

Management of Discogenic Lumbar Pain with Intradiscal Electrothermal Therapy (IDET)

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ABSTRACT

Aim: Evaluate the effectiveness of intradiscal electrothermal therapy in treating discogenic low back pain.

Methods: Using three data bases (PubMed, Cochrane and Scopus) we searched for clinical studies evaluating non-operative methods of treating discogenic back pain that were published between 2004-2012. Only systematic reviews and meta-analysis were included. Inclusion criteria: included if they met the following inclusion criteria: patients were at least 18 years of age; they were written in English and involved patients with chronic non-malignant pain who had never been surgical managed, after removal of duplicate citations only 4 articles were selected.

Results: The two systematic reviews and two meta-analyzes whose objective were to establish the IDET roll in the improvement of discogenic pain, did not find statistically significant evidence to recommend this treatment. Only one study established a possible improvement of discogenic pain at 6 months with acceptable evidence quality.

Conclusion: The current studies provide contradictory evidence of it benefit and it remains unclear whether these interventions confer stable long-term benefit. Thus, physicians must exercise caution in recommending this treatment for patients with discogenic chronic back pain.

Keywords: Intradiscal electrothermal therapy; Chronic pain; Pain management; Discogenic pain

INTRODUCTION: OVERVIEW OF BACK PAIN

Low back pain is one of the most frequent symptoms referred to the primary care physician, and represents the first cause of consultation for neurosurgeons and orthopedists [1]. Currently it is estimated that between 70% to 85% of general population has had pain in the lower back in at least a moment of their life [2]. The economic impact for the health system is similarly high, in the United States the expenses associated with the coverage of this entity correspond to 100 billion dollars a year [3] explained not only by the direct costs of their care, but also by the days of secondary lost work, being the second cause of labor absenteeism only surpassed by respiratory infections. All of the above contributes to the fact that low back pain syndrome is the main cause of mobility restriction, long-term disability and decreased quality of life in western countries [4].

Regarding the origin of lumbar pain, in 85% of cases it is not possible to identify a precise etiology, and it is classified as non-specific lumbar pain. Of the remaining 15% of cases in which it is possible to identify an etiological trigger factor, 98% corresponds to lumbar pain of biomechanical origin, finding the following diagnostic possibilities: I) Intervertebral disc degeneration, II) Herniated disc with root syndrome, III) Vertebral fractures, IV) Spondylolysis with vertebral lyththesis, IV) Muscle or ligament tears,

and V) Facet sprains. The remaining 2% corresponds to neoplastic or metastatic lesions, infectious diseases and inflammatory pathology of the spine or adjacent structures [5].

The Intervertebral Disc (IVD) degeneration alter the microarchitecture and its biomechanical function, allowing the abnormal growth of nociceptive nerve endings in to the disc (neo-innervation), and when they are stimulated by the inflammatory mediators during the degenerative process it appears the back pain [6]. Intra Discal Electrothermal Therapy (IDET) is a minimally invasive technique that involves the application of thermal energy to produce destruction of the neoterminations, thus eliminating the nociceptive stimulus [7].

Although the denervation of intervertebral disc is the main mechanism of action of the IDET, it is believed there are many others processes involved in the pain relief such as: the intradiscal pressure's decrease, the sealing of annular fissures and the disc stabilization by decreasing the amount of collagen fibers [7]. The main objective of this review was to establish the utility of IDET in the management of discogenic pain.

MATERIALS AND METHODS

A literature review was performed using the following search

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engines: PubMed, Cochrane and Scopus.

The search terms used were: “Intradiscal Electrothermal Therapy”, “thermal intradiscal”, “degenerative disc disease”, “intervertebral disc degeneration” “Chronic Low Back Pain” and “Discogenic low back pain”.

Studies were included if they met the following inclusion criteria: they were meta-analyzed or systematic reviewed; patients were at least 18 years of age; they were written in English and involved patients with chronic non-malignant pain who had never been surgically managed, we also exclusively selected papers published within the last 15 years.

All articles that did not meet these criteria were excluded, additionally articles without abstract or full text were not taken into account.

RESULTS

In total, 4 articles satisfied the inclusion criteria and were considered in the review: 3 systematic reviews and 1 meta-analysis (Table 1).

Lu et al. [8] found that there are few high-quality studies evaluating non-operative treatments for reducing discogenic low back pain, and that there is contradictory evidence regarding the IDET efficacy. While some studies analyzed by the authors demonstrated positive results with the IDET in the pain management, the stratified analysis suggested that IDET is only effective in patients who had mild pain.

After systematic review of 3 randomized controlled trials and one observational study Li et al. [9] concluded that there is only fair evidence for IDET only in a short-term (6 months) period.

Despite the poor evidence in relation to IDET, Appleby et al. [10] found that there is compelling evidence of its relative efficacy and safety based on a 17 peer-reviewed articles meta-analysis. Which detected an improvement in pain intensity and physical function

with lower disability index. The overall incidence of complications was 0.8%.

The systematic review by Freeman et al. [11] did not report any serious adverse events with the IDET, however it did not find either any significant difference between the intervention and control. The final conclusion was that this procedure does not have sufficient evidence to be recommended as treatment for patients with discogenic back pain.

DISCUSSION

The effectiveness of IDET in the management of discogenic lumbar pain has a broad theoretical scientific basis, but to date no clinical study of high methodological quality has been able to verify its effectiveness, and despite multiple published clinical studies, it remains a controversial treatment.

Anatomical background: Discogenic pain

The intervertebral disc is a fibrocartilaginous structure interposed between the vertebral bodies that allows movement between them, favoring the absorption and distribution of the axial and rotational biomechanical forces to which the spine is subjected. At lumbar level, they have a thickness of 7-10 mm and 4 cm in diameter, and overall represent one third of the height of the column. It is divided into two parts: the nucleus pulposus in the central part and the fibrous annulus in the peripheral zone. The hyaline cartilage plates of the vertebral bodies are found at the upper and lower levels. The anterior and posterior limits of the intervertebral space correspond to the longitudinal ligaments [12]. The nucleus pulposus is made up of randomly organized type II collagen fibers and elastin fibers with radial arrangement within a highly hydrated gelatinous structure of proteoglycans [13]. The fibrous annulus is composed of 15 to 25 layers of type I collagen fibers in parallel arrangement with each other with an average inclination of 60° with respect to the vertical axis [14].

Table 1: Summarizes the findings of the selected articles and show the author's conclusions.

Author	Design	Sources	Conclusion
Lu et al. [8]	Systematic Review	2 randomized clinical trials 11 Observational study, prospective 5 Observational study, Retrospective	It is uncertain if this type of intervention provides adequate long-term results
Li et al. [9]	Systematic Review	3 randomized clinical trials 1 Observational study, Prospective	Evidence for IDET acceptable for short term (6 months) treatment of discogenic lumbar pain
Appleby et al. [10]	Meta-Analysis	1 randomized clinical trials 13 Observational study, Prospective 3 Observational study, Retrospective	The pooled results of the published studies provide compelling evidence of the relative efficacy and safety of the IDET procedure
Brain and Freeman [11]	Systematic Review	2 randomized clinical trials 11 Observational study, Prospective 5 Observational study, Retrospective	The effectiveness of the IDET is weak and has not passed the standard of approval by the scientific community

The content of water and proteoglycans is higher in the nucleus pulposus (77% and 14%) than in the fibrous ring (70% and 5%). However, collagen is four times more abundant in the ring¹³. The hyaline cartilage plates of the vertebral bodies are less than 1 mm thick and are connected to the IVD by collagen fibers [15].

At birth the DIV has a rich blood supply; however, by the second year of life all blood vessels are obliterated. In adulthood the IVD disc is an avascular structure and supplies its requirements according to its location [16]. The central zone (nucleus pulposus and internal fibrous annulus) is nourished by diffusion from the adjacent vertebral vessels, and the external zone (external fibrous annulus) is nourished directly from blood vessels of adjacent soft tissues [17]. The blood supply distribution of the intervertebral disc explains the higher oxygen content in the peripheral zone of the same.

The nucleus pulposus (the central area of the IVD) is not innervated, the nerve endings are found exclusively in the outermost laminae of the fibrous annulus. These fibers come from branches of the sinuvertebral nerve, from nerves originated in ventral branches of the spinal nerves and of two plexuses located in the common anterior and posterior ligaments. Most of these fibers correspond to nociceptive terminals and only a minority are mechanoreceptor fibers. Clinically, external nociceptive fibers have great relevance in the development of discogenic pain, due to the abnormal growth towards the inside of the disc, with the subsequent stimulation by inflammatory mediators during the degenerative process [6].

Inflammatory mediators released during the IVD degeneration stimulate the nociceptive ends of the disc. It has been proven that the proinflammatory cytokines IL-1, IL-4, IL-6, IL-8, IL-12, IL-17, interferon- γ and Tumor Necrosis Factor Alpha (TNF α), due to their low molecular weight (<400 Da) diffuse freely from the nucleus pulposus to the fibrous ring innervated by the nociceptive terminals, generating pain [6].

There is a strong correlation between the severity of back pain and the degree of disc degeneration [13].

Currently, there are many well-known factors associated with the IVD degeneration, besides the normal aging process such as: trauma, vascular pathologies, diabetes mellitus, smoking, and genetics. All of these elements contribute to the IVD damage, due to the disturbance of blood supply and diffusion mechanisms, compromising the adequate IVD metabolic support, which manifests as dehydration of the nucleus pulposus, disc inflammation, height decrease and the appearance of annular fissures [8].

The consequences of restricted nutritional intake are the development of anaerobic metabolism with subsequent increase and accumulation of lactate, favoring the increase of hydrogen bonds with the consequent progressive degradation of the extracellular matrix by activation of metalloproteinases [6].

The loss of the normal structural arrangement of the IVD also favors the appearance of fissures in the fibrous ring, allowing the abnormal growth of nociceptive nerve fibers towards the interior of the disc (neo-innervation), whereby the degenerated intervertebral discs are innervated in their internal portion (nucleus pulposus), when normally there are only nerve fibers in its outermost portion. It is believed that these fissures also favor angiogenesis, since most of these anomalous nerve endings are accompanied by microvasculature [2].

Intradiscal Electrothermal Therapy (IDET)

This minimally invasive technique is based on the application of thermal energy in order to cause structural changes in the IVD. This procedure is usually performed under light sedation, introducing a flexible catheter (SpinoCATH[®]) into the IVD guided by fluoroscopy. Once the catheter's tip is in the posterior region of the fibrous annulus, it is heated up to 90°C (194°F), destroying the nociceptor terminations [8]. It last approximately 15 minutes and is an outpatient procedure [18].

The theoretical support of this procedure consists of the thermal ablation of the nociceptor fibers added to the shrinkage of the collagen fibers that improves the biomechanical properties of the disc.

Currently, the accepted indications for the IDET are: I) Persistence of symptoms of low axial lumbar pain and/or leg pain and impaired function for at least 6 months, 2) No response to conservative medical management for 6 weeks and 3) Pain reproducible by discography. The exclusion criteria are: I) Neurological alterations secondary to root compression, II) Severe disc degeneration, III) Previous surgery at the level to be intervened [8].

Recent evidence suggest that only highly select surgical candidates with mild disc degeneration, confirmatory imaging evidence of anular disruption, and highly concordant pain provocation on low-pressure discography possibly obtain a clinical improvement after IDET [19].

CONCLUSION

The degenerative pathology of the intervertebral disc is a complex and multifactorial process where homeostasis is lost between the cellular and extracellular components of the IVD, favoring the damage of the disc microarchitecture, which in turn ends neo-innervation and angiogenesis of the central portion of the disc, disc causing lower back pain. The intradiscal electrothermal therapy represents a minimally invasive approach whose theoretical sustenance is based on the thermal ablation of the nociceptive neo-fibers of the nucleus pulposus, this technique has a low incidence of complications compared to open surgery, due to its minimally invasive approach. However, the current studies provide contradictory evidence of it benefit and it remains unclear whether these interventions confer stable long-term benefit. Thus, physicians must exercise caution in recommending this treatment for patients with discogenic chronic back pain.

LIMITATIONS

There are some limitations in this literature review. This paper only examined studies published in a 15 years' time frame and IDET has been done since the early 2000s, therefore, there could exist remaining data not analyzed. Furthermore, there are several terms that can be used to describe discogenic back pain and it is possible that the keywords used did not fully found all of the studies that would fulfill the inclusion criteria. We also limited our literature search to articles published in the English languages; hence, it could be more relevant papers published in other languages.

CONFLICT OF INTEREST

The author reports no conflicts of interest in this work.

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