PERCUTANEOUS TREATMENT OF DISCOGENIC BACK PAIN WITH A PLASMA WAND

Caitlin Clark, B.A. and W. Craig Clark, M.D., Ph.D., FAANS, FACS, FICS

INTRODUCTION

In the United States, low back pain remains the fifth most common reason that patients seek medical care, and accounts for $30-50 billion in health care dollars spent annually. In the Emergency Department setting, two million people presented with low back pain from 2004 to 2008, which accounted for 3% of all visits. In addition, the prevalence of low back pain among Americans is between 20 and 30%, with those in the 45 to 60 year age range at greatest risk.[12]There are a large number of patients in the average neurosurgical practice who present with low back pain caused by painful disc bulges and protrusions, or discogenic back pain. This pain is contrasted to that of radiculopathy, which generally features leg pain and weakness in a dermatomal distribution.[13,15] Discogenic pain is pure back pain elicited with activities that increase intradiscal pressure, such as coughing, sitting, or flexion.

Treatment options for back pain include NSAIDs, muscle relaxants, facet blocks, epidural steroid injections (ESIs), and more invasive procedures including surgery and fusion. Though these treatments work for some, they are not always efficacious. For example,according to a recent systematic review of indications for ESIs[1],epidural steroid injections are usually better for radiculitis as opposed to discogenic back pain. In addition, discogenic back pain is often considered not sufficiently severe to warrant surgery, limiting the options for further therapy.

It is after medical therapy begins that the problem appears: what do we do when these patients fail to respond to routine conservative care? Surgery is an obvious option, but is more expensive and invasive, with attendant risks and potential complications, some brief hospitalization and days lost at work. The option investigated, Plasma Disc Decompression (PDD), avoids some of the major pitfalls encountered with surgery, is minimally invasive, and allows an additional treatment option in these patients.

BACKGROUND ON PLASMA AND COBLATION® TECHNOLOGY

Plasma is one of the four fundamental states of matter, and was first described by Crookes in 1879.The term “plasma” was first coined in 1929 by Irving Langmuir, an English physicist, when a glowing ionized gas was produced by electrical discharge in a tube, while the gas itself remained electrically neutral as a whole.Plasma is produced by raising the temperature of a gas until its molecules or atoms ionize, creating charged particles with an overall electrically neutral charge. Despite its neutral state, it is very electrically conductive, however, and responds strongly to electromagnetic fields.[2]It should be noted that the difference in temperature between the states of matter is marked, with the liquid state requiring temperatures between 0 and 100°C, while plasma requires temperatures greater than 100,000°C to form. Also, as the temperature increases and plasma is formed, the ions and electrons can move independently within a larger space.[2]The trademark Coblation® technology used for PDD, designed and patented by ArthoCare Corp., uses low-temperature radiofrequency energy (plasma) to ablate the defined volume of tissue by dissolution rather than the heat utilized by electrocautery and laser, which minimizes damage to surrounding healthy tissues. Unlike most electrocautery, laser, and electrosurgery devices, which operate using a power-regulated generator, Coblation® uses a voltage-regulated generator to provide protection against damage from thermal effects of

resistance (requiring increases in voltage) over time. As a result, the Coblation® technology functions at cooler temperatures than the power-regulated devices, producing tissue temperatures of 40-70°C, while the other devices produce tissue temperatures of 400-600°C. Coblation® is also more precise, allowing for the surgeon to only ablate tissue from a certain area, with minimal to no effects on surrounding healthy tissue, as it does not burn the tissue, but dissolves it.[6]

When the plasma wand tip begins to glow, it indicates that excited sodium ions from the conductive saline solution are present, and that plasma is being generated. The plasma does not generate much heat, as explained above, and does not burn the tissue. The tissue can sometimes turn brown, however, due to oxidation. Minimal adjacent cell necrosis occurs, with contiguous normal tissue damage only about 100-200 micronsin thickness.

Figures 1 and 2.ArthroCareCoblation Wand. Reprinted with permission by ArthrocareCorporation, 2008.[6]

PATIENTS AND METHODS

The first step to begin treatment involves a positive provocative discogram. The technique of provocative discography is well-established, and described elsewhere.[11] If the patient can localize their pain to 2 or fewer disc levels, the plasma wand is inserted through the discography needle and the decompression procedure begins. As the wand is inserted, the device is energized, and tissue ablation is performed for six seconds.The wand is then retracted over 12 seconds, coagulating the tissue and closing the created channel. The number of passes is variable, depending upon the amount of disc material that needs to be removed. The wand is removed, and prophylactic antibiotics are administered directly into the disc space. The patient is observed for one hour while lying in a semi-recumbent position, and is then discharged home.

Our study was a retrospective cohort study that involved 98 patients consecutively treated with PDD from 2007 to 2009. In order to participate in the study, the patients had to have undergone clinical examination, lumbar magnetic resonance imaging (MRI) showing no disc herniation or significant neural compression, and the requisite positive provocative discography. Only those patients with positive discography limited to two or fewer levels were treated. This treatment is contraindicated in pregnancy, patients with systemic infections, skin infection over the needle site, patients on anticoagulation therapy, and those who fail to localize their pain or have medical co-morbidities preventing the procedure. The patients were 57% female and 43% male, with median ages of 48.4 for women and 53.3 for men. Mean duration of follow-up was 15.2 months. All

patients were being concurrently treated in a pain clinic environment, and had failed oral medication and injection therapy for their low back pain.

The Visual Analog Scale (VAS) and Oswestry Disability Index (ODI) were used to measure improvement pre- and post-treatment. The VAS was utilized as a subjective pain scale measurement using a scale from 1-10, with 1 being no pain, and 10 indicating extreme pain. The ODI is an outcome measure used most often for spine that was developed in 1980. It uses 6 statements in ten categories (scored 0-5) to calculate a percentage score of functional disability.[14]The student's T-test was used to evaluate the difference in the pre- and post-treatment means of the VAS and the ODI.

RESULTS

The Oswestry Disability Index (ODI) showed that the mean value of the index improved from 71 prior to treatment to 54 after treatment ($p<0.008$). The Visual Analog Scale measurements showed a decrease from 8.4 prior to treatment to 5.5 after treatment ($p<0.0001$). Seventy percent of patients improved following treatment with PDD.Patients with a single discography level did appear to fare better than those with more than one level ($p<.05$). However, no clear causal relationship exists between the duration of pain and the effectiveness of treatment.

Figures 3 and 4. The Oswestry Disability Index (ODI) showed that the mean value of the index improved from 71 before treatment to 54 after treatment ($p<0.008$). The Visual Analog Scale (VAS) measurements showed a decrease from 8.4 prior to treatment to 5.5 after treatment ($p<0.0001$).

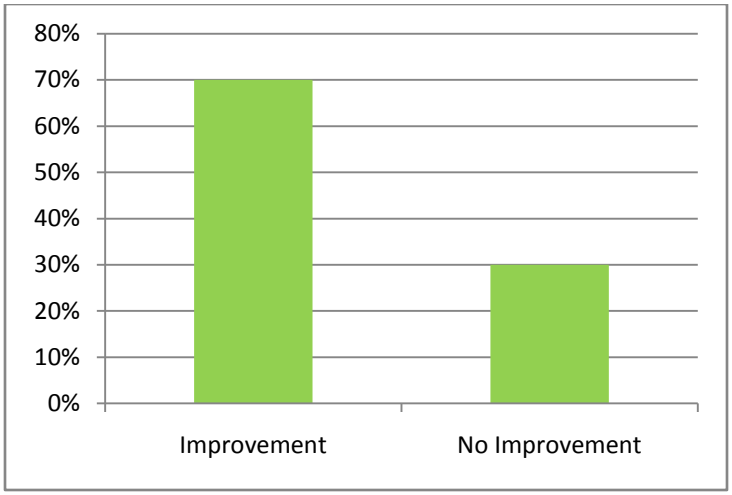

Figure 5. This graph reports that 70% of patients showed improvement. However, no clear relationship exists between duration of pain and effectiveness of treatment.

DISCUSSION

Patients with discogenic back pain constitute one of the more significant challenges for the spine clinician. Plasma Disc Decompression (PDD) is a minimally invasive, low-morbidity alternative that may offer promise as an option for further therapy in these patients. Ever since the original work by Mixter and Barr,[8] later confirmed by Semmes,[9] Spurling[10] and others, it has been widely accepted that the pain associated with herniated intervertebral discs is associated with mechanical compression of the neural elements. Disc decompression is based on the principle that excising a small amount of disc material can have significant effects on intradiscal pressure,[3,5] thereby reducing or eliminating pain. While this is widely accepted for cases involving nerve root compression, it is less clear in situations involving isolated refractory discogenic pain. Gerszten, et al., noted the benefits of PDD in the treatment of contained disc herniations when compared to continuing conventional treatment with transforaminalepidural steroid injections. They found that PDD was superior to the steroid injections in terms of both extent and duration of pain relief.[7]The current study tends to support those conclusions, and would expand the treatment indication to those patients with isolated discogenic back pain without radiculopathy. Patients in the current study were followed for a mean duration of just over 15 months, and no patients progressed to open surgical intervention during that time. This is a minimally invasive technique, and externally involves no more than a needle puncture site. The tissue effects of the Coblation® technology are well described,[4] and do not extend beyond the wand dimensions. Thus, there is no significant epidural fibrosis or scarring, and no adverse effects or increased risks should open surgery become necessary.

CONCLUSIONS

This study evaluates the efficacy of treating discogenic low back pain with a plasma energy source. The ability to treat chronic discogenic low back pain in a minimally invasive manner is intellectually very appealing, as these patients are very difficult to manage, with very few options for care. The small sample size of 98 prevents any generalizations in this regard, but it is felt that the technology does show promise. Patients with a single discography level did appear to fare better than those with more than one level. No clear relationship existed between the duration of the pain symptoms and the effectiveness of the treatment. Further experience with prospective trials, preferably randomized controlled trials in a multi-center setting, will be required to provide definitive data regarding this indication and treatment modality.

SOURCES:

1. Benyamin RM, Manchikanti L, et al. The effectiveness of lumbar interlaminar epidural injections in managing chronic low back and lower extremity pain.Pain Physician. 2012 Jul-Aug; 15(4):E363-404.
2. Bittencourt JA. Fundamentals of Plasma Physics. New York: Springer-Verlag, 2004.

3. Chen YC, Lee SH, Chen D. Intradiscal pressure study of percutaneous disc decompression with nucleoplasty in human cadavers. Spine J. 2003; 28:661-665.

4. Chen YC, Lee SH, Saenz Y, Lehman NL. Histologic findings of disc, end plate, and neural elements after coblation of nucleus pulposus: an experimental nucleoplasty study. Spine J. 2003; 3(6): 466-470.

5. Choy DS, Altman P. Fall of Intradiscal pressure with laser ablation. J Clin Laser Med Surg. 1995; 13:149-151.

6. Coblation Technology. ArthroCare Corporation, Sunnyvale, CA. 2008.

7. Gerszten PC, Smuck M, Rathmell JP, et al. Plasma disc decompression compared with fluoroscopy-guided transforaminal epidural steroid injections for symptomatic contained lumbar disc herniation: a prospective, randomized, controlled trial. J Neurosurg Spine. 2010; 12:357-371.

8. Mixter W, Barr J. Rupture of the intervertebral disc with involvement of the spinal canal. NEJM.1934; 211:210-215.

9. Semmes, RE. Diagnosis of ruptured intervertebral disc without contrast myelography and comment upon recent experience with modified hemilaminectomy for their removal. Yale J Biol Med.1939 May; 11(5): 433-435.

10. Spurling, RG. Lesions of the lumbar intervertebral disc: with special reference to rupture of the annulus fibrosis with herniation of the nucleus pulposus.Springfield: Charles C. Thomas; 1953.

11. Tomecek FJ, Anthony CS, Boxell C, Warren J. Discography interpretation and techniques in the lumbar spine. Neurosurgical Focus.2002; 13(2).

12. Waterman BR, Belmont PJ, Schoenfeld AJ. Low back pain in the United States: incidence and risk factors for presentation in the emergency setting.Spine J. 2012; 12:63-70.

13. Weisberg, LA, C Garcia, and R Strub. Essentials of Clinical Neurology. 3rd Ed. St. Louis: Mosby; 1996. 41 p.

14. Winn, HR. Youmans Neurological Surgery. 5th Ed. Vol. 1, Infection, Pain, Neurophysiological and Ablative Procedures, Rehabilitation. Philadelphia: Saunders-Elsevier; 2004. 243 p.

15. Young, RR, and RM Woolsey. Diagnosis and Management of Disorders of the Spinal Cord. Philadelphia: W.B. Saunders Company; 1995. 359 p.