The annual meeting of the American Association of Neurological Surgeons will be held April 8-13, 2000, in San Francisco. Members of the Pain Section will be leading and participating in a wide variety of pain-related-practical courses, breakfast seminars, and an afternoon Section Session that will enable neurosurgeons to get up-to-the-minute information about neurosurgical pain management issues from the experts.

Educational offerings of the Pain Section at the annual meeting will begin with weekend practical courses. Saturday will feature a full-day hands-on course presenting neuroaugmentative procedures for pain control, including spinal cord stimulation, neuraxial drug infusion, deep brain stimulation, and motor cortex stimulation. This course will be complemented, on Sunday, by a half-day practical course presenting neuroablative procedures for pain control. In addition, Sunday will feature a half-day course on surgical management of trigeminal neuralgia, including percutaneous balloon compression and radiofrequency techniques and microvascular decompression.

Breakfast seminars relevant to pain issues include, on Monday, “Management of Pain in the Trigeminal Distribution” and “Sympathectomy: Patient Selection, Contemporary Techniques, and Outcomes,” followed on Tuesday by “Neurosurgical Management of Intractable Pain.” This session will provide an overview of indications, patient selection, and outcomes of ablative and augmentative techniques for pain management. The Pain Section afternoon session will be held on Wednesday, and will feature a symposium on minimally invasive procedures for pain management. The open papers cover a wide range of topics of relevance to neurosurgical surgeons, including stimulation for treatment of intractable craniofacial pain, the pathophysiology of neuropathic pain and neuroparalytic keratitis, and epidural analgesia for postoperative pain control. (See pages 11 and 14 for further details.)

The William H. Sweet Young Investigator Award will be presented Wednesday afternoon during the Pain Section session. The recipient of the Sweet Award for 2000 is Alon Y Mogilner. Dr. Mogilner will present the results of his study, “Functional Brain Imaging and Spinal Cord Stimulation: Localization of Cortical Activity with Magnetoencephalography (Meg),” immediately after presentation of the award. We congratulate Dr. Mogilner on receiving this honor.

Active involvement of our members in our parent organizations and within the Section is essential if we are to achieve our goals of education, service, and research. I am pleased, as Chair of the Section on Pain, to recognize the contributions of the individuals who are involved in the practical courses, the breakfast seminars, and the afternoon session. Those whose participation will help make the AANS 2000 annual meeting successful, I extend my thanks. Those of you who wish to become active in the Pain Section should feel free to contact me, or any of the Pain Section officers or council members, to discuss opportunities for involvement.

See you in San Francisco.

Kenneth A. Follett MD, PhD
University of Iowa
Pain in the New Millennium
Ronald Dubner DDS, PhD Chief Editor, Pain

The new editors and I look forward to leading Pain into the new millennium. Our goal is to maintain the position of the journal as the leading academic journal in the field. As indicated in the preliminary pages of this issue, there are now six separate sections of the journal. Each Section Editor will be responsible for handling the reviews of manuscripts submitted to her/his section. Authors are invited to recommend which Section they would like their manuscript assigned to. An Associate Editor listed under each section will usually act as one of the referees for each manuscript. Other referees will be chosen from the worldwide pain research community. Section and Associate Editors have been appointed for specific terms of 6 or 3 years.

Our success will depend on the continued high quality of the clinical and basic science reports submitted by the readership. There are two areas, however, in which I believe we can show immediate improvement in the publication process of the journal. First, we need to reduce the time from submission to publication. This will require a shortening of the review process and a reduction in the backlog of papers accepted for publication. We hope to accomplish the former by converting the review traffic to electronic media. The Section Editors and the Chief Editor will communicate electronically and all the Associate Editors and other referees will be contacted by e-mail whenever possible. For this reason, a disk is now required at submission so that the manuscript can be distributed electronically. Referees will soon have the choice of receiving an electronic version of the manuscript in place of a hard copy. We will improve our tracking procedure so that referees will be notified immediately and repeatedly if their review is late. The final accepted version of the manuscript will be sent to the publisher as a hard copy for the present though we foresee a change to electronic transmission in time. Ultimately, we will make electronic submission of the manuscript available to authors. The backlog of accepted papers will be reduced by increasing the number of published pages per year. In 2000, we will publish 300 additional pages in the existing 15 issues, paid for by subscribers. In 2001, there will be 18 issues published. We hope to reduce the delay between acceptance and publication to 3±4 months starting in April 2000.

The second area of improvement involves changes in format of the journal as well as a further use of electronic publishing. A new type of submission will begin in 2000. These will be called Topical Reviews and will be invited short articles on new findings and issues in clinical and basic research related to pain. They will be published on a fast track, within 2 months of acceptance. In addition, they will be published electronically on Pain On-line free of charge to nonsubscribers as well as subscribers of the journal. At the moment, electronic access to full-text articles is only available to IASP members and subscribers. These Topical Reviews will be available indefinitely to anyone who accesses the Pain website. Readers of the website will also soon be able to request e-mail alerts of the table of contents of forthcoming issues of Pain.

I hope these proposed changes will provide more satisfactory communication during review and after publication. The Section Editors and I welcome any suggestions that readers and authors may have for further improvement of the journal.

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AANS (PAIN) BOOK SALE @ http://www.neurosurgery.org/marketpl/search/default.asp?class=Pain

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The DREZ Operation
edited by Blaine S Nashold Jr, Robert D Pearlstein, PhD, Allan H Friedman, MD, Janice Ovelmen-Levitt, PhD

The Primary Care of Neurological Disorders
edited by A John Popp, MD

Colleagues:

An application for membership in the Joint Section on Pain can be found on page 15 of this issue or at http://www.ohsu.edu/som-neurosurgery/news/membershipapp.html 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.
Pain Management for the Substance Abuse Patient

Joel L Seres MD, Northwest Occupational Medical Center, Portland, OR

The physician who manages the chronic pain patient must be prepared to handle a plethora of complicating influences. Psychosocial, biological, employment system issues and a spectrum of personality, motivational and compliance problems abound. The patient who is a substance abuser or who has a history of drug-related problems adds another nefarious element to the multiple pitfalls in treating the chronic pain patient.

The past fifty years of pain management has taught many lessons. For some patients, even those with substance abuse and complex, multifactorial histories pain management can be surprisingly straightforward. For most substance abusing patients however the issues are more complex and the outcomes less predictable.

The neurosurgeon is often in a difficult position. The patient presents for care seeing this as the “last resort.” This results in an inferred need that the surgeon must “do something,” even where there really isn’t a good “something” to do. However hard we try to avoid it, patient’s demands, both overt and implied have an influence on our therapeutic decisions and attitudes.

Sometimes patients who have a long history of problems respond dramatically to pain treatment and surgery. A surgeon who experiences such outcomes might assume that this is the usual expected outcome. While such outcomes do occur, they are less common. Those situations that present more complex issues are the ones that challenge our greatest ingenuity and effort. These take more of your time and the time of your staff.

Complicating the use of narcotics for pain control is the absence of efficacy testing. It is not usual that we actually test the patient for the amount of analgesia they receive from a drug. We often assume that a constant dose level infers constant analgesic effect. If fact the patient might really be getting little in the way of analgesia in a steady dose scenario. 1 Likewise we do not directly test for increased analgesic efficacy when we increase the dose of narcotics on patient demand. In effect we have no objective way to measure the benefit of narcotics in most patients. We assume that if the patient does not demand more or says that the dose is satisfactory that effective pain relief must be present. This is probably not always a valid assumption. Tolerance to the analgesic action of drugs occurs in animals and in humans alike.2

In cancer pain patients complicated by an addiction problem pain management is still achievable. Pain control can be managed with psychological support, medication contracts and appropriate dosing controls. Initially pain management is made difficult...“due to issues of distinguishing tolerance from disease progression, concurrent methadone maintenance, and drug seeking behavioral pattern.”3 In short it takes a team approach.4,5

Likewise it is important to recognize that patient response to narcotics is not necessarily linear to the dose given. “It is not uncommon for a patient with refractory cancer pain to obtain better analgesia with the same drug and dose following the introduction of psychological interventions...”6

A pragmatic approach to the abuse patient is helpful. Merely looking for some five behaviors that define abuse can help you recognize difficulties before they can defeat your efforts. (Table 1).7

One pain clinic found that:

- Of 403 patients 76 (18.9%) used narcotics chronically.
- Of these 27.6% met 3/5 of behavioral criteria for abuse (Table 1).
- Within one year 9 (2.2%) were treated for substance abuse or had legal difficulties.
- This small group created conflicts and consumed large amounts of clinic time and resources.8

Physicians often limit the amount of medication they prescribe because of concerns about monitoring and control by licensing bodies.9 With the relatively small numbers of patients that do cause problems these concerns should not impede appropriate care for the appropriate patient. While chronic steady-state drug dosing does not impair the ability to drive or to work, changes in dose can have effects lasting for a week or more.9

The backbone of appropriate drug control is the drug use contract. (Figure 1, page 5).10 This defines the behaviors that will or will not be tolerated. It defines the rules about refills and their requests, requires minimal levels of patient compliance in all therapies and monitors the patient’s drug taking behavior. Coupled with this is the “drug efficacy diary.” The patient monitors each dose and its effect in pain reduction.10 The patient must present the diary each time refills are requested. This helps to enroll the patient as part of the treatment team, it documents compliance and efficacy to any investigator and it encourages compliance. Mostly it reduces a lot of the pressure on the physician and the staff by having the patient do more. Compliance can be rewarded later by reduction in required record keeping.

Conclusions

Chronic pain patients who are substance abusers can be treated appropriately by recognizing the special problems they present. A team approach is necessary to maximize outcome and to avoid complications. Having the patient do more and document their participation can minimize the special demands caused by the substance abuse patient.

Table 1. Behaviors Suggestive of Abuse

- Excessive focus on opiate issues. This is especially important when it impedes progress in other areas such as physical conditioning, job seeking, improvement in domestic relations, etc.
- Early refills (3 or more) after setting up a contract with your patient. This is especially important when it is not associated with a worsening of the pain-producing pathology.
- Multiple calls to clinic administrators about the service you or the team is providing. Call to superiors for a drug is an ominous sign.
- Patient demonstrates a pattern of lost, stolen, spilled medications.
- You discover that the patient has supplemental sources of opiates. Medications may be obtained from other physicians, ER, or from recreational drug sources. This violates the minimal requirements of the drug use contract.

continued on page 5
Neuroaugmentation treatment strategies for the treatment of neuropathic pain syndromes

Richard K Osenbach, MD  Assistant Professor, Medical University of South Carolina

During the 1999 CNS Annual Meeting in Boston MA, I had the opportunity to moderate a luncheon discussion that included Richard Simpson, MD, PhD, Samuel Hassenbusch MD, PhD, George Mandybur, MD, and Yoshi Katayama, MD. The panelists discussed a wide range of neuroaugmentation treatment strategies for the treatment of neuropathic pain syndromes. I’d like to highlight some of the points that were made along with some additional comments regarding these therapies.

Spinal Cord Stimulation

Dr. Simpson began by speaking about spinal cord and peripheral nerve stimulation. In the United States, spinal cord stimulation (SCS) has traditionally been employed in patients with “failed back surgery syndrome” (FBSS) who have intractable neuropathic extremity pain. These patients typically have had one or more spinal procedures and continue to suffer pain from epidural fibrosis, arachnoiditis, or chronic nerve root injury. Spinal cord stimulation can be a very effective therapy for this group of patients. It should be stressed that while SCS may *occasionally* be effective for axial pain, the primary indication is pain in the extremity. I have personally observed sporadic, modest improvements in axial pain in patients who received a SCS for extremity pain. However, in my experience, and I believe in that of many other surgeons with considerable experience with SCS, effective stimulation for axial pain is difficult if not impossible to achieve on a consistent basis. Consequently, SCS is usually not recommended for patients whose primary pain complaint is axial. For those patients that are felt to be candidates for SCS, it is absolutely critical that a trial be conducted to determine efficacy before going on to a permanent implant. For better or worse, we have traditionally judged a trial as successful if the patient experiences at least a 50% reduction in pain.

Although SCS is utilized most frequently in patients with FBSS, it may be even more useful for other painful conditions. Complex Regional Pain Syndrome Type I (formerly known as reflex sympathetic dystrophy) responds well to SCS. One salient point regarding RSD is that the pain can spread over time and should be taken into account when implanting a SCS system in these patients. With RSD, it is helpful to initially choose a system that can be adapted or modified to accommodate additional electrodes should the need arise. Some of the other exciting applications for SCS that are not currently approved by the FDA include intractable angina and ischemic pain from peripheral vascular disease. Indeed, these latter two applications constitute the most frequent indications for SCS in Europe. The European studies have documented clear benefits of this therapy in both angina and peripheral vascular disease. In patients with intractable angina, the benefits of SCS include a reduction in the frequency and severity of angina attacks by at least 50% on average, a reduction in the consumption of short-acting nitrates, objective reduction in degree and duration of ischemia, and improvements in exercise capacity and activities of daily living. Patients with peripheral vascular disease experience similar benefits. It has been shown that SCS improves extremity blood flow and that most of the flow changes occur in the microcirculation. Indeed, improvement in pain in patients with peripheral vascular disease is closely correlated with increases in tissue oxygenation as measured by transcutaneous tissue oxygen pressure (TcPO2). In addition to the analgesic effect, SCS also promotes healing of ischemic ulcers and improves limb salvage rates. The latter two indications have been slow to catch on in the United States. I would hope that clinical trials can be conducted in an attempt to replicate the European data as SCS appears to be highly effective in these groups of patients.

Deep Brain Stimulation

Dr. Mandybur presented an overview of the applications of deep brain stimulation (DBS) for the treatment of chronic pain. Since the approval of DBS for the treatment of tremor, there appears to be a rekindling of interest in DBS for the treatment of chronic pain. Deep brain stimulation is a complex treatment of last resort for patients with long-standing, debilitating, intractable pain that has failed to respond to most reasonable conventional treatment modalities. Patients who are believed to be candidates for DBS should have a clear etiology for their pain. They should be evaluated in a multidisciplinary pain clinic and should undergo psychological screening.

Currently, the preferred sites of stimulation appear to be the somatosensory thalamus (ventrocaudal nucleus, Vc) and the periventricular gray (PVG). Stimulation of the sensory thalamus is similar to SCS in that it is a paresthesia-producing stimulation. Sensory thalamic stimulation is most useful for neuropathic pain that is often unresponsive to systemic opiates. In contrast, PVG stimulation is believed to cause the release of endogenous opioids and as such is most effective for nociceptive pain. In clinical practice, this may be an arbitrary separation since many pain syndromes have both nociceptive and neuropathic components, FBSS being a classic example. Patients may present with nociceptive axial back pain and neuropathic radicular pain secondary to nerve root injury. Consequently, except in cases where the etiology is unequivocal, the choice of stimulation site is not necessarily straightforward. In fact, in some cases it may be preferable to place an electrode in both the sensory thalamus and PVG and test the response in both sites. As with any neuroaugmentation procedure, the decision to proceed with implantation of a permanent system should be based on a trial period to determine the efficacy.

A meta-analysis of DBS has shown that the efficacy ranges from about 20% to 80%, (1). This meta-analysis includes 1,114 patients reported in the world literature for whom there was long-term outcome data available. Approximately 50% (561), of patients experienced long-term success. Overall, DBS showed more long-term benefit for nociceptive pain, (61% success) compared with neuropathic pain, (42% success). If one looks at efficacy based on site of stimulation it would appear that stimulation of the sensory thalamus is effective in patients with deafferentation pain, (56% long-term success; 228 of 409 patients) but singularly ineffective for nociceptive pain, (0/51 long-term successes). PVG stimulation on the other hand appears to be far more effective for nociceptive, (59% success;
References

1. Seres et al. Drug use and withdrawal


10. Seres drug use contract

Figure 1. This is an example of a contract. You will note that in addition to drug use issues it deals with common problems we have noted. We have found that preempting problems by discussing them beforehand can reduce their frequency and disruptiveness. Of course you can modify this contract to your own needs.

NORTHWEST OCCUPATIONAL MEDICINE CENTER

MEDICATION CONTRACT10

The purpose of this contract is to help us provide better service for you. We ask that you follow this agreement fully. If you feel the need to change any aspect of it you must first obtain agreement from your doctor in a new agreement. You may not change any part of this agreement on your own. We reserve the right to stop treating you any time that you do not fulfill your part of the agreement. Of course if this occurs we will give you four weeks notice in writing to find a new physician. We will be happy to forward the medical records that you desire to your new doctor.

We may ask you to keep records of a variety of items that will help us care for you. These may include your physical activities, your food intake, your pain level, your contacts with employers, your drug use, and other items as we require. Prescriptions may be refilled on alternate Tuesdays or later. We will not acknowledge refills before your refill date. We request that the patient call for refills, rather than a family member or friend. Your prescription can only be refilled on your request directly to our office.

Prescriptions are like money. If you lose your medication or the written prescription it will not be replaced. You will have to wait until your next visit. Until we get to know you well we will not prescribe large amounts of drugs to cover your trips out of town. Later, depending on your compliance we might be able to work something out.

In order for us to help you with your physical problem we will probably ask that you perform exercises that we teach. You must perform these on a regular basis several times each day. We may ask you to keep records of the exercises you do and when you do them. In order to obtain your refills it is necessary for you to bring these records with you. We must be the only physicians who are prescribing for you for any medication. If you are receiving drugs from other physicians, you must tell us. We may then modify our agreement.

We request that you keep “drug use diaries” when we first start with you. Later, if you demonstrate appropriate compliance we may modify our requirements. If you do not bring in your diaries as requested we may not continue prescribing for you.

We ask that you deal with all your questions while you are here in our office. We request that you call our office only for urgent matters. Also, please respect our rule that we would like only the patient to call for information, refills and appointments. This simplifies the work of our staff. If you have many questions we ask that you write them down. By bringing your list to the office our staff can help to answer your important questions more efficiently. We might ask you to repeat to us what we had discussed at our last visit. This way we can be sure that you understood what we said.

If you require additional time with any of our staff we ask that you schedule the time beforehand. This helps us spend the time you need with us without it disrupting an already busy schedule.

If you must cancel your appointment, please try to give us at least 48 hours notice. That way we can schedule some else who might be waiting. We are sorry that we are unable to provide baby-sitting services for you while you see the doctor or other members of our staff. Please be sure to bring with you all the records we ask that you keep. It may not be possible for us to see you without them.
247 of 419 patients) than for neuropathic, (23% success; 35 of 155 patients) pain. Currently, DBS is classified as an experimental procedure by the FDA although the procedure can be performed using physician discretion. Those of us who perform DBS for movement disorders and in select patients with chronic pain believe that it is a safe and effective procedure for those very select patients that have otherwise exhausted all treatment options.

Motor Cortex Stimulation

Professor Yoichi Katayama along with Professor Tsubokawa have been pioneers of motor cortex stimulation (MCX). Motor cortex stimulation is a fascinating treatment for selected neuropathic pain syndromes and for which the mechanism(s) of analgesia is poorly understood. It was initially employed primarily for the management of refractory central pain following stroke but has also been utilized in patients with trigeminal neuropathic pain, intractable phantom pain, and more recently peripheral deafferentation pain (2).

Motor cortex stimulation has the potential advantage that it can be successfully used in patients with profound sensory loss in the distribution of pain, even in cases of true anesthesia dolorosa. Remember, procedures such as SCS, peripheral nerve stimulation, and sensory thalamic stimulation depend on the patient being able to perceive the stimulation-induced paresthesias in the painful areas. Therefore, paresthesia-producing stimulation is usually ineffective in patients with profound sensory loss. Since the analgesic effect of MCX does not appear to depend on paresthesia, this technique can potentially be useful in patients with severe deafferentation pain. There is some suggestion that the potential efficacy of MCX can be predicted through pharmacological testing. A positive response to the intravenous (IV) infusion of barbiturates would suggest that MCX will be effective. Additionally, a negative response to IV opiate infusion is also thought to be predictive of success. Transcranial magnetic stimulation (TMS) has been utilized for the non-invasive measurement of motor evoked potentials. The motor cortex can easily be activated with TMS and it is possible that with further investigation, TMS could conceivably be used as an additional test to preoperatively predict the response to MCX.

Motor cortex stimulation involves epidural placement of a plate-type of electrode over the motor strip. The electrode must be placed over the motor areas that correspond to the pain distribution. In other words, treatment of facial pain requires the electrode to be placed over the area of cortex from which the face can be electrically activated. There are numerous methods of localizing primary motor cortex. My preference is to perform a small craniotomy under local anesthesia. The initial location of the motor strip is determined based on preoperative imaging studies and classic Taylor-Houghton lines. I might add that while this method might seem archaic in this modern age of frameless stereotaxis, etc. I have been impressed at the accuracy of these older methods. After the craniotomy is made, median nerve somatosensory evoked potentials are used to locate the central sulcus. Finally, bipolar electrical stimulation is performed to map motor responses. It is important to determine the threshold for motor responses such that the stimulation amplitude can be kept below this threshold to avoid motor responses and seizures. Once the appropriate area has been located, a Resume II electrode (Medtronic Neurological, Minneapolis, MN) is sutured to the dura and connected to a temporary extension that is brought out through the skin. Stimulation is performed for periods of 30 minutes about 4 times per day for several days to determined the effect on the patient’s pain. If the trial is successful, the electrode is then connected to a permanently implanted pulse generator. In my experience with several patients, the effective stimulation parameters have been as follows: frequency 50-60 Hz, pulse width 180-200 microseconds, amplitude 2-6 volts. In all cases the amplitude is kept below the threshold that produced motor contractions.

Nguyen et al. recently reported their results of MCX for neuropathic pain (3). Ten of 13 (77%) patients with central pain syndromes obtained a “significant” benefit while 9 of 12 patients (75%) with trigeminal neuropathic pain experienced similar benefits. Admittedly, MCX is not suitable or indicated in many patients. However, it would appear to be a potentially useful technique is selected patients with very difficult and refractory neuropathic pain syndromes.
Spinal Drug Infusion

Dr. Hassenbusch concluded the seminar by discussing spinal drug infusion for the treatment for chronic pain. In particular he discussed some of the new agents that have been or are currently being investigated as practical alternatives for spinal narcotics. Clearly, alternative agents will become increasingly important as more patients receive implanted pumps for chronic nonmalignant pain. Development of clonidine for both epidural and intrathecal delivery may represent one of the more important advances in the management of chronic pain. Clonidine exerts its effect through mechanisms separate from either opiates or local anesthetics. Presently in the United States, clonidine is approved for medium-term epidural administration in patients with cancer pain. Clonidine has been shown to produce effective analgesia either alone or in combination with morphine with which it is synergistic. Clonidine appears to be especially effective in various neuropathic pain syndromes, many of which are traditionally thought to be relatively refractory to opiates. The major problem with spinal clonidine is hypotension and bradycardia; therefore, titration and dosing need to be monitored carefully when administered through this route. Further studies are warranted and planned to determine the long-term effects of this agent when used for spinal infusion.

Local anesthetics such as bupivacaine continue to be used rather commonly in patients with nonalignment as well as cancer pain, often combined with morphine. In acceptable concentrations, local anesthetics alter neurotransmission in a reversible and predictable fashion. The addition of local anesthetics can sometimes improve pain control and reduce opiate requirements in patients who have developed tolerance to opiates. Another class of agents that has been investigated for spinal infusion is the calcium channel antagonists. A synthetic form of w-conopeptide MVIIA (SNX-111) has been developed that selectively binds to voltage-dependent calcium channels located in the spinal dorsal horn. SNX-111 (ELAN, Menlo Park, CA) has been shown to have potent anti-nociceptive action in animal models of both nociceptive and neuropathic pain. Human trials investigating safety and efficacy have been conducted and have demonstrated relatively good analgesic effect. However, the side effect profile was considerable. Therefore, it would appear that N-type selective calcium channel antagonists may be promising analgesics for spinal infusion. However, because of the adverse effects reported to date, further investigation is warranted before these agents are suitable for general clinical use.

There has recently been interest in the use of GABA-agonists in the treatment of pain. Baclofen, a GABA-B receptor agonist is well-known for its effect on both spinal and cerebral-origin spasticity. However, there have been animal studies documenting analgesic effects of spinal baclofen and some anecdotal reports of analgesic efficacy in patients with intractable central neuropathic pain. Midazolam, a GABA-A agonist also possesses anti-nociceptive properties and has been used both alone and in combination with clonidine in a small number of patients. This combination was shown to produce immediate nearly complete analgesia without clinically significant side effects or evidence of tolerance. The NMDA antagonists are another class of agents that have shown promise as analgesics agents particularly for neuropathic pain. Ketamine has been used for both epidural and intrathecal infusion and produces excellent analgesia. The major disadvantage of the NMDA receptor antagonists is that all cause to some extent phencyclidine-like adverse side effects that limits their usefulness. Also, there is some evidence that this class of agents produces neurotoxicity further limiting their use. Further investigation is therefore required before these agents will become clinically useful.

Presently, benign pain is the most common indication for the implantation of a spinal drug infusion device. In spite of the large number of pumps implanted, the use of chronic spinal opiates for benign pain remains controversial and is not universally accepted. There are still many questions that remain regarding this therapy. Who really are the most appropriate patients for this therapy? At what dose should morphine be considered a failure? When should one consider combining morphine with a second agent such as local anesthetics or clonidine? Since pumps have been implanted even in relatively young individuals, what is the true long-term efficacy after 5 or 10 years? Is there any evidence of neurotoxicity with long-term use of spinal narcotics? My personal belief is that this therapy can be beneficial in very carefully selected patients for whom there appears to be no other reasonable options. And, while I personally utilize spinal opiates for benign pain, I nonetheless continue to have real concerns regarding their long-term benefit. It is certainly naive for anyone to think that spinal administration of opiates circumvents or eliminates all of the problems that occur with systemic administration. Indeed, issues of tolerance and dose escalation are real problems that must be dealt with in these patients. Therefore I would urge all those who utilize this therapy to do so with careful consideration given the difficulties associated with the use of long-term opiates even when delivered intrathecally. Personally, I believe that the future of spinal infusion therapy lies in the development of new analgesic agents mentioned above that produce equivalent analgesia but lack the problems associated with opiates.

Summary

There are a variety of surgical options for patients with neuropathic pain syndromes. Although most of the procedures discussed above have a learning curve, they are for the most part technically simple and can be mastered by any neurosurgeon who has a desire to learn the techniques. While management of patients with chronic pain can be time-consuming and sometimes frustrating, helping patients who suffer with intractable debilitating pain can also be equally rewarding and I would encourage neurosurgeons across the United States to be proactive in rekindling an interest in the neurosurgical management of pain in the tradition of some of the great pioneers of pain surgery that have preceded us.

References
Selected Abstracts

Annual 49th CNS Meeting, Boston 1999

Motor Cortex Stimulation for Chronic Neuropathic Pain. Literature Review and Results from a Prospective Audit

Nikki Maartens, Dawn Carroll, Tipu Aziz, Carole Joint

**Background:** There is growing evidence to support the analgesic effectiveness of MCS in chronic neuropathic pain. Patients are considered eligible for MCS if they have failed to respond to all other analgesic interventions.

**Aims:** To evaluate the short and long term effectiveness of MCS.

**Methods:** Patients were implanted with a Medtronic Itrel 2 or 3rd device (2-stage surgical procedure). Resume® quadripolar electrodes were placed extradurally over the motor cortex strip. Intraoperative stimulation confirmed a motor response in the area of pain. Postoperative titration to find optimum stimulation parameters was carried out 4-6 weeks postoperatively. Standard outcomes were used to measure pain intensity and pain relief. Volunteered and observed adverse effects were documented.

**Results:** Five out of ten patients responded positively (at least 50% relief) to intermittent MCS. There were no seizures in patients who responded to stimulation. One patient who did not respond had a seizure during postoperative titration (9.6 volts). Technical problems were experienced with the hardware.

**Conclusions:** Fifty percent of patients treated responded positively to MCS. These findings are impressive, given that these patients had failed to respond to any other pain intervention. Our findings are comparable to those reported by other centers. An analgesic response was seen in patients with phantom pain (2), post-stroke pain (2), and posttraumatic neuralgia (1). However it is difficult to predict which patients are likely to respond to MCS and postoperative titration of the stimulation parameters may not always be straightforward. Randomized controlled trials are now urgently needed to test the true effectiveness of MCS. The possible mechanisms for MCS remain uncertain.

Spinal Cord Stimulation Electrode Design: A Prospective, Randomized Trial of Percutaneous ‘V’ Surgically Implanted, Insulated Electrode Arrays

Richard North, David H Kidd, Christopher Davis, John C Olin, Jeffrey M Sieracki

**Introduction:** Spinal Cord stimulation for chronic, intractable pain has been increasingly successful in clinical practice because of recent technical improvements, in particular the development of electrodes with multiple contacts, supported by programmable implanted pulse generators. Contemporary electrodes may in some cases be placed percutaneously, and in other cases require a limited laminectomy. Computer modeling predicts performance advantages for the insulated array requiring laminectomy, but there have been no clinical comparative studies of these designs.

**Methods:** We have performed a prospective, randomized controlled trial comparing two prototypical electrode designs. A series of 24 patients with chronic lumbosacral pain syndromes, in whom percutaneous four-contact electrodes were tested first, then underwent implantation at the same spinal level of two different electrode configurations: 12 received a new percutaneous four-contact electrode of the same design and 12 received an insulated four-contact array, implanted via laminectomy. Technical outcome has been assessed by a computerized system which allows direct patient interaction and quantitative measures. Clinical outcome has been assessed by a disinterested third party, using outcome instruments validated over the past two decades at a mean of 2.1 years (range 1.4-3.1) postoperatively.

**Results:** Technically, the insulated array performed significantly (p=0.0006-0.0039) better than the percutaneous electrode in the same patients by all 3 measures tested (overlap rating, overlap calculation amplitude), for “usage” amplitude at the 3 standard bipoles examined. Overlap of pain by paresthesias, calculated from patients’ drawings on a graphic input device was significantly better for the permanent electrode, whether percutaneous or insulated array. Patient ratings of overlap were significantly better for both permanent electrodes, as well; each design was superior by one of two measures. By comparison with the percutaneous temporary electrode, at subjectively identical stimulation intensities, the permanent insulated array required significantly lower amplitude. Clinically, the insulated array performed significantly (p<0.05) better as well: 10 of 12 patients with this electrode were “successes” (>50% relief by standard rating methods; would repeat for the same result), versus only 5 of 12 with the percutaneous electrode.

**Conclusions:** The technical advantages we have demonstrated for insulated spinal cord stimulation electrode arrays, by comparison with percutaneous arrays, are associated with superior clinical outcome.

Evaluation of Efficacy of Transverse Tripolar Stimulation on Chronic Low Back Pain Relief: Results of a Single Center

Slavin KV, Burchiel KJ, Anderson, VC, Cooke B

**Objectives:** The goal of this study was to evaluate the efficacy of the transverse tripolar spinal cord stimulation system (TTS) in providing relief of low back pain (LBP) in patients with chronic nonalignment pain.

**Methods:** Transverse tripolar electrodes were implanted in the lower thoracic region (T8/9 to T12/L1) in 10 patients with chronic neuropathic pain. All patients reported a significant component of LBP in combination with unilateral (n=5) or bilateral (n=5) leg pain. Electrodes were placed within 2 mm of midline, with placement confirmed radiographically. After lead implant, patients underwent a 6-11 day outpatient stimulation trial. Low back pain intensity and functional disability were assessed preoperatively and at 1 and 3 months post-implant by 100 mm visual analogue scale (VAS) and Oswestry LBP questionnaire. Complications were assessed throughout.

**Results:** The average age of patients was 49 ± 7 years (38-58) years. One patient reported inadequate pain relief during trial and was not implanted with a permanent generator. Low back pain VAS showed a nonsignificant decrease of 26%, from 64 ± 19 to 47 ± 30 (P=0.25; paired t-test) after one month of stimulation. Similarly, Oswestry disability was not improved (P=0.46; paired t-test). Surgical complications included: infection necessitating removal of the lead (1), delayed wound healing (1) and receiver pocket hematoma (1). Four patients (44%) required lead repositioning...
to provide maximal overlap of paresthesia with painful area. Four of nine patients experienced problematic positionally-dependent stimulation. Longer follow up showed that 3/9 (33%) of patients had their stimulators removed due to their ineffectiveness.

**Conclusion:** Chronic LBP is not particularly responsive to the transverse stimulation provided by the TTS system.

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**Long-Term Efficacy of Intrathecal Morphine in the Treatment of Nonmalignant Pain: A Retrospective Study**

Oren Sagher, Visbual C Gala, Susan Grube, Randy Roth, James A Taren

The use of intrathecal morphine in the treatment of chronic, nonmalignant pain has become an increasingly popular practice. However, considerable controversy remains over its use in this setting given the dearth of evidence concerning its long-term efficacy. We undertook a retrospective analysis of 67 patients implanted with intrathecal pumps for treatment of chronic, nonmalignant pain. Specifically, we examined intrathecal dose requirements, and therapy outcome as measured by: (1) failure of therapy, (2) functional capacity measures (SF-36), (3) patient self-reports of pain (VAS) and (4) patient satisfaction measures. Data concerning functional capacity and pain levels were obtained at the patient’s initial evaluation prior to implantation and then again during the follow-up period utilizing the same instruments. The mean follow-up period in the study was 26.8 months (range 0.3-60.7 months, n=67). Intrathecal morphine dose gradually and inexorably climbed throughout the duration of the study from an average of 1.2mg/day to 25mg/day. Failure of intrathecal morphine therapy—defined as pump explantation or switching to alternative narcotics or admixtures—occurred in 50% of patients during the study period. Standard measures of functional capacity (SF-36) and pain (VAS) showed slight but significant (SF-36, p<0.05; VAS, p<0.01) improvement over the study period, and most patients surveyed believed intrathecal therapy successfully treated their pain. This retrospective analysis suggests that intrathecal morphine therapy improves pain and functional ability in patients with chronic, nonmalignant pain. The use of morphine however, appears to be associated with significant dose escalation which may limit the usefulness of this modality.

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**Chromaffin Cell Allograft for Cancer Pain Management**

Yves Lazorthes, Jean Claude Bes, Brigitte Sallerin, Jean Tkacuk, Mathieu Tafani, Helene Duplan, Jean-Christophe Sol, Bernard Malavaud

Data reported from preliminary clinical trials of adrenal medullary transplants into the CSF for irreducible cancer pain are contradictory. The objective of this phase II study was to confirm the feasibility and to evaluate the analgesic effects of this approach. The prospective study concerned 20 allografts for 15 irreducible cancer pain patients, following the failure of oral opioids. All patients were treated daily with intrathecal morphine, (I-Th morph).

Effects were interpreted as a function of the following 3 parameters: pain intensity score (from 0 to 10); activity pattern and complementary narcotic intake.

**Results:**
- **excellent-5 cases,** (pain score; 0-1, complete interruption of I-Th morph); **good-2 cases,** (pain score <2, diminution of I-Th morph); **moderate-4 cases,** (pain score <3, stability of I-Th morph); **failure-3 cases,** (pain >3, increase of I-Th morph).

Clinical data were correlated to met-enkephalin levels in the CSF. Macroscopic examination at autopsy and immunocytochemical microscopy of transplanted tissue fragment, in two patients successfully treated over a period of 1-year, confirmed the presence of surviving chromaffin cells in the spinal subarachnoid space.

With appropriate modifications to optimize functional survival, this conservative approach can become an alternative means of controlling pain refractory to traditional pharmacotherapies. However controlled trials are required to demonstrate the validity of this innovative cell therapy. The availability of human donor tissue is a major obstacle, therefore alternative graft sources must be pursued. We will discuss the perspectives of xenogenic transplants and genetically-engineered cell lines.

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**Epidural Motor Cortex Stimulation for Chronic Pain: The Utility of Functional Brain Imaging**

Alon Mogilner, Alexander, Beric, Djordje Sterio, Rodolfo Llinas, Patrick J Kelly, Ali R Rezai

**Introduction:** Chronic epidural motor cortex stimulation has shown promise in the treatment of patients with refractory deafferentation pain. Precise placement of the electrode over the motor cortex region corresponding to the area of pain is essential for the success of this procedure. Whereas standard anatomical landmarks have been used in the past, the use of functional brain imaging can be beneficial in the precise planning of the procedure. We report the use of functional–imaging guided frameless stereotactic surgery for epidural motor cortex stimulation.

**Methods:** Three patients with chronic refractory facial pain underwent surgery. The day before surgery, the patients had an MRI with skin fiducial markers, followed by Magnetoencephalography (MEG) mapping of the sensory and motor face and hand areas. Functional MRI was also performed using a facial motor task paradigm. The functional imaging data was integrated into a frameless stereotactic system (CYGNUS, Compass International, Rochester MN) database using a 3-dimensional co-registration algorithm. Subsequently, patients underwent awake frameless stereotactic craniotomy using the integrated anatomic and functional imaging data for surgical planning. Intraoperative somatosensory evoked potentials (SSEPs) and direct stimulation were utilized for final placement of the electrode.

**Results:** Direct stimulation and SSEPs performed intraoperatively confirmed the accuracy of the functional imaging data. All patients reported significant pain relief at 3 month follow-up.

**Conclusion:** The interactive use of functional and anatomic imaging data allows for precise and efficient planning of epidural motor cortex stimulation procedures.

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Selected Abstracts cont on page 10
SF-36 Health Survey in Cervical and Lumbar Outcome Assessment

Fred Geisler, Lori Alderete, James Grutsch

**Introduction:** The SF-36 Health Survey was designed to evaluate the effectiveness of medical interventions from the patient point of view. The role of the SF-36 in lumbar and cervical radiculopathy outcome assessment was investigated in this study.

**Methods:** Baseline data was collected on 1,100 spine patients between September 1994 and March 1999. At the initial office visit before seeing the physician, patients were educated on the importance of tracking clinical data pertaining to their health and were given the SF-36 for completion. Currently, we are reporting a convenience sample of 343 patients who completed both a baseline and a follow-up survey. Average follow-up time was 354 days from baseline.

**Results:** Patients were categorized by their initial treatment intervention into four categories: lumbar fusion (n=84), lumbar non-fusion (n=64), cervical fusion (n=95), and patients treated conservatively (n=100). The decline between baseline and post-intervention bodily pain domain score was greater than 0.5 standard deviations. This difference was significant for improvement in lumbar fusions, lumbar non-fusions, cervical fusions (p=0.000001; 2-tailed paired t-test) and conservatively treated patients (p=0.00014; 2-tailed paired t-test). The patients experienced a clinical reduction in bodily pain. The cervical fusions and lumbar non-fusions achieved statistical significant (<0.05) improvement, but both scores improved by less than 0.5 standard deviations.

**Conclusion:** Based on our results the SF-36 Health Survey is useful in measuring patient improvement following surgical and nonsurgical intervention for radicular pain. It is particularly sensitive in demonstrating improvement in the bodily pain and physical function categories.

Peripheral Neurostimulation to Control Intractable Occipital Neuralgia

Richard Weiner, Kenneth Reed, Kenneth Alo, Michelle Fuller

**Aim:** To evaluate the effectiveness of a new subcutaneous peripheral nerve stimulation technique for the treatment of intractable occipital neuralgia.

**Methods:** Since 1992, a new surgical technique involving subcutaneous insertion of single or dual percutaneous peripheral nerve stimulator electrodes was developed for treatment of intractable occipital neuralgia by the senior author. The implanted electrodes at the level of C1 utilized a variety of quadripolar and octapolar lead arrays to produce pain blocking paresthesias in the region of the greater and/or lesser occipital nerves in 35 patients over a 6 year interval.

**Results:** Patient outcome rates to date: excellent-55%, (>75% pain relief); good-30%, (>50% pain relief); fair - 15%.

**Conclusions:** Subcutaneous application of peripheral nerve Stimulation techniques at the level of C1 appears to be reasonably effective in controlling otherwise intractable occipital neuralgia type headache and should be considered as a treatment alternative to more aggressive surgical interventions.

Facet Denervation in the Treatment of Chronic Spinal Pain of Facetory Origin

Vicente Vanaclachoa, Gloria Villares, Felix Panta, Nieves Saiz-Sapena

Facet denervation is an effective treatment to control cervical, thoracic or lumbar pain of facetory origin. The pain is generally due to osteoarthritic changes, but also to whiplash injuries or any kind of facet stress.

**Patients and Methods:** From April 1994 to December 1998, 216 patients underwent facet block testing for the lumbar area and 78 for the neck. Out of them 78% passed the test in the lumbar area and 87% in the neck. Four patients in the lumbar area felt relieve for months and refused any further treatment. The age of the patients ranged from 23 to 73 years, (n=63.2 years). Male/female ratio was 1.5/1. No complications were seen either in the procedure or in the follow-up.

**Results:** Pain relief lasting longer than 15 days was 92% (1 month), 76% (3 months), 67% (6 months), 56% (1 years) and 40% at two years for the lumbar area. The cervical area feared somewhat better, with 90% (1month), 86% (3 months), 78% (6 months),

**Conclusions:** Intrathecal infusion pump therapy may have a high rate of complication. The observed complications are diverse, sometimes difficult to diagnose, and potentially life threatening. Rapid changes in the availability of intrathecally administered medications from pump failure appears to cause a clinically severe syndrome of withdrawal related autonomic dysreflexia (baclofen) characterized by severe spasms, hypertension, confusion, fever, and pain. A fourth patient experienced withdrawal due to programming error. One patient presented with overdose secondary to a refilling concentration error.

Intrathecal infusion of baclofen and/or morphine can provide effective relief of otherwise intractable symptoms related to a wide range of pathology. However, complications related to these infusion pumps may be frequent and diverse. Records are available for fourteen patients who underwent operative procedures related to intrathecal infusion pumps over the last five years at Stanford University Hospital. Most patients have required frequent titration of infusion dosed as guided by their symptoms. Six patients developed a total of nine major complications requiring reoperation, intensive care management, or hospital admission. Major complications included: pump disconnection or failure, wound dehiscence, meningitis, programming or filling error leading to major drug overdose or withdrawal, infection and CSF leak. There were two infections requiring pump removal, two wound dehiscences, one meningitis, one CSF leak, two programming errors, and three lumbar catheter pullout/disconnects. Three cases with acute medication cessation due to catheter problems all presented with withdrawal related autonomic dysreflexia (baclofen) characterized by severe spasms, hypertension, confusion, fever, and pain. A fourth patient experienced withdrawal due to programming error. One patient presented with overdose secondary to a refilling concentration error.

**Conclusions:** Intrathecal infusion pump therapy may have a high rate of complication. The observed complications are diverse, sometimes difficult to diagnose, and potentially life threatening. Rapid changes in the availability of intrathecally administered medications from pump failure appears to cause a clinically severe syndrome of withdrawal related autonomic dysreflexia. A high level of vigilance should be maintained when treating patients with intrathecal infusion pumps.

Selected Abstracts cont on page 12

Selected Posters

**Annual 49th CNS Meeting, Boston 1999**

Complications of Intrathecal Infusion Pump Therapy

Carter Beck, Gary Heit, Lawrence M. Shuer

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Of Interest at the 2000 Annual AANS Meeting April 8-13, 2000 Moscone Center, San Francisco

PRACTICAL CLINICS

008 Saturday April 8, 8:00 AM - 5:00 PM
Neuroaugmentative Procedures for Pain Control
Director: Jaimie Henderson
Faculty: Joel Seres, George Mandybur, Oren Saghier, Richard Weiner, Michael Munz, Richard Penn, Richard Osenbach, Samuel Hassenbusch, Richard North, Robert Levy
CLINIC FEE $325, MATERIAL FEE $0, TOTAL $325
The indications and techniques of implantable stimulation and drug delivery systems will be taught through lectures and hands-on laboratory. Techniques to be discussed include spinal cord stimulation, drug pumps for intrathecal administration, deep brain stimulation and motor cortex stimulation. Participants are encouraged to bring challenging cases for discussion.

Learning Objectives: The participants should be able to use various techniques and rationale for the use of implantable stimulation and drug delivery systems, describe the patient selection process for neuroaugmentative pain control techniques and describe complications, complication management, and outcomes of neuroaugmentative procedures for pain control.

026 Sunday April 9, 8:00 AM - 12:00 PM
Trigeminal Neuralgia
Director: Jeffrey Brown
Faculty: Harry Van Loveren, Jeffrey Keller, Robert Nugent, Samuel Hassenbusch, Jung Lee
CLINIC FEE $325, MATERIAL FEE $325, TOTAL $650
This clinic will provide cadaver-based experience in operative and percutaneous surgical treatment of trigeminal neuralgia. Participants will have experience inserting a balloon catheter or electrode through the foramen ovale with fluoroscopic guidance. They will also be guided through the technique of microvascular decompression while performing their own dissections. Didactic sessions will focus on decision-making principles, complication avoidance and problem cases.

Learning Objectives: The participants should be able to use varied radiographic techniques to place a cannula through the foramen ovale, describe the anatomic principles of microvascular decompression of the trigeminal nerve and describe the common complications of percutaneous and microvascular decompression techniques for the treatment of trigeminal neuralgia.

027 Sunday April 9, 8:00 AM - 12:00 PM
Neuroablative Procedures for Pain Control
Director: Nicholas Barbaro
Faculty: TBD
This clinic will describe the spinal cord and brain ablative techniques currently used to treat painful conditions. Participants will be given hands-on instruction by neurosurgeons who routinely use these techniques in their practices.
CLINIC FEE $325, MATERIAL FEE $0, TOTAL $325
Learning Objectives: Attendees should be able to recognize the indications for ablative techniques in the surgical management of pain, integrate a variety of ablative neurosurgical techniques into their practices and evaluate the currently available instruments used in ablative neurosurgical techniques.

BREAKFAST SEMINARS

121 Monday April 10, 7:30 AM - 9:30 AM
Management of Pain in the Trigeminal Distribution
Moderator: Oren Saghier
Panelists: Jeffrey Brown, Robert Levy, Kim Burchiel, Ronald Brisman
This seminar will provide the participant with guidelines for accurate diagnosis and effective management of patients with facial pain syndromes.

Learning Objectives: The participants should be able to recognize diagnostic clues in order to arrive at an accurate diagnosis of facial pain, apply diagnostic criteria in the medical treatment of facial pain and define the role of surgery in the management of facial pain.

920 Tuesday April 11, 7:30 AM - 9:30 AM
Neurosurgical Management of Intractable Pain
Moderator: Blaine Nashold
Panelists: Samuel Hassenbusch, Nicholas Barbaro, Kim Burchiel
This seminar will discuss current evaluation and treatment of patients with intractable pain. Patient selection and indications for specific techniques and outcomes for both ablative and neuroaugmentative techniques will be emphasized.

Learning Objectives: Attendees should be able to access patients with chronic and intractable pain syndromes and apply appropriate evaluation and treatment protocols to their management.

PAIN POSTER VIEWING SESSION

Wednesday April 12, 2:00 PM - 2:45 PM
SPECIAL SESSION- Primary Care Physicians
Wednesday April 12, 1:30 PM - 3:30 PM
CHRONIC PAIN-Kim Burchiel
The session on chronic pain will first highlight the differences between acute pain, chronic pain, and cancer pain. We will discuss the optimal management of the complex chronic pain patient in the multidisciplinary pain center environment. The pharmacologic management of pain, including the use of antiinflammatory agents, antidepressants, anticonvulsants, and analgesics, will be covered. The appropriate use of opioids in chronic pain will be reviewed, as well as the use of patient “contracts,” and informed consent for chronic opioids. We will review appropriate patient selection for neurosurgical referral for chronic pain, as well as what type of preliminary information the neurosurgeon needs to complete his evaluation. The specific neurosurgical evaluation of the chronic pain patient, including detailed psychological testing, will be discussed. Patient selection for invasive pain-relieving procedures will be reviewed. The indications and criteria for patient selection for reversible, nondestructive neuromodulation procedures such as spinal cord stimulation, and intrathecal opioid administration will be covered in detail. Results and complications of these procedures will be discussed. Likewise, the indications for nonreversible, ablative procedures such as neurectomy, rhizotomy, cordotomy, DREZ lesions, tractotomy, thalamotomy and cingulotomy will be discussed. The results and complications for these procedures will also be covered.

continued on page 14
Radiosurgery causes partial axonal degeneration of the trigeminal nerve. At higher doses, partial nerve necrosis is found. We believe that these effects impact on the physiology of trigeminal neuralgia.

The Histologic Effects of Trigeminal Nerve Radiosurgery in the Primate Model: Implications for Trigeminal Neuralgia Radiosurgery

Douglas Kondziolka, David Lacomis, Ajay Niranjan, Yoshimasa Mori, Satoshi Maesawa, Wendy Fellows, L Dade Lunsford

Trigeminal nerve stereotactic radiosurgery can eliminate the pain of trigeminal neuralgia and preserve facial sensation, but the histologic and physiologic effects of the response are not understood. We used a subhuman primate model to characterize the imaging and histologic effects of trigeminal nerve radiosurgery.

Two adult baboons underwent stereotactic MRI-guided radiosurgery using the gamma knife. A non-irradiated baboon brain and nerves served as a control. A single 4mm isocenter was targeted to each proximal trigeminal nerve just anterior to the pons to deliver a maximum dose of 80 or 100 Gy (total = 4 nerves). Six months later, repeat MR imaging was obtained, the animals were killed, and the brains and nerves were studied using light and electron microscopy.

Imaging showed a 4mm diameter of contrast-enhancement at the target site in each nerve. All irradiated nerves showed axonal degeneration and mild edema at the target with remnants of some myelinated axons. Large and small myelinated, and unmyelinated fibers were affected. No inflammation was found. Necrosis was more pronounced after 100 Gy. The trigeminal ganglion appeared normal. Control nerves showed only factal splitting of the myelin sheath.

Conclusion: RF rhizotomy represents a minimally invasive and low-risk technique with a high rate of efficacy.

Outcomes Of Posterior Fossa Exploration for Trigeminal Neuralgia

Philip V Theodosopoulos, Elysa J Marco, Charles B Wilson

Introduction: Trigeminal neuralgia is a common neurosurgical condition. Several studies have attempted to assess the prognostic factors for a successful outcome with a clear consensus. We reviewed the UCSF experience with microvascular decompression and rhizotomy for trigeminal neuralgia.

Methods: A retrospective review of 564 consecutive patients with trigeminal neuralgia operated by CBW was performed. Patients with clear root entry zone vascular compression underwent MVD while the rest underwent rhizotomy. Logistic regression continued on page 13
was used to assess correlations between preoperative variables with long-term outcome and postoperative complications.

**Results:** The mean age was 61.3 years. Mean duration of symptoms was 7.95 years. Vascular compression was present in 70% of the cases. Mean follow-up was 37.5 months. Long-term improvement of trigeminal pain was present in 91.9% of all patients, with complete absence of pain in 76.3% in the MVD group and 69.7% in the rhizotomy group. Predictors of resolution of pain were older age (p=0.0003), V3 involvement (p=0.046), presence of vascular compression (p=0.0171) and immediate postoperative relief of pain (p=0.0002). Thirty seven percent of the patients developed postoperative numbness. There were no perioperative deaths. Postoperative infection and aseptic meningitis rate were 1.4% and 7.3% respectively.

**Conclusion:** The presence of vascular root entry zone compression and immediate postoperative pain relief as predictors for successful long-term outcome confirm previously published results. Yet, older age and V3 involvement are variables affecting outcome that have not been reported before. In the absence of vascular root entry zone compression, rhizotomy offers good long term pain relief with minimal side effects.

Gamma Knife Radiosurgery for Trigeminal Neuralgia: The Initial Experience at The Barrow Neurological Institute

Patrick Han, Andrew G Shetter C Leland Rogers, Jeffrey A Fiedler, Kris A Smith, Iman Feiz-Erfan, Paul W Detwiler, Randall W Porter, Burton L Speiser

**Introduction:** Multiple treatments are available for trigeminal neuralgia (TN). This report analyzes the first 43 TN patients treated with Gamma Knife (GK) radiation at our institution.

**Methods:** Outcome was evaluated by a standard questionnaire mailed to each patient. There were 25 females and 18 males (mean age, 66.1 years). Twenty-two had undergone prior invasive treatment for TN. Patients were treated in a uniform fashion: 35Gy at the 50% isodose via a single 4-mm collimator targeting the ipsilateral trigeminal root entry zone.

**Results:** Initial pain improvement occurred in 97.7% (42/43). Pain was scored as level I to IV (see Table 1). The mean time to onset of pain relief was 30.6 days; maximal relief occurred at 77.8 days. There was no correlation between degree of response and prior treatment. Complications have been limited to facial sensory loss (3/43, 7%), rated as bothersome in none. No patient has developed anesthesia dolorosa, corneal anesthesia, or keratitis. Mean follow-up time was 9 months.

**Conclusion:** Although longer follow-up will be required for a thorough appraisal, GK treatment for TN appears promising. It carries a low risk of facial hyposthesia, and, in our experience, has not been associated with other complications.

<table>
<thead>
<tr>
<th>TABLE-1 Pain Score Level</th>
<th>% patients</th>
</tr>
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<tbody>
<tr>
<td>I</td>
<td>34.9% (15/43)</td>
</tr>
<tr>
<td>II</td>
<td>7.0% (3/43)</td>
</tr>
<tr>
<td>III</td>
<td>14.9% (15/43)</td>
</tr>
<tr>
<td>IV</td>
<td>20.9% (9/43)</td>
</tr>
<tr>
<td>V</td>
<td>2.3% (1/43)</td>
</tr>
</tbody>
</table>

I: no pain, no medications; II: occasional pain, not requiring medications; III: some pain, inadequately controlled by medication; IV: pain, inadequately controlled by medication; V: no pain relief.
Learning Objectives: Attendees should be able to describe the role of the neurosurgeon in the evaluation and treatment of the chronic pain patient. They should be able to discuss the appropriate use of neuromodulation, and of ablative procedures to alleviate pain. Attendees should be able to decide when to refer a patient with chronic pain to a neurosurgeon, and what to expect from the ensuing course of neurosurgical treatment.

LOW BACK PAIN—Kim Burchiel
Low back pain is prevalent in the population, with 80% of people experiencing an episode of pain once in their life. It is a fairly common reason to access the medical care system. The disease is usually self-limited and can be managed with minimal utilization of tests and therapeutic interventions. Unfortunately the care of these patients is fragmented and services are over utilized because of the lack of good training on the care of these patients in our residency programs.

This session will cover the management of patients with low back pain. It will teach the primary care physician the appropriate care of these patients using the best evidence in the literature. A review of an efficient history and physical exam sufficient to exclude dangerous causes of low back pain will be done. Referral guidelines to a neurosurgeon will also be discussed. This will allow the primary care physician to take ownership of the low back pain patient and feel more comfortable in their management.

AANS/CNS Section on Pain Session
826 Wednesday April 12, 2:45 PM–5:30 PM
This session will serve as a forum for the presentation of topics on the neurosurgical management of pain.

Symposium 2:45 PM–4:00 PM
Minimally Invasive Procedures for Pain Management
William H Sweet Young Investigator Award 4:00 PM–4:15 PM
Functional Brain Imaging and Spinal Cord Stimulation: Localization of Cortical Activity Magnetoencephalography (meg)
Alon Y Mogilner, presented by Kenneth Follett
Scientific Session 4:15 PM–5:30 PM

Discussion and Conclusion: Healthcare places a strong emphasis upon cost modeling analysis. In order for physicians to succeed in modern medicine, they must become not only experts in their specialty field, but also become experts in providing the most economic health care.

Calendar of Events

23-28 September 2000
50th Congress of Neurological Surgeons Annual Meeting
Location: San Antonio, TX
WWW: http://www.aans.org/meetings/cns/

26-29 October 2000
3rd National Trigeminal Neuralgia Conference
Contact: TNA Conference Office, % Leong & Associates
4815 Rugby Avenue, Suite 203, Bethesda, MD, 20814-3033
Location: The Double Tree Hotel, Pittsburgh PA,
WWW: http://www.tna-support.org
Phone: 301-654-3967
e-mail: lawleong@juno.com

2-5 November 2000
19th Annual Scientific Meeting American Pain Society
Contact: American Pain Society
4700 W. Lake Avenue
Glenview, IL 60025-1485
Location: Hyatt Regency Atlanta, Atlanta, GA
Phone: 847-375-4715 Fax: 847-375-4777
E-mail: info@ampainsoc.org

April 2001
69th American Association of Neurological Surgeons Annual Meeting
Location: TBD

19-22 April 2001
20th Annual Scientific Meeting American Pain Society
Contact: American Pain Society
4700 W. Lake Avenue
Glenview, IL 60025-1485
Location: Phoenix, AZ
Phone: 847-375-4715 Fax: 847-375-4777
E-mail: info@ampainsoc.org

16-21 September 2001
XII World Congress of Neurological Surgery
Location: Convention & Exhibition Centre, Sydney, Australia
WWW: http://www.nsa.on.net/wfns.htm
e-mail: macc@senet.com.au

29 September-4 October 2001
51st Congress of Neurological Surgeons Annual Meeting
Location: San Diego, CA

17-22 August 2002
10th World Congress on Pain
Location: San Diego, CA
WWW: http://halcyon.com/isap
e-mail: isap@locke.hs.washington.edu

continued from page 11
continued from page 10
continued from page 13
I. Biographical

Name: ____________________________________________________________________________________________

Birth Place: _______________________________________ Birth Date:____________________________________

Citizenship _______________________________________

Home Address: ____________________________________ Office Address: ________________________________

Fax:  _________________ Phone: ____________________ Fax: __________________  Phone: ________________

II. Category of Membership Requested:

❑ Active  ❑ Associate  ❑ Corresponding

III. Education

Premedical collegiate education (institutions/dates) _______________________________________________________

Final degree (institutions/dates) _______________________________________________________________________

Medical education (institutions/dates) __________________________________________________________________

Final degree (institutions/dates) _______________________________________________________________________

Internship or equivalent (institutions/dates) ______________________________________________________________

Residency or other graduate training (institutions/dates) ____________________________________________________

Residency training institution _________________________________________________________________________

Completion (or expected completion) Date ______________________________________________________________

IV. Membership, Certification and Practice

Are you now 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 Name:____________________________________________________________
❑ State or provincial medical society Name:___________________________________________________________
❑ American Association of Neurological Surgeons
❑ Congress of Neurological Surgeons
❑ American Academy of Pain
❑ International Association for the Study of Pain
❑ American Pain Society

Medical Licensure State _______________________________ Dates ________________________________

Signature____________________________________________ Date _________________________________

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