



Western Neurosurgery REVIEW

A newsletter for referring doctors

Spring 2002

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In addition, learn more about our physicians and medical staff, about neurosurgery and spine surgery, as well as many of the more common symptoms and conditions that our physicians treat. ♦

Neurosurgical Spinal Cord Operations for the Treatment of Pain

By Jason E. Garber, M.D.

A broad spectrum of neurosurgical operations and procedures have been employed for the treatment and management of pain. The type of pain a patient is experiencing—cancerous or non-cancerous, acute or chronic—as well as the quality of the pain, determines which of the various methods are used. This article details the neurosurgical operations on the spinal cord for the management of pain.

The three major procedures discussed here include anterolateral cordotomy, myelotomy, and dorsal root entry zone (DREZ) lesions. These ablative spinal procedures serve as

intermediate options between intracranial brainstem ablations and peripheral nerve lesions. The risks incurred with spinal procedures are generally lower than those associated with intracranial procedures. However, they have a more limited pattern of anatomic coverage. Peripheral denervations are technically easier to perform, but often they affect only a very limited anatomic area and have a higher chance of pain recurrence. The actual selection of an operation for a specific patient should be based upon the type of pain (e.g., nociceptive, neuropathic, or visceral), the location of the pain, and the cause of the pain (e.g., cancer vs. non-cancer).

Welcome Jason E. Garber, M.D.

The physicians of Western Regional Center for Brain & Spine Surgery—Drs. Steven W. Agata, Benjamin H. Venger, William D. Smith, John A. Anson, and Derek A. Duke—are pleased to welcome our newest associate, Jason E. Garber, M.D.

Dr. Garber received his undergraduate degree at Duke University and his doctorate of medicine at the University of Texas Health Science Center at San Antonio. During his residency training at Baylor, Dr. Garber developed extensive clinical understanding and



Jason E. Garber, M.D.

surgical expertise in the treatment of degenerative and traumatic disorders of the spine. Dr. Garber also spent part of his neurosurgical training at the M.D. Anderson Cancer Center, one of the world's leading cancer hospitals. Dr. Garber trained there with one of the most

Anterolateral Cordotomy

Anterolateral cordotomy is the surgical procedure by which the spinal anterolateral ascending system for the transmission of pain (spinothalamic tract) is interrupted for the relief of pain. A percutaneous and an open technique are options: the anatomic goal for each technique is the same, and results differ only with respect to the risks of each strategy and to long-term results. In many ways, it represents another example of an old procedure that has recently found increased use because of the percutaneous technique,

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Candidates for Anterolateral Cordotomy

Optimal candidates for this procedure should have unilateral severe pain not adequately treated by less invasive methods. With regard to neuropathic pain, cordotomy appears to be more effective in the treatment of intermittent shooting pain and evoked pain (i.e., allodynia and hyperpathia) rather than distressing dysesthesias such as steady

Almost all cordotomies have been performed for pain from cancerous origin, often lung- or gastrointestinal- type cancers.

burning, prickling, aching, or crawling. Tabetic or pseudotabetic pain, although it has a dysesthetic quality, seems to respond to cordotomy as well.

Anatomically, the procedure is indicated for pain in C5 or lower dermatomes, preferably unilateral. It is almost entirely used for patients with pain from cancer, including those who previously could not be subjected to the major operation of laminectomy and spinothalamic section because of debilitation or a preterminal state. It is increasingly rare to use cordotomy to treat painful conditions that are intractable and non-malignant in nature, although some argument can be made for use in the treatment of nociceptive pain, albeit of non-cancer origin. When bilateral cordotomy is required, the contralateral procedure is performed as a second stage no less than one week after the first stage.

Anterolateral Cordotomy: Contraindications

The major contraindication to either percutaneous or open surgical cordotomy is severe pulmonary dysfunction. A previous pneumonectomy is not an absolute contraindication, provided

that remaining pulmonary function is satisfactory. The area of interest, the reticulospinal tract, is critical for automatic or unconscious breathing. Because of its close proximity to the spinothalamic tract, this is somewhat of a concern when performing a cordotomy. Prior loss or significant decrease in this automatic breathing on the opposite side (for example from prior contralateral cordotomy or Pancoast syndrome) can lead to a total loss of unconscious respiration (Ondine's curse).

Recently acquired neurologic deficits, such as paresis or rectal or bladder disturbance, can either be aggravated or recovery delayed by the superimposition of cordotomy. In this case, the effect is usually temporary. Midline pain is a relative contraindication even with bilateral cordotomy. General medical contraindications such as a severe bleeding diathesis, unstable cardiac function, and untreated severe systemic infection should also be taken into consideration prior to performing these procedures.

Percutaneous cordotomy is a valuable procedure for the treatment of severe pain syndromes, especially if located in one limb and nociceptive in quality. With the addition of CT-guidance, the technique has become more facile.

The benefits, in terms of almost immediate pain relief and limited need for outpatient follow-up, are both cost-effective and gratifying.

In the majority of series published in the literature, almost all cordotomies have been performed for pain from cancerous origin, often lung or gastrointestinal type cancers. Rarely, the procedure has been used in the treatment of lumbar radiculopathy or peripheral neuropathy.

Anterolateral Cordotomy: Outcomes

"Adequate" levels of pain relief are found in as high as 95% of patients upon discharge from the hospital. At last follow-up, however, the success rate can drop to 84%. It is estimated that more than 50% of these patients felt they had received major help, could return to routine activities, and did not have problems of drug usage or distress severe enough to undergo repeat cordotomy.

Repeat cordotomies may be necessary in 10-20% of patients and, despite the prior cordotomy, can usually achieve levels of analgesia to acute testing pain. It appears that true pain relief, however, is captured in only about half of these patients undergoing a repeat cordotomy.

The complication rate from a unilateral cordotomy is low. The mortality rate can vary between 0.6-6%, almost always related to respiratory problems. Bowel incontinence and mild worsening of micturition can be seen in up to 2-10% of patients—both should be transient. Significant permanent worsening of bladder function, however, can be seen in 2-10% of patients. Although information relative to sexual function is difficult to obtain, it appears that about 4% of males will note decreased sensation about the genitals on the analgesic side; true impotence appears to be very rare, even with bilateral cordotomies.

While a postoperative Horner's Syndrome is frequently seen (as often as 75% of patients), it is usually transient. Many patients will complain of transient neck pain, often described as burning or dysesthetic, from the area of the needle puncture. Transient hypotension can also be seen (2-8%).

Permanent weakness or ataxia, usually ipsilateral to the side of the cordotomy (2-10%) is a potential side

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effect. A mild or transient ipsilateral weakness/ataxia is reported in 3% to as many as 70% of patients. Contralateral limb weakness, presumably from lesioning too deep into the spinal cord, can also occur (1-6%).

Postcordotomy dysesthetic syndromes—burning distress throughout the entire area that was made analgesic—can occur in 1% to as many as 10% of patients. The mechanism of action is unknown. Dysesthesias, in 16%, are noted separately. These sensations (e.g., tingling, burning, prickling in the area of pathologic implication) are not complications *per se*. They are uncomfortable feelings that were usually present preoperatively but were not conspicuous because of overriding pain. Once the pain had been ablated by the cordotomy, the dysesthesias became discernible and prominent, although it usually takes time to develop.

Open Surgical Cordotomy

Open surgical cordotomy has become a procedure of largely historical interest. However, the open technique might still be employed in some rare circumstances, such as in facilities in which percutaneous cordotomy equipment is not available or when the surgeon performs it so infrequently as to lose skill in the procedure. The indications for the open technique are the same as the percutaneous counterpart.

After open cordotomy, immediate relief was reported in 70 to 90% of patients who had undergone unilateral procedures and in 40 to 78% of those with bilateral procedures. Mortality rates for open cordotomy ranged from 3% for the unilateral procedure to 20% for bilateral procedures. Paresis and urinary complications were high (10-20%), especially after bilateral procedures. Respiratory complications comprised the most common cause of death, but the exact numbers were not

listed. Postcordotomy dysesthetic syndromes can occur in 11% of patients. Open surgical cordotomy seems to be less effective and certainly has a higher risk of complication than the percutaneous techniques.

Present data strongly suggests that open myelotomy is an effective procedure albeit for a limited subset of cancer patients with intractable pain that is either bilateral or midline, especially located in the pelvis.

Percutaneous Cordotomy

Percutaneous cordotomy is simpler and better tolerated than the open surgical technique. Because the anatomic and physiologic bases for pain relief are the same for all cordotomies, true differences in long-term results might not be discernible. However, such advantages as the ease of performance, drastic reduction of risk, and the additional advantages of and repeatability literally ad infinitum, make percutaneous cordotomy the procedure of choice.

Percutaneous cordotomy is a valuable procedure for the treatment of severe pain syndromes, especially if located in one limb and nociceptive in quality. With the addition of CT-guidance, the technique has become more facile. The risks of the procedure are significant but acceptable for this group of patients, especially those with limited expected survival times from cancer. The benefits, in terms of almost immediate pain relief and limited need for outpatient follow-up, are both cost-effective and gratifying.

Myelotomy

The original aim of commissural myelotomy was to interrupt the decussating second-order spinothalamic fibers involved in pain perception on both sides of the body as they travel in the anterior commissure of the spinal

cord. The length of the myelotomy incision should have been proportional to the extent of pain. What was seen, however, even after extensive longitudinal splitting of the spinal cord over several centimeters, was that a girdle of analgesia was present in the expected area but that pain relief extended caudally into regions that had no demonstrable sensory changes.

The two basic strategies for midline myelotomy are the following: open, requiring a laminectomy, opening of the dura, and making a lesion under direct vision; and closed, making a lesion through a needle that has been passed through the skin, between adjacent laminae, and into the spinal cord.

Open Myelotomy

Open myelotomy is a major surgical procedure that should be considered with caution. Patients in poor condition who have a short life expectancy are not often suitable. On the other hand, even the most extensive myelotomies have not guaranteed long-lasting pain relief. A CT-guided technique has also been described in the creation of lesions in the same area.

Percutaneous Myelotomy

Percutaneous myelotomy is scarcely described in the literature; the procedure has probably been performed in about 150 patients although pain relief in large regions of the body has been reported in as many as 79% of patients with cancer. Coagulation of the high spinal central gray matter produces dramatic changes in sensation and pain relief over variable but widespread regions of the trunk and extremities.

In this technique, only a single lesion is made in the center of the spinal cord at a segment just above the highest level of the painful areas. A single lesion is made at the thoracolumbar junction of the spinal cord (so-called punctate mid-

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line myelotomy) for the most common use of this procedure—pelvic visceral pain from rectal or uterine cancer. Follow-up times and areas of sensory loss have been variable and the duration of pain relief is not clear.

Percutaneous Myelotomy: Outcomes

Despite the well-documented shortcomings, there are certainly some rewarding clinical results. These come in cancer patients with pain in the pelvis, perineum, and/or both lower extremities. Good pain relief without significant analgesia is also occasionally

In percutaneous myelotomy, coagulation of the high spinal central gray matter produces dramatic changes in sensation and pain relief over variable but widespread regions of the trunk and extremities.

seen. In combined series, total relief of pain or total cessation of analgesics was initially reported in 92% of 175 patients, most of whom had cancer pain. This rate, however, dropped to 59% at last follow-up or death in the cancer pain patients. There has been great variance in these results, however, between different series, possibly because of differences in technique, especially the depth of the sectioning.

Complications have been reported in 5 to 10% of the reported cases. Most surgeons agree that the typical open longitudinal midline myelotomy produces a temporary loss of pain and temperature sensation in a girdle area that corresponds to the region of the cord incision. How long this unexplained sensory loss persists is unclear. Postoperative mortality has been low (0-3%) in most recent series. Rarely, a

dysesthetic or radicular pain of mild severity might occur at the top end of the area of pain relief. Other side effects include hyperesthesia, diminished proprioception, paresis, or incoordination of gait, motor and sphincter disturbances.

Although myelotomy remains a useful procedure, caution should be exercised in regard to recommending myelotomy as the initial procedure for the relief of cancer pain. This procedure can be useful for the relief of bilateral pelvic and perineal pain because the other surgical alternative is bilateral cordotomy, which carries increased risk of bladder dysfunction. Epidural and intrathecal narcotics have unquestionably greatly reduced the numbers of patients who need ablative surgery for cancer pain. For the management of non-cancer pain, open myelotomy is difficult to accept. Present data strongly suggests that this is an effective procedure albeit for a limited subset of cancer patients with intractable pain that is either bilateral or midline, especially located in the pelvis.

Dorsal Root Entry Zone Lesions

The dorsal root entry zone (DREZ) operation entails making a series of lesions aimed at the substantia gelatinosa Rolandi and the surrounding fiber tracts. This operation involves the destruction of dorsal horn neurons and perhaps of the axons traveling in juxtaposition to the gray matter, particularly those segments that correspond to the patient's reported area of pain. It has been almost exclusively used for pain states characterized by an injury to the nervous system and thought to have a peripheral-central pain mechanism.

Few, if any, traditional surgical procedures have a significant chance of alleviating the pain that follows deafferentation. Certainly, rhizotomy, cordotomy, myelotomy, or sympathectomy is unlikely to produce long-term pain relief. DREZ lesions appear to be

remarkably effective in brachial plexus avulsion and are reasonably effective for the relief of postparaplegic pain, postamputation pain, posttherapeutic neuralgia, and for a small number of miscellaneous neuropathies and myelopathies.

Brachial plexus avulsion, other brachial plexus destructive lesions, sacral root avulsion, and postparaplegic pain are diagnoses that have been considered as most appropriate for treatment by DREZ lesions. The procedure has also been used, although with a lower success rate, in the treatment of: phantom limb pain; stump pain; post-thoracotomy pain; posttherapeutic neuralgia; peripheral mononeuropathy; spinal cord tumor; multiple sclerosis; causalgia; and postrhizotomy pain. Specific predictive factors to indicate a favorable outcome are being developed.

The indications for consideration of DREZ lesions as a mechanism for the treatment of chronic pain include an established diagnosis and failure of medical-pharmacologic management. In addition, it is important the patient has an understanding of alternative strategies, risks, and potential benefits. As previously mentioned, the diagnoses listed above are those that have thus far

The dorsal root entry zone (DREZ) operation has been almost exclusively used for pain states characterized by an injury to the nervous system and thought to have a peripheral-central pain mechanism.

been considered to be appropriate for DREZ lesions. The number of patients treated, however, is currently limited in some of these diagnostic groups.

Contraindications relate to the patient's general health and ability to withstand a major surgical procedure, including such factors as infection,

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resistance to wound healing, blood and coagulation problems, and poor cardiopulmonary status. Patients who have a significant emotional component to their pain are rarely good surgical candidates, although the ravages of chronic pain can alter patients' judgment and emotions.

DREZ lesions are performed under general anesthesia and require a laminectomy over each segment to be lesioned. For brachial plexus avulsion involving C5 to T1 dorsal roots, it is necessary to do a C4 through T1 laminectomy. The postoperative course is usually benign; many patients have transient dorsal column or pyramidal tract dysfunction, but few have permanent deficits. It is presently unclear which method of destroying the dorsal horn is safest and most effective.

Pain Situations Responsive to DREZ

The most common and most successful application of DREZ lesions is for the relief of the pain of brachial

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plexus avulsion. This traumatic disaster is most common in young men who ride motorcycles. An overall 83% success rate has been reported with many follow-ups of longer than 5 years. A few patients with sacral root avulsions have been included in these series. No other diagnosis has as high a likelihood of success, and no other operation is as likely to relieve this type of deafferentation pain.

Postparaplegic and postquadriplegic

pain are relieved by DREZ lesions. The long-term success rate is 54%, but the duration of follow-up has been variable. Some of the reported patients had drainage of post-traumatic syringomyelia at the same time; it is unclear if DREZ lesions alone are responsible for their pain relief.

Another type of central pain that has responded to DREZ lesions is postamputation pain. Within in this category are two different types of pain syndromes: stump pain and phantom limb pain. The overall results for post-amputation pain are 39% success in a group of 28 patients. DREZ lesion is not highly recommended for stump pain.

Positive Indications for DREZ and Chronic Pain

As more reports continue to be published regarding DREZ lesions, clear indications become more apparent for DREZ lesions in the management of chronic pain. The DREZ lesion is the only operation that was specifically designed to treat central and deafferentation pain. It is widely recognized that all standard ablative neurosurgical procedures are much more effective against pain associated with nociception (especially cancer pain) than they are against peripheral-central pain states. It remains unclear whether DREZ lesions are useful in patients with cancer pain; dorsal rhizotomy seems to be a less formidable operation for denervation of the painful area. The results of rhizotomy are variable, however, and it remains unclear whether the addition of ganglionectomy can improve them. Perhaps DREZ lesions will be effective in this type of pain.

DREZ lesions can achieve variable results because of differences in lesion placement. It is not known how many segments above or below the level of injury the lesions should be made. Patients who have failed to obtain good pain relief might continue to suffer because the lesions did not extend far

enough rostrally or caudally, yet the failure to relieve pain is ascribed to

The actual selection of an operation for a specific patient should be based upon the type of pain (e.g., nociceptive, neuropathic, or visceral), the location of the pain, and the cause of the pain (e.g., cancer vs. non-cancer).

a deficiency of the operation itself. The poor results that sometimes follow DREZ lesions could be caused by failure of the surgeon to destroy the necessary amount of tissue, or these results could be a result of inherent shortcomings in the operation as a concept.

Conclusion

Intraspinal ablative procedures are not necessarily first line treatments for pain. They remain in a second tier of a long treatment continuum that includes:

- (a) **systemic treatments, such as various medications or physical therapy**
- (b) **direct operations, such as spinal stabilization or surgical decompression**
- (c) **thorough psychological evaluation and treatment as appropriate**
- (d) **chemotherapy and/or radiotherapy (for cancer patients)**

Decisions regarding the optimal treatment of patients with painful neurological conditions will be made as a collaborative effort between the neurosurgeon, the patient, and other specialists.

The Western Regional Center for Brain and Spine Surgery is dedicated to the comprehensive neurosurgical treatment and care of patients in Nevada, as well as in the surrounding areas. If you or any of your patients have any questions regarding the neurosurgical management of pain conditions, please do not hesitate to contact us at (702) 737-1948 or (800) 334-0878. Further information may also be obtained on our web site as well at www.BrainAndSpineOnline.com. □



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Western Neurosurgery Review is published by Western Regional Center for Brain & Spine Surgery for the practice's referring doctors and their staffs.

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Welcome to Jason E. Garber, M.D. (continued from page 1)

recognized authorities for the surgical treatment of primary and metastatic malignancies of the spine.

Upon completing his general neurosurgical training at Baylor College of Medicine in Houston, Texas, Dr. Garber was awarded the Cloward Fellowship by the American Association of Neurological Surgeons. This award provided him the opportunity to facilitate a career in both the research and clinical aspects of neurosurgery.

Dr. Garber then completed a one-year fellowship in complex spine reconstruction surgery at the Medical College of Wisconsin. This provided greater exposure to both the judgment and technical aspects of adult and pediatric spinal and reconstructive procedures. Through this

additional training, Dr. Garber has developed a special interest in the evaluation and treatment of reconstructive spine surgery patients.

As a neurosurgeon, Dr. Garber treats the full spectrum of both intracranial and spinal disorders. These include brain tumors (primary and metastatic, adult and pediatric),

During his training and fellowship studies, Dr. Garber developed extensive clinical understanding and surgical expertise in the treatment of degenerative and traumatic disorders of the spine.

congenital skull and intracranial diseases and maladies, pituitary tumors, aneurysms and vascular malforma-

tion, brachial plexus problems and injuries, chronic pain conditions, and peripheral nerve disorders. Dr. Garber, in addition to his pediatric spine training, also trained at the Texas Children's Hospital in Houston, where he developed an interest in pediatric brain surgery. He welcomes all infant, child, and adolescence patients to his practice. Dr. Garber has also published both general and text chapters on spinal surgery and pain management.

Dr. Garber grew up in Houston. His hobbies include traveling, archaeology, photography, and salt-water aquariums.

We are very excited that Dr. Garber has chosen to join the Western Regional Center for Brain & Spine Surgery. He will begin seeing patients at the beginning of July. □