

*The American Association of Neurological Surgeons and  
the Congress of Neurological Surgeons Joint Section on*



# Pain



n e w s l e t t e r

*Message from the Chairman*

**1. Satellite Symposium in Montreal**

One of the most exciting upcoming events for the Section on Pain is the satellite workshop to be held on October 2-4, Wednesday afternoon and Thursday and Friday at the end of the CNS annual meeting in Montreal. This workshop will have a



faculty of twenty-one neurosurgeons and represent leading neurosurgical pain management expertise in the US for ablative, augmentative and trigeminal procedures. To maximize faculty/participant interactions, the registration will be limited to only 50 post-residency neurosurgeons. Anyone interested should contact me by e-mail (samuel@neosoft.com) or by FAX (713-794-4950) as soon as possible for further information.

**2. Sectional Activities at the AANS and CNS Annual Meetings**

The upcoming AANS annual meeting in Minneapolis will include a number of educational events related to pain management. Three practical courses will be offered: a full-day course entitled Neuroaugmentative Procedures for Pain Control, directed by Kim Burchiel, and two half-day courses entitled Ablative Neurosurgery for Pain (Robert Coffey, Director) and Trigeminal

Neuralgia (Jeff Brown, Director). In addition, two breakfast seminars will be offered. Robert Wilkins will lead one of these, entitled Surgical Options for Trigeminal Neuralgia, and I will direct another entitled Neurosurgical Management of Cancer Pain.

The Section on Pain scientific program will be held on Wednesday afternoon. The Section symposium topic will be "Persistent Pain after Spinal Surgery - What do I do now?" with David Kelly, Joel Seres and John Loesser as speakers. Also as part of the session, the William H. Sweet Young Investigator Award will be presented to John G. Piper, MD, from the University of Iowa. The full scientific program can be found on page 8.

At the 1995 CNS meeting in San Francisco, there was a full-day practical course, Augmentative Procedures for Pain Control, and two luncheon seminars, Neurosurgical Procedures for Pain Relief and Trigeminal Neuralgia. The Section on Pain Wednesday afternoon program included a

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symposium entitled Pain Medicine and Neurosurgery, with Donlin Long, Kim Burchiel, and Philipp Lippe.

### 3. New Section Exhibit

The Section also unveiled its new exhibit at the CNS San Francisco meeting. Please try to come by the section exhibit at the Minneapolis meeting to see it. Under Jeff Brown's direction, the exhibit has become an informative promotion for the history and role of pain management.

### 4. Special Task force to Examine the Role of Neurosurgery in Pain Management

A special task force has been created, under the leadership of Roberto Heros and with the active involvement of Kim Burchiel. Its purpose is to examine the role of neurosurgery in the field of pain management, specifically in relation to neurosurgical residency training, accreditation of neurosurgical pain management fellowships and multispecialty certifications in pain medicine via a conjoint board, for example, the American Board of Pain Medicine.

### 5. Standards for Spinal Cord Stimulators

Rick North, in conjunction with the Drugs and Devices Committee, has completed work on a set of voluntary standards for implantable stimulators. Similar standards are being developed for implantable, programmable infusion pumps.

### 6. New CPT Codes for Implantable Infusion Systems

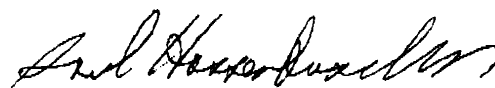
As of January 1st, new implantable pump CPT codes are available. Briefly, there are separate codes for spinal catheter placement (62350) and programmable pump placement (62362) with codes now available for catheter revision (62355) and pump revision (62365). The RVU values for each of these procedures matches closely those for spinal stimulation. A mailing is being sent to all members of the AANS and the CNS to detail the available codes and RVU values for both implantable pump and stimulation procedures. The mailing also serves as a first notice for the satellite workshop at the Montreal meeting in October.

### 7. Joint Section Status

In other areas, the joint section status is completed and the Section on Pain is rapidly integrating itself into the various activities of both the CNS and the AANS. Efforts have begun to establish new CPT codes for CPT '98 for thoracic and cervical facet block and facet denervation. The Section will be sending a representative to a Joint Section meeting on Neurosurgical

Outcomes, convened by Rich Toselli. This meeting should lay the foundation for the formal development of outcome studies in the various neurosurgical disciplines.

As the Section's leadership is handed over from myself to Bob Levy, the Joint Section on Pain has become, in my opinion, one of the most active and progressive sections. This is a result of the active involvement of many people in many different areas and emphasizes the goal of both the AANS and the CNS: that the sections should be working groups of neurosurgeons, all striving to improve patient care, working conditions for our colleagues and neurosurgery in general. If there are any questions or comments, feel free to contact me at any time by email (samuel@neosoft.com) or by FAX (713-794-4950).



Samuel J. Hassenbusch, MD, PhD

### From the Internet ...

The Section on Pain is actively involved in the development of the **NEUROSURGERY ON-CALL™ (N://OC)** Project. Our goal is to facilitate communication between members of the Section and all neurosurgeons across the world who are interested in treating pain. In particular, we would like to encourage all centers who are conducting clinical studies for innovative treatments of pain to provide the inclusion criteria and the name of the contact person(s) for patient referrals. Another goal of the project is to establish a "consultation corner" which will facilitate consultations among expert members for collective opinion. The Section encourages all members and non-members to send us your remarks and comments on the format and the services you expect from the Pain Section on the internet.

Please send your comments to Jamal Taha, MD via email (tahaj@aracnet.com) or FAX (503-494-7161).



Contributions from:

## The 45th Annual Meeting of the Congress of Neurological Surgeons

October 14-19, 1995

### COMPLICATIONS OF MICROVASCULAR DECOMPRESSION

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Microvascular decompression for the treatment of hyperactive cranial nerve disorders such as trigeminal neuralgia and hemifacial spasm has become a well accepted and often recommended treatment modality. Improvements in microneurosurgical technique and intraoperative physiologic monitoring appear to have both improved results and decreased morbidity.

In order to better quantify these findings, 213 consecutive operations by a single surgeon (TJL) for the treatment of typical trigeminal neuralgia, hemifacial spasm, disabling positional vertigo and tinnitus and glossopharyngeal neuralgia were retrospectively reviewed. Outcome definitions utilized were: "excellent," if the patient experienced 90% pain relief or greater and required no medications; "good," if the patient experienced greater than 75% pain relief and only intermittent medications were needed; and the outcome was considered a "failure" if the patient experienced less than 75% pain relief and/or required any degree of chronic medication. The definitions employed for complications were "total," which would include any and all complications, and "major," if the complication resulted in permanent deficit or required operative intervention.

One hundred fifty-two operations were performed for the treatment of typical trigeminal neuralgia. Twenty-three of these were re-operations. One patient required bilateral procedures. Overall, procedures were performed in 97 women and 45 men, with an average age

of 59 years (range 26-87 yrs). Results were considered excellent in 106 (70%) and good in 15 (10%), for an 80% success rate. There were 31 failures (20%), including 8 re-operations in a follow-up ranging between 1 and 19 months. Complications in trigeminal nerve surgery included one instance of hearing loss (0.7%) and one cerebellar hemorrhagic infarction (0.7%). This hemorrhagic infarction was most unusual and occurred on the third postoperative day. It appeared to be a hemorrhagic venous infarction due to delayed thrombosis of a brainstem and cerebellar peduncular venous angioma. After evacuation of the clot, the patient did well. There was one middle cerebellar peduncular infarct, four instances of facial numbness (3%), one corneal sensory loss, two aborted procedures and one transient IV nerve paresis. One aborted procedure was the result of significant scarring and bleeding during an attempted reoperation. One patient had a very atherosclerotic anterior inferior cerebellar artery (AICA) which was adherent to the dura with brainstem perforators coming off, limiting exposure and retraction. The total complication rate was 11 out of 152 operations (7%), with major complications occurring in eight of these (5%). Interestingly, there were no complications in any of the reoperations, with the exception of the one aborted procedure.

Thirty operations, including three reoperations, were performed for hemifacial spasm in 16 women and 13 men. Their average age was 55 years (range 29 to 75 yrs). Results were considered excellent in 19 (65%) and good in 5 (17%), for an 83% success rate. There were five failures (17%) in a follow-up ranging from 1 to 16 months. Complications occurring during microvascular decompression of cranial nerve VII included one transient hearing loss, one extracranial vertebral artery injury requiring later surgical repair, one transient IX/X paresis and one case which was aborted secondary to exposure. This latter case involved a patient who had a severe Chiari I malformation and who had undergone a prior suboccipital decompression and duraplasty in order to try

to obtain more room. However, it was not possible to enter the cerebellar pontine angle and the case was aborted. The total complication rate was 4 out of 30 cases (13%) with one major complication, the vertebral artery injury.

Twenty-three operations were performed in 19 patients for tinnitus and disabling positional vertigo. Three of the operations were bilateral and one was a reoperation. Patients ranged in age from 32 to 68 years (mean 54 yrs). Twelve patients reported marked improvement, two reported partial improvement. Four patients reported no change, with one lost to follow-up. Follow-up ranged between 1 and 16 months. Complications for microvascular decompression of cranial nerve VIII were minor and included one transient hearing loss and one wound infection for a total of 2 complications out of 23 operations (9%).

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... microvascular decompression operations can be performed with negligible mortality [and] a total morbidity of about 10% ...

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Eight operations (including one reoperation) for microvascular decompression of cranial nerves IX and X were performed for glossopharyngeal neuralgia. These four men and four women ranged in age from 23 to 74 years (mean 47 yrs). Five patients reported an excellent result (63%) and two patients reported good results (25%), for an 88% successful outcome. There was one failure in the reoperated patient (13%), in a follow-up ranging from 3 to 23 months. Complications in this group included one IX and X paresis, yielding a total (major) complication rate of 13% (1/8).

General complications among all operations included two CSF leaks, three cases of “aseptic meningitis” requiring lumbar puncture and one distal embolization from an arterial line. There was no mortality and, interestingly, no complications were noted in reoperations. Out of 213 operations, complications occurred in 25, for an overall complication rate of 12%, with a major complication rate of 5% (10/213) [see Table, right]. Interestingly, there was only one instance of hearing loss out of the 213 cases (0.5%).

We have found that the complication rate can be decreased by adequate visualization, limiting retraction and intraoperative physiologic monitoring using brainstem auditory evoked potentials. Sparing venous struc-

tures when possible as well as insulating nerves from heat during bipolar coagulation of veins will help avoid complications. Meticulous hemostasis and attempted water tight closure will also improve the complication rate. In addition, we have also found that treating all vascular compression will improve results and that increased successful results, decreased negative explorations and a decreased complication rate will occur with increasing experience of the surgeon.

In reviewing the effect of surgical experience upon the occurrence of hearing loss at the University of Pittsburgh, it is clear that the addition of intraoperative monitoring and increased experience results in a better outcome. In operations for trigeminal neuralgia, the rate of hearing loss in over 1600 cases prior to 1990 was 1.3%. Since 1990, the incidence has been lowered to 1% (837 cases), for a total hearing loss rate of 1.2%. In hemifacial spasm, the rate of hearing loss before 1990 was 3.8% (692 cases) and since 1990 has been 1% (208 cases). Interestingly, for microvascular decompression of cranial nerves IX and X, there has never been a case of hearing loss in over 123 cases (69 pre- and 54 post-1990).

We also looked at the effect of surgical experience on other complications at the University of Pittsburgh. Prior to 1990, 2,420 patients were operated upon for microvascular decompression of various cranial nerves. Since 1990, there have been an additional 1,099 operations. Instances of cerebellar injury dropped from 0.9% before 1990 to 0.6% since and overall hearing loss decreased from 2.0% to 0.9% in the post 1990 era. Instances of CSF leak have also dropped somewhat from 2.5% before 1990 down to 1.9% since.

In conclusion, microvascular decompression operations can be performed with negligible mortality, a total morbidity of about 10% and major morbidity of less than 5%. Decompression of all involved vessels and increased experience will lead to improved results.

MICROVASCULAR DECOMPRESSION	
Event	Number
Total Operations	213
Mortality	0
Total Complications	25/213 (12%)
Major Complications	10/213 (5%)
Hearing Loss	1/213 (0.5%)

## SIGNIFICANCE OF TEMPERATURE IN TRIGEMINAL NEURALGIA RADIOFREQUENCY RHIZOTOMY

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Percutaneous radiofrequency trigeminal rhizotomy (RFTR) is an established treatment for medically refractory trigeminal neuralgia (1). Letcher and Goldring hypothesized that RFTR results in a selective destruction of the unmyelinated C fibers and the small myelinated fibers associated with the level of temperature applied to a peripheral nerve (2). This mechanism allows for selective control of pain without compromising sensory function in the area of pain, thus avoiding the unpleasant feeling of deafferentation. Work by Broggi and Siegfried suggested that there is a narrow (5 to 8°C) critical temperature range in which RFTR is maximally effective (3).

To optimize the clinical temperature range, 73 patients were studied. There were 41 females and 32 males, whose ages ranged from 33 to 98 years (mean of 68 and median of 71 yrs). RFTR was performed with temperatures ranging from 60°C to 90°C. The following aspects were studied: immediate success rate, three-week success rate, recurrence rate, degree of numbness described by the patient and radiological findings around the trigeminal pathways.

The overall immediate success rate was 99%, dropping to 86% three weeks after surgery. Reoperations increased the success rate to 97%. The long-term success rate was 78% (1 to 3 year follow-up). The data suggest that a significant benefit can be obtained by applying temperatures between 70-80°C. A significant decrease in the frequency of patients' complaints of numbness was observed when temperatures below 75°C were used ( $P < 0.025$ ). Females complained more frequently of numbness than males. The recurrence rate followed a linear curve that was inversely proportional to the level of temperature ( $P < 0.001$ ). In addition, we noted a difference in the success rate among patients with imaging abnormalities and those without abnormalities: 84% for patients with abnormalities versus 68% for those without imaging findings.

Overall, this study shows that there is a trade off between recurrence rate and numbness when using RFTR and the procedure can be tailored based on the patient's acceptance of numbness. Moreover, one should expect a higher success rate when a cause for the trigeminal neuralgia is identified by imaging studies.

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3. Broggi, G, Siegfried, J: The effect of graded thermo-coagulation on trigeminal evoked potentials in the cat. *Acta Neurochirurgica (Suppl)* 1977; 24, 175-178.

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## COMPARATIVE ASSESSMENT OF BACK PAIN TREATMENT IN CLINICS

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Low back pain (LBP) occurs frequently in the modern industrialized society and is considered a major health care problem. The estimated cost of LBP treatment in the United States alone approached 24 billion dollars in 1990. However, in many cases, no underlying pathology can be found to account for the morbidity and loss of work that occurs in most cases. Despite the enormous impact, there are few guidelines for the clinical management of LBP patients.

Many industrial and epidemiological studies have suggested that there are a variety of psychological factors associated with low back pain. Undoubtedly, continuous pain in the human body will provoke psychological dysfunction. For individuals affected by

chronic back pain, psychological dysfunction, including depression, anxiety, hypochondriasis and hysteria, is also common. All of these will evoke a negative reaction or desire for self-protection against the physician and hospital visit. Indeed, this psychological disturbance is associated with a high rate of failed treatment.

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Comparative psychophysical assessment and physical measurements can successfully rate the functional capacity of conservative treatments at busy clinics ...

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Semi-quantitative pain scales have been traditionally used during clinical evaluation of low back pain treatment. However, since pain carries mixed psychophysiological information about the well-being of the patient, an emphasis should be placed on evaluating the comprehensive reaction to the back pain treatment. For this reason, neurosurgeons must use multi-dimensional pain scales to assess and predict treatment outcome properly. Since measurement of pain alone has been criticized as a subjective method, measuring predominantly non-physiological changes, we evaluated cross-modality matching and range of lumbar segment motion to compare subjective and objective responses in assessing the outcome of pain treatment.

Subjects were outpatients (N=16; 7 males, 9 females), selected on the basis of recurrent localized back pain without systemic disease and structural deformities of the spine. Data were collected using the Pain Perception Profile (PPP). The PPP, developed by Tursky et al., uses cross modality matching (CMM) procedures to scale and verify the relative magnitude of pain descriptors in three dimensions: the intensity dimension, which measures the degree of pain, the reactive dimension, which evaluates patients' reaction to the pain and the sensation dimension, which characterizes what the pain feels like. Prior to completing the PPP, patients are introduced to the computer system and allowed to practice using a standard set of lines and numbers presented in random order. Using a mouse and numeric keyboard, patients are asked to record an estimate of lines and numbers proportional to the pain descriptors displayed on the computer monitor. Two inclinometer techniques were used to assess the spinal range of motion (SROM). Spinal manipulation was used as a conservative treatment for low back pain. Four sets of PPP and SROM data were obtained before and after each visit.

Paired t-tests were performed (pre-treatment and

post-treatment) to determine the immediate effect of treatment on pain. Intensity (PPPI), reaction (PPPR) and sensation (PPPS) scores of pain were computed from the response function. The intensity dimension (PPPI) of pain, as a measure of the degree of pain, was decreased immediately following treatment (Session I:  $P < 0.001$ ; Session II:  $P < 0.03$ ). Similarly, the sensation scale (PPPS) showed significant changes (Session I:  $P < 0.02$ ; Session II:  $P < 0.01$ .) Conversely, the affective dimension (PPPR), or patients' response to pain, did not change significantly ( $P > 0.05$ , Session I and II.)

Paired t-tests and correlation coefficients were also calculated using long-term treatment data. Only the intensity (PPPI) dimension of pain showed significant reduction ( $P < 0.05$ .) Gross spinal motion (GP) significantly increased during the treatment period as evidenced by the inclinometer measurement (GP increased 10 degrees from pre-treatment to post-last treatment,  $P < 0.01$ .) However, changes of true lumbar motion were not significant.

In conclusion, this study used a combination of objective and subjective psychophysical pain analyses to determine the correlation between parameters during conservative treatment for low back pain. Cross modality matching was used to minimize the subjective bias associated with pain descriptors. Comparative psychophysical assessment and physical measurements can successfully rate the functional capacity of conservative treatments at busy clinics, adding less than ten minutes to the length of each visit.

#### Colleagues:

Enclosed in this issue of the Pain Newsletter is an application for membership in the Joint Section on Pain (see page 11.) We encourage you to forward this application to colleagues with interests in pain management.

The goals of the Section are to assure the highest quality of medical care for the management of patients with pain problems and to assure an appropriate socioeconomic and political climate conducive to the effective and efficient delivery of medical care to patients with pain problems.

## Spinal Cord Stimulation in Reflex Sympathetic Dystrophy Results in Normalization of Sweat Production and Reduction of Temperature Asymmetry

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Brett Stacey, M.D.

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Broseta (1982), Broggi (1987), Robaina (1989), and Barolat (1989) have reported that spinal cord stimulation (SCS) provides significant pain relief in a good proportion of patients with Reflex Sympathetic Dystrophy (RSD). In spite of this evidence, SCS is still used infrequently in RSD. In fact, many textbooks neglect to mention SCS as one of the treatment modalities for RSD. We propose that laboratory testing of autonomic function may be an objective tool for evaluating outcome and may help in resolving the controversies regarding diagnostic criteria for RSD.

The autonomic function laboratory screening we have used for RSD consists of measurement of resting sweat output (RSO), measurement of resting skin temperature (thermography), and Quantitative Sudomotor Axon Test (Q-SART) recording. In confirming the diagnosis of RSD, we use the putative diagnostic criteria proposed by Wilson (1990) and modified by Gibbons (1988), scoring on the basis of specific clinical findings (burning pain, hyperpathia/allodynia, temperature/color changes, edema, hair/nail growth changes) and laboratory results (thermography, bone x-rays, three-phase bone scan, quantitative sweat test, and response to sympathetic blocks). The interpretation is that a score greater than 5 indicates probable RSD, 3-5 indicates possible RSD, and a score less than 3 indicates that RSD is unlikely.

Six consecutive patients were referred by our multidisciplinary pain clinic for SCS screening for intractable pain due to RSD, four female and two males. The age range was 27 to 56, with a mean of 42 yrs. Remarkably, 50% of our patients developed "migration" of the RSD symptoms and signs to one or more of the other limbs. Laboratory screening was obtained pre- and three months post-implantation of the SCS system.

Medtronic Resume leads were implanted in four patients (2 cervical and 2 thoracic) and Pisces-Quad leads in two (thoracic). An Itrel II generator was internalized following a successful three day stimulation trial. SCS induced very early reversal of symptoms and signs. Patients had resolution of swelling, discoloration, and skin temperature changes of the involved limb, followed by satisfactory pain relief confirmed by discontinuation or reduction in opiate administration. All patients kept the stimulator turned on constantly. One patient required replacement of an exhausted battery in 12 months. The Q-SART study results following SCS demonstrated excessive resting output in 3/6 patients, resolving in 2/5 patients studied for more than three months following implantation.

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... laboratory testing of autonomic function may be an objective tool for evaluating outcome and may help in resolving the controversies regarding diagnostic criteria for RSD

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Excessive, active persistent sweat production (volume 7.64 microliters) in 3/6 patient resolved (volume 2.17 microliter), with normalization of Q-SART curve morphology. Diminished active sweat production in 4/6 patients improved in 2/5 patients after implantation. Thermography studies demonstrated that the temperature asymmetry, ranging from 2 to 5°C on the symptomatic limb in 6/6 patients, clearly improved in all patients studied for more than three months, with less temperature asymmetry in two, no temperature asymmetry in one, and smaller area of temperature asymmetry in two.

We conclude that SCS is effective in the treatment of RSD. Laboratory studies of sudomotor function and measurement of skin temperature are valuable tools for quantitative assessment of improvement. More importantly, the observed normalization of both excessive and deficient sweat production volumes with SCS suggest central modulation of the sudomotor reflex by afferent stimulation. This would support the hypothesis that reflex pattern changes in postganglionic cutaneous vasoconstrictor neurons in RSD are related to central (dorsal horn) changes.

Of Interest at:

The 64th Annual AANS Meeting  
 Minneapolis, MN  
 April 27- May 2, 1996

**SCIENTIFIC SESSION**

Wednesday, May 1

**Symposium**

“Persistent Pain after Spinal Surgery

“What do I do now?”

Moderator: Robert M. Levy

Co-Moderator: Samuel J. Hassenbusch

**Special Presentation**

William H. Sweet Young

Investigator Award in Pain Medicine

John Piper, M.D.

**Scientific Session**

Moderator: Robert M. Levy

Co-Moderator: Samuel J. Hassenbusch

- 837. Systematic Studies in Visceral Nociceptive Processing. John G. Piper, Kenneth A. Follett, Timothy J. Ness, Bret A. Dirks.
- 838. Dysesthetic Pain in Patients with Syringomyelia. Thomas H. Milhorat, Rene M. Kotzen, Harrison T.M. Mu, Anthony L. Capocelli, Robert H. Milhorat.
- 839. A Prospective, Randomized Study of Spinal Cord Stimulation Versus Reoperation For Failed Back Surgery Syndrome. Richard B. North, David H. Kidd, Steven Piantadosi.
- 840. Pharmacologic Mechanisms of Pathologic Hyperalgesia in Neuropathic Pain: The Role of the Adrenergic Receptor. Robert M. Levy, James Leiphart, Cynthia Dills, Damon Salzman.
- 841. Dorsal Column Stimulation Inhibits the Tail Flick Reflex in Rats: A Model for Studying DCS. Kenneth A. Follett, Manh Nguyen, John VanGilder, Timothy J. Ness.
- 842. Upregulation of  $\alpha$ -2-Adrenergic Receptors in the Spinal Cord Dorsal Horn in Postsurgical and Neuropathic Pain. Robert M. Levy, James Leiphart, Cynthia Dills, Holly Duncan.

**PRACTICAL COURSES**

Saturday, April 27 1:00-5:00 PM

004 Trigeminal Neuralgia

Director: Jeffrey A. Brown

Faculty: Harry Van Loveren, Thomas J. Lovely, H. Dong Jho, Jeffrey A. Brown, G. Robert Nugent, John M. Tew, Mark C. Preul

Saturday, April 27 1:00-5:00 PM

008 Ablative Neurosurgery for Pain

Co-Directors: Laligam Sekhar, Donald Wright, Jeffrey Keller

Faculty: Mark Kotapka, William Monacci, Sean O'Malley, Ghessan Beijami, Peter Nora, Annette Kock, Sandy Franco

Sunday, April 28 8:00AM- 5:00 PM

018 Neuroaugmentive Procedures for Pain Control

Director: Kim Burchiel

Faculty: Giancarlo Barolat, Samuel Hassenbusch, Robert Levy, Richard North, Richard Penn, Joel Seres, Andrew Shetter, Richard L. Weiner

**BREAKFAST SEMINARS**

Monday, April 27

114 Neurosurgical Management of Cancer Pain

Moderator: Samuel J. Hassenbusch

Panelists: Kim Burchiel, Giovanni Broggi, Richard North, John Loeser

Thursday, May 2

416 Surgical Options for Trigeminal Neuralgia

Moderator: Robert H. Wilkins

Panelists: Thomas H. Lovely, Richard L. Rovit, Sten Hakanson, Fredy Hilzer

## A Chronic MRI Study of Temperature-Controlled Radiofrequency Lesions in the Brain

Keyvan Farahani, Ph.D.  
 Keith L. Black, M.D.  
 Antonio De Salles, M.D., Ph.D.  
 Paul S. Mischel, M.D.  
 Robert B. Lufkin, M.D.

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Radiofrequency (RF) thermocoagulation is a well-established neurosurgical method for interruption of pain pathways and correction of movement disorders (1-3). Modern stereotactic applications of this technique in the brain have taken advantage of image guidance provided through the high soft tissue definition of magnetic resonance imaging (MRI) (4-6). In this long-term MRI study of RF lesions, our aim was twofold: (1) to investigate the MRI characteristics of thermal lesions that are produced at different temperatures in a normal brain model, and (2) to study the time course of such lesions.

After obtaining the approval of our institutional subject protection committee, forty interstitial RF lesions were produced in vivo in the frontal lobe of anesthetized rabbits at 50°C, 60°C, 70°C and 80°C, in 60 seconds. Spin echo T2-weighted MRI images of the lesions were obtained at various time intervals, from 20 minutes to 1 month post-lesioning. At every imaging interval, two specimens from each temperature category were excised and preserved for histological evaluation. Images were used for analysis of the lesion area and correlation with histology.

The results were as follows: For 60 seconds of RF exposure, no thermal lesions were formed at 50°C. At 60°C, only edematous lesions were formed. At 70°C and 80°C, lesions of comparable area (28 +/- 5 mm<sup>2</sup> and 30 +/- 4 mm<sup>2</sup>, respectively) were composed of a central zone of coagulative necrosis, surrounded by a ring of edema, which correlated well with the corresponding histology. The edematous component of thermal lesions expanded in size within 24 hrs and resolved within two weeks after lesion placement, leaving behind the irreversible necrotic center.

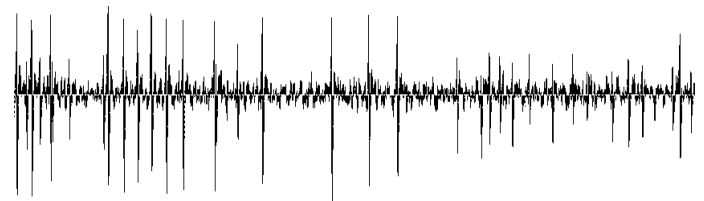
Recently, we reported our MRI observations of the hyperacute development of RF thermal lesions in the brain (7). In the present study, we demonstrated the sensitivity of MRI to various degrees of thermal insult in a normal brain model. Furthermore, in our long-term MRI

monitoring of such lesions, we observed the resolution of the edema component within two to three weeks of lesion placement.

In conclusion, MRI provides an effective method for guidance and monitoring of RF thermocoagulation in soft tissue. With respect to the central nervous system, the increased patient access offered by some open architecture MRI systems should allow the expansion of minimally invasive MRI-guided interventions to a number of neurosurgical specialties, including pain management.

### References

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2. Samii, M, Moringlane, JR: Thermocoagulation of the dorsal root entry zone lesions for the treatment of intractable pain. *Neurosurgery* 1984: 15, 953-955.
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## Calendar of Events

March 11-14, 1996

5th John J. Bonica Vail Pain Conference

Sponsor: Department of Anesthesiology  
The Ohio State University

Location: Vail, CO

Contact: A. Rogers, Department of Anesthesiology,  
The Ohio State University, 410 W 10th  
Avenue, Columbus, OH 43210

Phone: 614-293-8487

Fax: 614-293-8153

March 26-29, 1996

5th John J. Bonica Hawaii Pain Conference

Sponsor: Department of Anesthesiology  
The Ohio State University

Location: Wailea, Maui, HI

Contact: A. Rogers, Department of Anesthesiology,  
The Ohio State University, 410 W 10th  
Avenue, Columbus, OH 43210

Phone: 614-293-8487

Fax: 614-293-8153

March 27-31, 1996

American Society of Regional Anesthesia, 21st Annual  
Meeting

Sponsor: American Society of Regional Anesthesia

Location: San Diego, CA

Contact: ASRA PO Box 11086,  
Richmond, VA 23230-1086

Phone: 804-282-0010

Fax: 804-282-0090

April 9-14, 1996

New Frontiers in Pain Management

Sponsor: Maricopa Medical Center/Arizona Pain  
Institute

Location: Scottsdale, AZ

Contact: MMC/API, 2601 E Roosevelt,  
Phoenix, AZ 85010

Phone: 602-267-5633

Fax: 602-267-5518

April 11-14, 1996

7th National Meeting for State Cancer Pain  
Initiatives

Sponsor: State Cancer Pain Initiatives

Location: Austin, TX

Contact: Resource Center for State Cancer Pain  
Initiatives, 1300 University Ave., Room 3675,  
Madison, WI 537067

Phone: 608-265-4013

Fax: 608-265-4014

April 27- May 2, 1996

64th Annual Meeting of the American Association of  
Neurological Surgeons

Sponsor: American Association of Neurological Sur-  
geons

Location: Minneapolis, MN

Contact: AANS, Suite 100, 22 S. Washington Street,  
Park Ridge, IL 60068

Phone: 847-692-9500

Fax: 847-692-2589

August 17-22, 1996

8th World Congress on Pain

Sponsor: International Association for the Study of Pain

Location: Vancouver, BC, Canada

Contact: IASP, 909 NE 43rd Street, Suite 306,  
Seattle, WA 98105-6020

Phone: 206-547-6409

Fax: 206-547-1703

September 28-October 3, 1996

Congress of Neurological Surgeons Annual Meeting

Sponsor: Congress of Neurological Surgeons

Location: Montreal, CAN

Contact: CNS, 22 S. Washington Street,  
Park Ridge, IL 60068

Phone: 847-692-9500

November 14-17, 1996

15th Annual Scientific Meeting of the American Pain  
Society

Sponsor: American Pain Society

Location: Washington, DC

Contact: APS, 4700 W. Lake Ave.,  
Glenview, IL 60025-1485

Phone: 847-375-4715

Fax: 847-375-4777

*Application for Membership*  
**Section on Pain of the American Association of Neurological Surgeons**

**I. Biographical**

Name \_\_\_\_\_  
Birthplace \_\_\_\_\_ Birthdate \_\_\_\_\_ Citizenship \_\_\_\_\_  
Home Address \_\_\_\_\_ Home Phone ( ) \_\_\_\_\_  
Office Address \_\_\_\_\_ Office Phone ( ) \_\_\_\_\_

**II. Category of Membership Requested**

Active       Associate       Corresponding

**III. Education**

Premedical collegiate education (institutions/dates) \_\_\_\_\_  
Final degree (institution/dates) \_\_\_\_\_  
Medical education (institution/dates) \_\_\_\_\_  
Final degree (institution/dates) \_\_\_\_\_  
Internship or equivalent (hospitals/dates) \_\_\_\_\_  
Residency and other graduate training (institutions/dates) \_\_\_\_\_  
Residency training institution \_\_\_\_\_  
Completion (or expected completion) Date \_\_\_\_\_

**IV. Membership, Certification and Practice**

Are you certified by the American Board of Neurological Surgery?  Yes/Year \_\_\_\_\_  No

Are you certified in neurosurgery by another examining board?  Yes/Year \_\_\_\_\_  No

**Are you a member of:**

- American Medical Association
- Local or regional medical society
- State or provincial medical society
- American Association of Neurological Surgeons
- Congress of Neurological Surgeons
- American Academy of Pain
- International Association for the Study of Pain
- American Pain Society

Name: \_\_\_\_\_

Name: \_\_\_\_\_

Medical Licensure State \_\_\_\_\_

Dates \_\_\_\_\_

Signature \_\_\_\_\_

Date \_\_\_\_\_

*Please return this completed application to:*  
*Section on Pain, Membership Department, 22 South Washington Street, Park Ridge, IL 60068*

AANS/CNS  
Joint Section on Pain  
22 S. Washington St.  
Park Ridge, IL 60068

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Joint Section on Pain  
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M.D., Ph.D.  
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Vice Chairman  
Robert M. Levy, M.D.  
Chicago, IL

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