

REVIEW ARTICLE

INTERVENTIONAL TECHNIQUES FOR TREATMENT OF DISCOGENIC PAIN

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HOW TO CITE THIS ARTICLE:

Megha Jain, Roopesh Jain. "Interventional techniques for treatment of discogenic pain". Journal of Evolution of Medical and Dental Sciences 2013; Vol2, Issue 34, August 26; Page: 6542-6548.

ABSTRACT: This review article describes the various image guided interventional techniques used for treating chronic backache attributed to disc related pathologies. With the aim of minimum invasion and maximum relief, these procedures comprise predominantly of annuloplasty and disc decompression via different mechanisms. Newer therapies, although in experimental stage, have also been discussed briefly- their objective being restoring disc height and its biomechanical function by substitution of biochemical constituents, regeneration of cartilaginous end plate and lastly artificial disc implantation.

KEY WORDS: Backache; discogenic pain; interventional technique; disc decompression

INTRODUCTION: Backache is major health problem affecting all age groups with intervertebral disc disease forming one of the major causes. The term 'discogenic pain' was attributed to back pain resulting from disc related pathologies.

Conservative management like oral analgesics, traction, spinal stabilization and exercises are effective only to some extent and take long duration to give long lasting results. Major surgical intervention in form of total disc excision and arthrodesis had its own pitfalls as any major surgical procedure.

However with advancement of technology, minimally invasive Image guided interventional techniques were introduced which included intradiscal steroids, chemonucleolysis, disc decompression, annuloplasty and various procedures using intradiscal laser device application.

TREATMENT MODALITIES: Two of these minimally invasive percutaneous procedures which gained popularity, involved coagulation of the posterior annulus via flexible electrode and decompression of the painful disc. Such percutaneous procedures have been classified as below:

ANNULOPLASTY:

- A. Intradiscal electrothermal therapy (IDET)
- B. Radiofrequency posterior annuloplasty (RFA)
- C. Biacuplasty

PERCUTANEOUS DISC DECOMPRESSION

- A. Laser discectomy
- B. Radiofrequency Coblation (plasma discectomy)
- C. Mechanical disc decompression
- D. Manual percutaneous lumbar discectomy

ENDOSCOPIC PERCUTANEOUS DISCECTOMY

PROCEDURES: All procedures were primarily carried out under fluoroscopic guidance with a preliminary discography and pain provocation test to evaluate the affected disc.

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Brief outline of these procedures with their mechanism of action and effectivity are discussed below:

CHEMONUCLEOLYSIS: With derivation of chymopapain enzyme from papaya fruit in 1940, experiments to use it for scientific benefit were conducted in 1963, Smith et al¹ used its dehydrating effect in treatment of discogenic pain –Injecting the drug into the nucleus pulposus of the painful bulging disc caused the disc to lose its turgidity and shrink as a result of depolymerization of the proteoglycan and glycoprotein molecules in the nucleus pulposus—this ‘shrinking effect’ causes the disc to reduce in its height and girth, relieving pressure on the traversing neural component -the source of pain. However anaphylaxis was found to be a major severe complication reported in at least 1 % cases.

Indications were patients with radiculopathy and where conservative management failed to relieve pain after disc herniation was confirmed by MRI, CT or Myelogram.

Various studies (Kim et al²) proved that patient with moderate to severe positive SLR and younger patients showed higher success rate (94.6 % in teens, 82.3% in patient in their thirties, and 70% in patient of >=50 yrs age) .Those with positive pain provocation test had 91.7 % success rate compared to 73.1 % in those with negative test.

Another alternative used was ‘medical Ozone’ (O₂ and O₃ mixture) by C. Verga in 1983 – relapse occurred in < 2 % cases after fifteen years of treatment. However data is insufficient to conclude on its effectivity.

ANNULOPLASTY:

IDET – In the year 2000 Saal and Saal³ developed this technique for patients of chronic discogenic low back pain. In view of the fact that the disc and especially the annulus has nociceptive nerve receptors which increase on trauma and degeneration, purpose of this technique was to thicken and modify the collagen fibres so as to contract and decrease its vascularity, with resultant reduction in annular fissure and increase in stability of disc itself. IDET also thermo coagulates the nociceptive receptors in the annular wall thus destroying the ability to transmit pain signal itself.

A 17 G needle is inserted percutaneously via posterolateral approach under fluoroscopic guidance and a 30 cm catheter with a flexible 5-6 cm heating tip is threaded circumferentially into the disc to reach the pathologic area of annulus –position is once again confirmed by fluoroscopy and the catheter tip heated to 90 degree C over 13 minute period –temperature is maintained for 4 minutes. The catheter and needle are removed and patient observed for few hours and discharged the same day.

Few of the indications that have been cited are chronic low back pain, failed conservative therapy, absence of neurologic deficit, negative SLR, and positive pain provocation test. Criteria for exclusion are nonspecific inflammatory arthritis and lumbar pain that is not related to spinal disorder.

Complications although not so frequent include breakage of the catheter, cauda equine syndrome, epidural abscess / infection, and rarely damage to the spinal cord. Evidence shows that IDET as a treatment is moderate in managing chronic discogenic low back pain.

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RFA - 'Radio frequency annuloplasty'- this is a minimally invasive technique wherein RF thermal energy is delivered to the disc to treat lower back pain. The RF catheter electrode system uses heat to coagulate and decompress disc material, providing effective pain relief. Ideal candidates are those with long standing low back pain as a result of an internally disrupted disc. The evidence for RFA was limited for short-term improvement, and indeterminate for long-term improvement in the management of chronic discogenic low back pain

Under Fluoroscopic guidance, a cannula is inserted into the intervertebral disc. The catheter electrode is then introduced through the cannula into the outer disc tissue. RF current flows through the electrode, heating the tissue located adjacent to the active tip of the electrode to a specific temperature specified for therapy. The physician observes temperature changes in surrounding tissue continuously throughout the procedure with the help of an external temperature monitor. Complications observed are similar to IDET

BIACUPLASTY - A relatively newer technique for annuloplasty, it incorporates a bipolar system wherein , under fluoroscopic guidance, two cooled RF electrodes are placed via 17-gauge trans discal introducers in the posterior annulus using posterolateral, oblique approach (Kapural and Mekhail⁴). These RF probes are so positioned as to create a bipolar configuration. A gradual increase in temperature of the electrodes to 55°C over 11 minutes is done. After completion of the procedure, the patient is kept under observation for 45 minutes and then discharged.

DISC DECOMPRESSION:

LASER DISCECTOMY--Ascher, Choy et al⁵ published their experiences with the use of a neodymium: yttrium-aluminum-garnet (Nd: YAG) laser on the lumbar spine for nucleolysis. There are several types of lasers in use for the lumbar spine--most common being the holmium: yttrium aluminum-garnet (Ho: YAG) laser—it is most commonly paired with the endoscope for disc ablation and removal capabilities. As the affected tissues absorb the laser, light is converted to heat. At 100°C, tissue vaporizes and ablation takes place. As a small amount of nucleus pulposus is vaporized, intradiscal pressure decreases, allowing the disc to return to its normal state. Depending on the type, the laser is either fired as a pulse or continuously. The Ho: YAG laser is pulse-fired. Newer laser models offer side-firing capabilities. This advancement helps to provide more control of laser placement, better observation, and can help reduce the risk of injury to several areas, especially those anterior to the spinal column.

Laser discectomy is commonly indicated for a patient with confirmed disk herniation and those suffering from radiculopathy. A ruptured annulus and lateral recess stenosis are less common indications. In 2002, Tsou and Yeung⁶ reported the 9-year retrospective results of their percutaneous transforaminal approach, with an 88.1% result. Other studies report success rates from 78% to 85% in retrospective studies. The evidence is moderate for short-term and limited for long-term relief.

Negative aspects of the laser include a steep learning curve for the physician. The use of lasers coupled with an endoscopic approach significantly increases the difficulty level for the surgeon.

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RF COBLATION (Plasma Discectomy): The first nucleoplasty was performed in 2000. Radiofrequency Coblotion combines disc removal and thermal coagulation to decompress a contained herniated disc. With the patient lying prone, a 17 G obturator stylet is guided fluoroscopically via posterolateral approach - the nucleus pulposus is first ablated with RF waves causing a molecular dissociation process converting tissue into gas, which is removed through the needle. As the stylet is withdrawn, coagulation takes place thermally treating the channel, which leads to a denaturing of nerve fibers adjacent to the channel within the nucleus pulposus. This process is repeated up to six times within an individual disc. The patient is then sent to recovery and later sent home the same day.

Indications for this procedure include low back pain with or without radiculopathy, contained herniated disc, and failed conservative therapy. Contraindications include those with spinal stenosis, severe disc degeneration with loss of disc height of 50% and spinal fracture or tumor.

MECHANICAL DISC DECOMPRESSION: Another technique of percutaneous discectomy under fluoroscopic guidance which uses a 'Decompressor', was introduced in 2002. It comprises of a disposable, self-contained, battery operated hand piece connected to a helical probe. When activated, the probe rotates creating suction to pull the milled nucleus pulposus from the disc up the cannula to a suction chamber at the base of the handheld unit. This efficient removal of disc material decreases surgical procedure time to approximately 30 minutes; with the actual time of use for the probe not exceeding 10 minutes. The procedure is performed under fluoroscopic guidance. Percutaneous discectomy generally has a reported success rate of 60% to 87%.

MANUAL PERCUTANEOUS DISCECTOMY: Percutaneous lumbar discectomies have been performed for more than 30 years. Hijikata et al.⁷ first reported performing a percutaneous nucleotomy in 1975. This procedure included the use of 3 to 5 mm cannulas and curettes with time-consuming manual removal of the nucleus pulposus using a pituitary forceps. The theory was that the reduction of Intradiscal pressure would reduce irritation of the nerve root and the nociceptive nerve receptors in the annulus. The procedure remained limited in use until 1985, when Onik et al.⁸ developed a new and smaller type of aspiration probe, which reduced risk of injury to the peripheral nerves and the annulus, facilitated easier removal of the nucleus pulposus with an all-in-one suction cutting device, and also decreased the time of surgery.

ENDOSCOPIC PROCEDURES:

PERCUTANEOUS ENDOSCOPIC DISCECTOMY: In 1931, Burman was the first reported author who introduced the concept of direct visualization of the spinal cord followed by Mixter and Barr who, a few years later, performed an open laminectomy with discectomy for the treatment of a disc herniation into the spinal canal. Later on, Pool⁹ introduced the concept of intra thecal endoscopy. Due to surgical complications of intraspinal surgery, endoscopy remained forgotten until the work carried out by Ooi et al.¹⁰ during the 1970s. In 1975 Hijikata et al.⁷ demonstrated a percutaneous nucleotomy by means of arthroscopy instruments for disc removal for the treatment of posterior or posterolateral lumbar disk herniation under local anesthesia--In 1985, Onik et al.⁸ reported the

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development of a 2 mm blunt-tipped suction cutting probe for automated percutaneous discectomy at L4-L5 or higher levels.

TRANSFORAMINAL ENDOSCOPIC MICRODISCECTOMY: The technique of foraminal epidural endoscopic discectomy (FEES) was developed from epidural endoscopy. FEES differ from other percutaneous discectomy procedures in that direct visualization of the epidural space, the pathology, and neuro anatomic structures is possible.

As with other forms of minimally invasive surgical disc procedures, patient selection is critical. Patients should have leg pain more severe than back pain and 6 months of failed conservative therapy.

REGIONAL ENDOSCOPIC TECHNIQUES:

LUMBAR DISCECTOMY: This is the ultimate form of minimally invasive spine surgery. In this technique, an endoscope is used. The whole procedure is performed under local anesthesia patient is made to lie prone and an exact entry point is mapped on the patient's body using an image intensifier X-ray system and a long spinal needle is introduced from the posterolateral aspect of the lumbar spine. Through this needle, a guide wire is inserted. Then a dilator and a cannula are inserted, through which the endoscope is passed. The camera and monitor attached to the endoscope allow the prolapsed part of disc to be removed under direct vision. The patient usually gets immediate pain relief and can go home in 24 hours

CERVICAL DISCECTOMY: Many authors believe that a right-sided approach should always be used for right-handed practitioner and a left-sided approach when left-handed as disc in the cervical region cannot be approached posteriorly (because of the spinal cord), anteriorly (because of the airway), or poster laterally (because of the vertebral artery and the uncinat process)

NEWER THERAPIES: Current treatments attempt to reduce pain rather than repair the degenerated disc. They are mainly conservative and palliative, and are aimed at returning patients to work. They range from bed rest to analgesia, the use of muscle relaxants or injection of corticosteroids, or local anesthetic and manipulation therapies. Disc degeneration-related pain is also treated surgically, either by discectomy or by immobilization of the affected vertebrae.

Because disc degeneration is thought to lead to degeneration of adjacent tissues and be a risk factor in the development of spinal stenosis in the long term, new treatments are in development that are aimed at restoring disc height and biomechanical function.

THESE INCLUDE:

Oral Glucosamine and Chondroitin Sulfate Enhance Proteoglycan Synthesis--Glucosamine and Chondroitin sulfate synergistically enhance the natural hyper metabolic repair response of chondrocytes and retard the enzymatic degradation of cartilage.

Cell-Based Therapies - The aim of these therapies is to achieve cellular repair of the degenerated disc matrix. Growth factors can increase rates of matrix synthesis by up to fivefold. Direct injection of growth factors or cytokine inhibitors has proved unsuccessful because their effectiveness in the

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disc is short-lived hence gene therapy and cell implantation is now under investigation; it has the potential to maintain high levels of the relevant growth factor or inhibitor in the tissue. In gene therapy, the gene of interest is introduced into target cells, which then continue to produce the relevant protein. And in cell implantation the cells of the degenerate disc are supplemented by adding new cells.

Augmentation of Nucleus Pulposus-The objectives of augmentation of the nucleus pulposus following disc removal are to prevent disc height loss and the associated biomechanical and biochemical changes by injecting biomaterials that act as substitute for nucleus pulposus.

Regeneration of the Cartilage Endplate -Endplate therapy is a potential means of enhancing biomaterial integration and cell survival, but remains a long-term and currently untested methodology

Disc Implantation-The newest technology in back surgery is the artificial disc replacement surgery. The development of a prosthetic disc poses tremendous challenges, but the results from initial efforts have been promising.

CONCLUSION: The various image guided percutaneous interventional techniques for treating discogenic pain aim at minimal invasion and maximum relief, however various studies conducted point to inconclusive evidence wherein its edge over surgery in terms of affectivity is yet to be proven. It has been observed however that these minimally invasive techniques provide an alternative for treatment of discogenic pain with the appeal of short term relief, cost effectivity and possibly, less long term side effects. The value of most of these therapies is yet to be established and thus more clinical studies are needed.

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Date of Submission: 08/08/2013.

Date of Peer Review: 19/08/2013.

Date of Acceptance: 21/08/2013.

Date of Publishing: 23/08/2013