Dr. O. Howard Reichman
Dr. Clark Millikan
Dr. Phillip Weinstein
Dr. Wesley Moore

1979: Dr. Patrick J. Kelly
Dr. George Ojemann
Dr. George Prigatano
Dr. Donald Richardson

1980: Dr. Martin, Weiss, USC
Dr. Theodore Roberts
Dr. Robert Anderson
Dr. Richard Worley
Dr. M. Peter Heilbrun
Dr. George Sanborn
Dr. Clifford Snyder
Dr. Ann Osborn
Dr. K.C. Wong

1981: Dr. William Buchheit
Dr. Thomas Carlow
Dr. John A. Kusske
Dr. Gail Neeley
Dr. Robert Segal
Dr. Earl Walker

1982: Dr. James Harp
Dr. Richard Hermann
Dr. John R. Mullan
Dr. Phanor Perot

1983: Dr. Rubin Bressler
Dr. Harold Hoffman
Dr. Ron Lemire
Dr. Joachim Seeger

1984: Dr. Gary G. Ferguson
Dr. Madan V. Kulkarni
Dr. Jim L. Story
Dr. John M. Tew, Jr.

1985: Dr. Ernst Grote
Dr. John Loeser
Dr. James Ogilvie
Dr. John Robertson

1986: Dr. Albert Rhoton
Dr. Bryce K. A. Weir

1987: Dr. Burton P. Drayer
Dr. Patrick J. Kelly
Dr. David G. McLone

1988: Dr. Peter J. Jannetta
Dr. H Ric Harnsberger
Dr. Kalmon D. Post

1989: Dr. M Stephen Mahaley
Dr. Robert G. Ojemann
Dr. John Stears

1990: Dr. Charles G. Drake
Dr. Sanford J. Larson
Dr. John Stears
Dr. Dwight Parkinson

1991: Dr. Bennett Stein
Dr. Robin Humphreys
Dr. Daniel J. Sexton

1992: Dr. L Nick Hopkins
Dr. Wolfhard Casper
Dr. Taka Fukashima

1993:	**Dr. Raj K. Narayan**
	Dr. Donlin M. Long
	Dr. Edward H. Oldfield
1994:	**Dr. Alan Cohen**
	Dr. Stephen Papadopoulous
	Dr. Laligam N. Sekhar
1995:	**Dr. Hunt Batjer**
	Dr. Thomas Brott
	Dr. Thomas Mehalic
1996:	**Dr. Daniel Barrow**
	Dr. Michael Scott
1997:	**Dr. Steve Giannotta**
	Dr. Charles Tator
1998:	**Dr. Richard Morawetz**
	Dr. David Piepgras
1999:	**Dr. Edwards Laws**
	Dr. Regis Haid
2000:	**Dr. Albert Rhoton**
	Dr. Neal Martin
2001:	**Dr. Markin Weiss**
	Dr. J Patrick Johnson
2002:	**Dr. Duke Samson**
	Dr. Edward Benzel
2003:	**Dr. M Gazi Yasargil**
	Dr. Kevin Foley
2004:	**Dr. Arthur Day**
	Dr. Kevin Foley
2005:	**Dr. Kim Burchiel**
	Dr. Alex Valadka
2006:	**Dr. Daniel Resnick**
	Dr. Rayminel Sawaya
2007:	**Dr. Mark Hadley**
	Dr. Michael Bliss
2008:	**Dr. Peter Black**
	Dr. Kim Burchiel
2009:	**Dr. Doug Kondziolka**
	Dr. Neil Kitchen
2010:	**Dr. Lori Shutter**
	Dr. Guy Clifton
2011:	**Dr. Fredirick Boop**
	Dr. Robert Rostomily
2012:	**Dr. Jeff Bruce**
	Dr. Charles Branch
2013:	**Dr. Frederick Lang**
	Dr. Jamie Ullman
2014:	**Dr. James Rutka**
	Dr. M. Sean Grady
2015:	**Dr. Nicholas Barbaro**
	Dr. Randall Chesnut
2016:	**Dr. Richard Ellenbogen**
	Dr. Anthony Asher
2017:	**Dr. James Goodrich**
	Dr. B. Gregory Thompson
2018:	**Dr. Hunt Batjer**
	Dr. John Hurlbert
	Dr. William Couldwell
2019:	**Dr. Michael Lawton**
	Dr. Juan Uribe
2021:	**Dr. Nino Chiocca**
	Dr. David Langer

ABSTRACTS

TITLE: Development Of An Automated Machine Data Processing Algorithm To Eliminate Human Error And Variability In Intraoperative Neuromonitoring Interpretation Of Changes In TC-MEP Signals In Nerve Roots In Pedicle Subtraction Osteotomy

ABSTRACT: Intraoperative neuromonitoring (IONM) has limited predictive value to detect nerve root deficit after pedicle subtraction osteotomy (PSO) for Adult Spinal Deformity (ASD). Here, we develop an automated decision algorithm to detect changes in IONM data during PSO surgery and compare the predictive performance of this algorithm to human alerts.

METHOD: Thirty-three PSO cases with complete neuromonitoring data were identified from a single surgeon cohort to be used as training testing dataset. Normalized changes in the motor evoked potential (MEP) from baseline MEP data was used to create a high-dimensional decision variable for each trial of IONM data. We tested whether this signal could (1) serve as an alert signal to detect post-operative weakness, (2) predict the degree of post-operative weakness, and (3) outperform human neuro-monitoring staff using an alert threshold. The correlation was found using Pearson's linear correlation coefficient and the quality of the prediction was tested by calculating the area under the curve (AUC) found with a receiver operating characteristic (ROC) analysis.

RESULTS: Of the 33 PSO cases, 15 patients (45.5%) had a new post-operative neurological deficit. For patients who developed motor weakness post-operatively, the average drop in motor score was 7.33 points (MRC grading system). The sensitivity and specificity of intra-operative neuromonitoring staff alerts were 0.33 and 0.56, respectively (positive predictive value, PPV, 0.38). The automated algorithm predicted post-operative weakness with an AUC of 0.78. The magnitude of the automated alert signal was also highly correlated with the degree of post-operative weakness ($r=0.69$, $p<0.00001$). Setting a threshold of 10 standard deviation units of the alert signal, the sensitivity and specificity of the automated algorithm improved to 0.67 and 0.89, respectively (PPV 0.83).

CONCLUSION: The current study strongly suggests that automated algorithms can improve the predictive power of IONM to detect post-operative nerve root weakness in spinal deformity surgery.

TITLE: Ultrasound in Human Spinal Cord Injury: From Bench to OR.

ABSTRACT: Spinal cord injury is a devastating condition that has significant consequences for patients, caregivers and the healthcare system at large. To date there

has been a lack of an accurate and reproducible biomarker to predict spinal cord injury severity and response to therapy. Recently, there has been an expansion in the implementation of contrast enhanced ultrasound in studying spinal cord injury. In this study we present the first quantitative analysis of perfusion in human spinal cord injury.

METHOD: Patients described in this study were derived from an early retrospective analysis of prospectively collected data from a larger, long-term study. A study protocol was reviewed and approved by the University of Washington IRB. Patients presenting to Harborview Medical Center emergency room with acute traumatic spinal cord injury planning to undergo operative decompression and stabilization were eligible for recruitment. Upon completion of an otherwise routine posterior decompression and stabilization, contrast enhanced ultrasound was performed. An intravenous bolus injection of DEFINITY(R) contrast agent (1.3mL DEFINITY/8.7mL saline) was given. The spinal cord was imaged continuously to record contrast inflow and washout. Manual regions of interest in the Phillips QLab software were placed for quantitative analysis of peak contrast intensity.

RESULTS: A total of 8 patients were recruited so far. The average age of all patients was 57 years. 3 patients presented with an ASIA A exam and did not improve upon discharge. 5 patients presented with an incomplete spinal cord injury examination, 4 of whom improved upon discharge. The average percent change in peak intensity for patients who presented with a complete injury was 1.3 versus 0.6 for incomplete ($p=.012$) Likewise, patients who had improvement in neurological exam demonstrated a percent change in peak intensity of 1.4 as compared to 0.46 in patients who did not improve ($p=.025$).

CONCLUSION: This study represents the first quantitively analysis of spinal cord perfusion in human spinal cord injury. Here we present perfusion as a biomarker for injury severity. In our cohort of 7 patients, we found a statistically significant difference in spinal cord perfusion between patients who had improvement in neurological exam and those that did not.

TITLE: Epidemiology of Gunshot Wounds to the Spine in the United States from 2015-2019: A National Trauma Databank Analysis

ABSTRACT: Firearm injuries in the United States pose a significant public health burden. To date, there are scarce data on gunshot wounds (GSW) involving the spine. The purpose of this study was to identify epidemiological trends in GSW to the spine and its associated spinal cord injury (SCI) and mortality rates.

METHOD: A cross-sectional study of the multicenter American College of Surgeons National Trauma Databank (NTDB) was performed using data from 2015-2019. GSW injury was identified using ICD-9 or ICD-10 primary presentation codes. Abbreviated Injury Scale (AIS) codes were used to identify spine anatomic involvement and SCI. Outcomes included in-hospital mortality and GSW-related SCI.

RESULTS: A total of 5,021,316 adult and pediatric patients were included in the NTDB from 2015-2019 from over 750 participating hospitals. Of the 107,233 patients (2.1% of total) presenting with GSW, 9,023 patients had associated spine involvement (8.4%). Overall rates of GSW and spinal GSW were similar across years. Cause of spinal GSW injury was most commonly assault (86.7%). The thoracic spine was most commonly affected (42.8%) followed by lumbar (39.7%) and cervical (24.2%). Cervical SCI present in 8.7% of all spinal GSW (35.7% of cervical GSW), thoracic SCI in 17.4% (40.6% of thoracic GSW), and lumbar SCI in 8.1% (20.3% of lumbar GSW). Mean age was 29.0 ±12.2 years, 88.5% were male, 62.4% were black, 23.7% were white, and 13.9% were another race. Alcohol screening (BAC >= 0.08) was positive in 12.1%, and illicit drugs were positive in 24.4%. Spinal GSW had high associated in-hospital mortality (8.1%), and patients with cervical involvement (18.1%), cervical SCI (30.7%), and thoracic incomplete SCI (13.6%) had significantly higher mortality than patients without these injury patterns.

CONCLUSION: Spinal GSWs are relatively common with high associated rates of SCI and in-hospital mortality.

TITLE: Peripheral Nerve Entrapment Mimicking Cervical or Lumbar Pathology

ABSTRACT: Recent methods and guidelines regarding evaluation and management of entrapment neuropathies were reviewed.

METHOD: Updated guidelines and methods for management of these conditions is synthesized and presented.

CONCLUSION: The management of entrapment neuropathies remains a key part of neurosurgical practice.

TITLE: The appropriate use of middle meningeal artery embolization for treatment of subdural hematoma.

ABSTRACT: The use of MMA embolization as a standalone and adjunctive treatment of chronic and subacute subdural hematoma has grown in popularity over the previous five years. Its adoption is now widespread. This presentation will review the evidence base and provide recommendations for appropriate utilization of this technique in common neurosurgical practice.

METHOD: Recent literature publications and society guidelines describing the use of MMA embolization will be presented and assessed, along with quality of evidence for various clinical situations. The cost of this procedure will also be estimated.

RESULTS: Embolization of the MMA for subdural hematoma can be divided into core and exploratory applications. Novel approaches include preventing recurrence after surgical drainage in patients requiring anticoagulation.

CONCLUSION: MMA embolization will continue to serve as a tool in the management of subdural hematoma.

TITLE: Transfusion Guidelines in Traumatic Brain Injury: A Systematic Review of Currently Available Evidence

ABSTRACT: TBI is a leading cause of disability and death, and anemia in the setting of TBI carries risk of worsening ischemia and poor neurologic outcomes. Optimized oxygen carrying capacity is vital to prevent permanent neurological dysfunction after TBI and establishing a TBI-specific transfusion threshold may help prevent the long-term consequences of persistent anemia. Therefore, the objective of this systematic review is to apply current literature to better define the optimal transfusion threshold for TBI patients

METHOD: A systematic review was conducted following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The databases PubMed, Google Scholar, and Web of science were queried using the search terms “transfusion” and “traumatic brain injury”. Articles were then reviewed for relevant outcomes pertaining to RBC transfusion thresholds and corresponding complication rates.

RESULTS: 15 articles met search criteria and were reviewed for analysis. TBI patients that received transfusion tended to be primarily male patients with worse Injury Severity Score (ISS) and Glasgow Coma Scores (GCS) on admission. Head Abbreviated Injury Scale (AIS) scores were similar between transfused and non-transfused populations. Meta-analysis of eligible studies suggested that TBI patients who receive transfusions are older ($p=0.04$), have worse ISS scores at presentation ($p=0.001$), and have higher mortality rates ($p<0.0001$, Figure 3c) and complication rates ($p<0.0001$). Additionally, while many studies support restrictive (hgb < 7 g/dl) transfusion thresholds over liberal (hgb < 10 g/dl), meta-analysis revealed no significant difference in mortality ($p=0.79$), and recent level II evidence supports improved mortality rates with an intermediate transfusion threshold of hgb < 9 g/dL.

CONCLUSION: Establishing a transfusion threshold for TBI patients is a complex endeavor, and current literature is inconsistent regarding the benefits and risks of restrictive and liberal transfusion thresholds. Emerging evidence suggests that an intermediate threshold of hgb < 9 g/dL may benefit TBI patients, but further clarification is warranted.

TITLE: Motorized Robotic Cervical Traction: Proof of Concept

ABSTRACT: In acute distraction-type cervical spine injuries, particularly facet dislocations, manual traction may be necessary to achieve mechanical stability and spinal cord decompression. The most commonly applied cervical traction method is the Gardner-Wells device, which consists of tongs with skull pins pulled away from

the torso using a series of pullies and weights. This method relies on outdated technology without any safeguard in place to prevent over-traction or weights being pulled/released inadvertently.

METHOD: In a collaboration between the departments of mechanical engineering and neurosurgery, a prototype device for performing automated robotic cervical traction was designed with the following capabilities: real-time force measurement with a load cell sensor, non-backdriveable linear actuator kinematic system with force and displacement control, adaptability to either a Gardner-Wells skull tong or a Mayfield head clamp, multiple degrees of freedom which are independent of skull pin placement, and an emergency stop feature. Ergonomics and degrees of freedom were assessed using a skeleton model. Mechanical testing in tension loading was performed using a spring model.

RESULTS: Computer assisted design (CAD) modeling of the proposed prototype was performed and the device was subsequently manufactured in-house. The device was capable of attaching to both a Mayfield clamp and Gardner-Wells skull tongs. When attached to a full skeleton model, the device was able to perform in multiple degrees of freedom (60 degrees of flexion, 30 degrees of extension, and 30 degrees of lateral bending). In a simple tension spring loading model, a force vs. time curve was generated demonstrating the device's ability to reach a steady state desired force of 25 pounds of traction over approximately 40 seconds. The device weighs approximately 20 pounds and requires fewer steps to assemble than traditional weight and pulley traction. The device does not interfere with lateral radiograph capture.

CONCLUSION: A preliminary prototype capable of performing automated robotic cervical traction demonstrates proof-of-concept and several advantages over traditional weight and pulley traction. Further cadaveric studies are needed to evaluate device efficacy and safety.

TITLE: Laser Interstitial Thermal Therapy for Cerebral Cavernous Malformations: A Systematic Review of Indications, Safety, and Outcomes

ABSTRACT: Cerebral cavernous malformations (CCM) in deep, eloquent areas present a surgical challenge. Laser interstitial thermal therapy (LITT) may present itself as a safe, minimally invasive treatment option.

METHOD: Electronic databases were searched from inception to October 7, 2021 for articles with CCM and LITT keywords. Studies describing CCMs treated with LITT were included.

RESULTS: A total of 32 patients with CCMs in lobar (79%), basal ganglia (12%), and brainstem (9%) locations were treated with LITT. Indications for LITT included drug-resistant seizures (75%), unacceptable surgical risk (22%), recurrent hemorrhage (16%), and early intervention to discontinue anti-epileptic drugs (3%). No death nor CCM-associated intracranial hemorrhage occurred intra- or post-operatively, and most patients experienced no adverse effects or transient effects that resolved at follow-up (88%). Of those treated for CCM-associated epilepsy, 83%

experienced Engel Class I seizure freedom and most were Class IA (61%). The vast majority of patients experienced symptomatic improvement (93%) and a decrease in anti-epileptic drugs was reported in over half of patients (56%) with 28% able to discontinue all anti-epilepsy medications following LITT.

CONCLUSION: LITT appears to be a safe, efficacious treatment in patients that are unable to tolerate open surgery, for CCMs located in deep, eloquent areas, and in lesions presenting with medically refractory seizures or recurrent hemorrhages.

TITLE: Treatment Strategies for Recurrent Posterior Communicating Artery Aneurysms

ABSTRACT: Endovascular treatment of posterior communicating artery artery has a high recurrence rate when compared with surgical treatment. We aim to describe our experience with the treatment of recurrent aneurysms in this location.

METHOD: The study included patients who underwent treatment of recurrent posterior communicating artery aneurysms. Patient who have had endovascular or surgical treatment were included. Medical records were retrospectively reviewed.

RESULTS: Overall recurrence was high. Ruptured status, size, partial endovascular treatment were associated with recurrence. We have had performed open and endovascular treatment for recurrent aneurysms. Age of the patient and anatomical characteristics are the main factors to be considered.

CONCLUSION: Recurrence of communicating artery aneurysms are common. Open and endovascular treatment are both safe strategies to treat recurrent aneurysms.

TITLE: High-grade glioma imaging volumes and survival: A single-institution analysis of 101 patients after resection using intraoperative MRI

METHOD: This was a retrospective analysis of patients with glioblastoma (GBM) or isocitrate dehydrogenase wild-type anaplastic astrocytoma who underwent resection using iMRI from 2011 to 2021. Volumetric analyses of T1-weighted contrast-enhancing (T1W-CE), T2-weighted (T2W), and T2W fluid-attenuated inversion recovery (FLAIR) sequences were assessed at preoperative, intraoperative, immediate postoperative, and three-month postoperative timepoints. Statistical analyses were carried out using log-rank and multivariable Cox proportional hazard regression analyses.

RESULTS: A total of 101 patients (median age 57.0) were treated. In keeping with prior studies, statistically significant associations between increased EOR and improved PFS and OS were seen ($p=0.012$ and $p=0.006$). The results demonstrated significant associations between lower preoperative T2W, 3-month postoperative T2W, and 3-month postoperative FLAIR volumes with longer PFS and OS ($p=0.045$

and p=0.026, p=0.031 and p=0.006, p=0.018 and p=0.004, respectively), as well as significant associations between lower immediate postoperative T2W and immediate postoperative FLAIR volumes with improved OS (p=0.002 and p=0.02). There was no observed association in either PFS or OS for patients undergoing additional resection after initial iMRI scan (p=0.387 and p=0.592).

CONCLUSION: This study of 101 patients with new or recurrent HGGs shows three-month postoperative T2W and FLAIR imaging volumes were significant independent prognosticators with respect to PFS and OS. In addition, this study did not demonstrate improvement or worsening of PFS or OS for those patients undergoing further resection after initial iMRI scan.

TITLE: Temporal dynamics of human amygdalar activation and salience network engagement during emotive facial processing

ABSTRACT: The amygdala is a locus for emotive facial processing, with suggested roles in processing threat and ambiguous, socially-relevant information. Mood disorders have been associated with altered activation dynamics in salience and affect brain networks, including aberrant amygdalar activation. Neuroimaging studies have explored emotion processing, but the neurophysiological basis of emotion discrimination remains unclear. Here, we characterize amygdalar activation of 3 neurosurgical patients during a facial emotion discrimination task.

METHOD: An image of an emotional face was displayed for 2 seconds, followed by 7 emotion word choices: sad, angry, disgusted, neutral, happy, surprised, fearful. The subject was instructed to select the word that corresponded to the image. Amygdalar local field potentials (LFP) were recorded with intracranial electrodes. Time-series theta power plots were generated by band passing (4-8Hz) and calculating average power with 500 ms bins and 10 ms step size. Significance for time-series power plots was evaluated using the nonparametric permutation test, and peak theta-latency using Kruskal-Wallis testing.

RESULTS: Analysis of amygdalar activation dynamics revealed increases in theta power (4-8Hz) following presentation of emotive faces (n=3). Earlier peaks in amygdalar theta power were observed for fearful and surprised faces. We also analyzed the activity in regions associated with the salience network (n=1). These early peaks in amygdalar theta power coincided with increased theta power in orbitofrontal cortex, gamma power in temporal pole, and high gamma in anterior cingulate.

CONCLUSION: Early peaks in amygdalar theta power with co-activation of nodes in the salience network suggest engagement of a vigilant mode of emotion processing, as the social value associated with fearful or surprised faces could vary with situational context. Timing of theta oscillations in the amygdala may contribute to establishing a hierarchy of emotional salience. Understanding this hierarchy may advance the neuroscience of emotion processing with implications for mood disorder-associated dysfunction.

TITLE: Applying 3D Printing and Modeling for Preoperative Reconstruction and Instrumentation Placement Planning in Complex Deformity Correction

ABSTRACT: Advances in 3D-printing technology have enabled the development of customized instrumentation and surgical training platforms. However, no existing studies have assessed how patient-specific 3D-printed spine models can facilitate patient education and operative planning in complex spinal deformity correction. As such, we present a cost-effective technique for constructing personalized 3D-printed spine models for patients with severe spinal deformities, and to outline how these models can promote informed consent, trainee education, and planning for instrumentation placement and alignment correction.

METHOD: Two patients underwent surgical correction of progressive thoracolumbar deformities. Full-scale 3D-printed models of each patient's spine were produced preoperatively and used during clinic evaluations, surgical planning, and as intraoperative references.

RESULTS: Each model took nine days to build and required less than 60 US dollars of material costs. Both patients were treated with a posterior approach and contiguous multilevel osteotomies. Postoperatively, their alignment parameters and neurologic deficits improved.

CONCLUSION: Personalized 3D-printed spine models can aid in patient education, surgical training, visualization, and correction of complex spinal deformities.

TITLE: Pediatric traumatic brain injury in a geographically dispersed population: relationship between distance to definitive neurosurgical treatment and outcome

ABSTRACT: There are limited data on the association between transport distance and outcomes in pediatric patients with severe traumatic brain injuries (sTBIs), despite children having to travel further to pediatric trauma centers (PTCs). The objective of this study is to assess whether distance from a PTC is associated with outcomes in children who undergo cranial surgery after sTBI.

METHOD: Children with sTBI who underwent craniectomy/craniotomy at our PTC between 2010 and 2019 were identified retrospectively. Of these 92 patients, 83 sustained blunt injury and underwent surgery within 24 hours. Demographics and transport characteristics were obtained. Distance from injury location to PTC was based on injury zip code and calculated as Euclidean distance. Variables associated with transport, including distance, time, and rural-urban disparity, were analyzed for correlation with poor outcome.

RESULTS: Of the 83 patients identified, 81 had injury location information. Forty patients were injured within 30 miles of the PTC and 41 were injured 30 miles from the PTC. Injury severity and pediatric trauma scores were not significantly different between groups. Sixty-eight children (82%) had a satisfactory outcome and 10 (12%) died. There was a nonsignificant association between distance traveled and poor

outcome, even when the cohort was stratified into those with subdural hematomas and those with nonabusive injuries.

CONCLUSION: Most children in this cohort made a moderate to good recovery. Children injured at greater distances from the PTC did not have worse outcomes; however, studies with larger cohorts are needed to make a more definitive conclusion regarding prehospital pediatric transport systems in this population.

TITLE: Patient selection for neuromodulation approaches for the treatment of intractable epilepsy

ABSTRACT: The previous decade has witnessed the emergence of new technologies for the treatment of surgically untreatable intractable epilepsy. These include DBS, RNS, and combined approaches.

METHOD: Review of indications and outcomes for difficult to treat cases of intractable epilepsy, including patient selection for resection plus RNS, RNS plus DBS, and esoteric DBS targeting locations.

RESULTS: The incorporation of thalamic stimulation was used in 14 cases. In three of these, a single thalamic lead was used with a cortical / subcortical RNS electrode. Seizures can be seen spreading within the thalamus at lower amplitudes using conventional RNS recordings.

CONCLUSION: The use of RNS and DBS together provides an option for surgical management of intractable epilepsy.

TITLE: Impact of site of origin on meningioma recurrence

ABSTRACT: Recently published high profile articles identify differences in the genetic composition of meningiomas that may predict recurrence rate. These genetic differences may underlie differences in recurrence seen based upon site of origin.

METHOD: We reviewed 330 cases over 30 years of practice. We divided the data according to site of origin and tracked time to recurrence. We tested the impact of site of origin while controlling for extent of resection.

RESULTS: Midline meningiomas had higher recurrence rates, although this difference was no longer significant after controlling for EOR. However, recurrence was not predicted by the presence or absence of brain invasion.

CONCLUSION: The relationship between site of origin and recurrence likelihood may be confounded by EOR, which differs by location.

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2023

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