

Intradiscal Electrothermal Treatment for Chronic Lower Back Pain Patients with Internal Disc Disruption

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Chronic lower back pain is one of the most common musculoskeletal problems; it is also the most expensive industrial injury. Not surprisingly, many treatments have been developed to combat this expensive and debilitating condition. One of these, intradiscal electrothermal treatment (IDET), was developed for patients with chronic discogenic lower back pain who failed to improve with any of the wide variety of non-surgical treatments. The present study sought to evaluate the efficacy of IDET for patients with chronic lower back pain. Twenty-five patients were enrolled in this prospective study; the patients received IDET between June 2001 and June 2003. MRI was used to confirm the diagnosis of internal disc disruption in all patients. The patients then underwent a pre-operative provocative test and discography. The follow-up duration was at least 1 year in all cases, and the visual analogue scale, recovery rate, and satisfaction of each patient were evaluated. The average age of the patients was 32 years (age range 18 to 49 years), and the patient group was 33% male and 67% female. Of the 25 patients, 5 underwent lumbar fusion surgery within 1 year of IDET. After IDET, 8 patients (32%) reported more pain than before, 14 patients (56%) reported less pain, and 3 patients (12%) experienced no change. Twelve patients (48%) were satisfied with IDET, 11 (44%) were dissatisfied, and 2 (8%) were undecided about the treatment. At least 1 year after IDET, nearly half the study patients were dissatisfied with their medical outcome. Consequently, 5 patients (20%) underwent fusion surgery at 1 year after IDET. Although other studies have shown good results with IDET for at least 2 years, this investigation suggests the IDET may be somewhat less effective. In order to firmly establish the efficacy of IDET for treating chronic discogenic lower back pain, additional studies with larger numbers of patients evaluated over longer time

periods are recommended.

Key Words: Intradiscal electrothermal treatment (IDET), internal disc disruption, back pain

INTRODUCTION

Chronic lower back pain is one of the most common musculoskeletal problems and represents the most expensive industrial injury.¹⁻³ It has been estimated that up to 80% of the general population experiences lower back pain at some time,⁴ and even despite its widespread nature, the management of chronic lower back pain remains a formidable challenge for spine specialists. Reports attribute approximately 40% of chronic lower back pain to an internal disc disruption, and these abnormal disc changes might induce back as well as thigh pain.⁵ While internal disc disruption is recognized as a cause of discogenic lower back pain, there is no shortage of controversy as to its diagnosis and management.⁶

Both surgical and non-surgical approaches have long been used to treat chronic lower back pain, especially in cases of internal disc disruption, but no approach has been without problems.^{5,6} Whereas lumbar fusion surgery has traditionally been used to treat discogenic back pain, patients and spine specialists have recently shifted their preference to noninvasive or minimally invasive procedures in place of surgical operations, such as the long-standing lumbar fusion procedure.^{7,8} This shift in opinion introduces the need for an alternative therapy for chronic lower back pain.

Intradiscal electrothermal treatment (IDET) was developed as a potential alternative therapy for

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patients with chronic lower back pain resulting from an internal disc disruption who failed to improve with any of the wide variety of non-surgical treatments available.^{9,10} IDET involves coagulating the annulus fibrosus of the painful disc with a flexible electrode, which is threaded into the disc percutaneously under fluoroscopic control. The procedure has been promoted by several articles that have reported both favorable and unfavorable responses.¹⁰⁻¹⁴ The mechanism by which IDET relieves discogenic diseases is unclear,¹⁵ and the success rate of the IDET procedure is also in question.^{10-14,16} Thus, this study evaluated the efficacy of IDET for patients with chronic lower back pain diagnosed as internal disc disruption by monitoring the level of pain and satisfaction of patients at least 1 year after IDET.

MATERIALS AND METHODS

Twenty-five patients were enrolled in this prospective study and underwent IDET between June 2001 and June 2003. Physical examination and MRI were used to diagnose internal disc disruptions in all enrolled patients, with the MRI films of each patient classified according to the grading system reported by Thomson.^{17,18} A discography was also taken and a provocative test was performed pre-operatively. All patients had a positive discogram, a diagnosis of discogenic lower back pain, and a history of failed conservative treatments. The inclusion and exclusion criteria for performing IDET were as follows:

Inclusion criteria

- Unremitting, persistent lower back pain of continuous duration for at least 6 months
- Lack of satisfactory improvement with a comprehensive non-surgical treatment such as oral anti-inflammatory medication, physical therapy, epidural pain block, or activity modification
- Normal neurological examination
- Negative straight leg raising test
- Provocative test positive for discogenic pain
- MRI not demonstrating a neural compressive lesion

- Preserved disc height of at least 50%

Exclusion criteria

- Inflammatory arthritis
- Stenosis, segmental instability
- Disc extrusion or sequestered disc
- Evidence of neural compression on MRI
- Previous lumbar surgery
- Severe loss of disc height (at least 50%)
- Worker insurance cases

All patients underwent routine IDET. Under local anesthesia, an 18-gauge spinal needle was placed, with fluoroscopic guidance, into the center of the disc to be treated. An intradiscal catheter with a temperature-controlled thermal resistance coil was passed deeply through the needle and navigated intradiscally by fluoroscopy. The catheter was pushed as far as possible adjacent to the inner posterior annulus and then gradually heated to 90°C over 12 minutes. This temperature was maintained for 4 minutes, after which 1 mg of cephazolin was injected intradiscally as a prophylactic against infection. No steroids or other medicines were injected.^{9,10}

Following IDET, all patients were discharged from the hospital within 3 days. Regular post-operative follow ups were performed at 3 and 6 months, 1, 1.5, and 2 years. At least 1 year after IDET, variations in the patients' symptoms, particularly in back pain, satisfaction rates, visual analog scale (VAS), and self recovery rates, were recorded and compared with the pre-operative status.

RESULTS

Demographic characteristics

The IDET study group was composed of 25 patients (9 males and 16 females; mean age, 32 years; range, 18 to 49 years) with a pre-IDET symptom duration of approximately 2 years. Most patients had more than two experiences of another treatment such as medication, physical therapy, pain block, acupuncture, herbal medication, or chiropractic treatment. The IDET targets were L3/4 in 3 patients, L4/5 in 13 patients, and L5/S1 in 9 patients. The disc degeneration grade

Table 1. Thompson's Disc Degeneration Grade (Macro)

Nucleus	Anulus	Endplate	Vertebral body
Bulging gel	Discrete fibrous lamellas	Hyaline, uniformly thick	Margins rounded
White fibrous tissue Peripherally	Mucinous material between lamella	Thickness irregular	Margins pointed
Consolidated fibrous tissue	Extensive mucinous infiltration; Loss of anular-nuclear demarcation	Focal defect in cartilage	Early chondrocyte or osteophyte at margin
Horizontal cleft parallel to endplate	Focal disruptions	Fibrocartilage extending from subchondral bone-irregularity & focal sclerosis in subchondral bone	Osteophyte < 2 mm
Cleft extend through nucleus and anulus		Diffuse sclerosis	Osteophyte > 2 mm

Table 2. MRI Grading

Structure	Distinction of nucleus & anulus	Signal intensity	Height of disc
Homogeneous, bright white	Clear	Hyperintense isointense to CSF	Normal
Inhomogeneous C/S horizontal band	Clear	Hyperintense, isointense to CSF	Normal
Inhomegeneous, gray	Unclear	Intermediate	Normal to slight decrease
Inhomogeneous, gray to black	Lost	Intermediate to hypointense	Normal to moderate decrease
Inhomogeneous, black	Lost	Hypointense	Collapsed disc space

on MRI according to Thompson's grading (Table 1 and 2) was recorded, with 9 patients in grade II and 16 patients in grade III (Table 3).

Clinical results

At least 1 year after the IDET procedure, 21 of the 25 study patients complained of lingering back pain despite some relief of symptoms compared to their pre-IDET status. On the visual analog scale, 7.3 points were checked pre-IDET and 4.9 points were checked 1 year after IDET. The recovery rate for overall back pain symptoms was approximately 40%. Regarding the number of back pain complaints, 8 patients (32%) complained of more pain after the treatment, 3 patients (12%) reported no changes, and 14 patients (56%) reported less pain compared with their pre-IDET status. In terms of satisfaction rate, 12 patients (48%) were satisfied with IDET, 11 patients (44%) were dissatisfied, and 2 (8%) were undecided (Table 4).

Complications

Within 1 year of IDET, 5 of the 25 patients (20%) had undergone a lumbar surgery (all were fusion surgeries). One patient who received IDET at the L3/4 disc for back pain complained 5 weeks later of similar back pain as well as newly-developed radiating pain in both lower extremities. This patient was treated conservatively with medications, a back brace, and physical therapy, but his symptoms increased in severity. He also complained of chills and night fever. A second lumbar spine MRI was taken (Fig. 1) to evaluate the spine status, this time showing endplate erosion, edema, and periligamentous spreading along the posterior longitudinal ligament and infiltrating the paravertebral soft tissue. These findings were consistent with discitis. The patient underwent L3-L4 lumbar fusion surgery 2 months after IDET. In the other back operation cases for patients complaining of increased pain after IDET, 2 patients underwent

Table 3. Demographic Characteristics

#	Sex	Age (yrs)	Dx	Sx (yrs) [†]	Level (L)	Disco	MRI*	F/U (yrs)
1	F	28	IDD	2	4/5	+	3	2
2	M	35	IDD	5	5/1	+	3	2
3	F	40	IDD	8	4/5	+	2	2
4	M	18	IDD	2	4/5	+	2	2
5	F	32	IDD	1	5/1	+	3	2
6	M	23	IDD	1	4/5	+	3	2
7	F	38	IDD	1	5/1	+	2	2
8	F	35	IDD	3	4/5	+	2	2
9	F	39	IDD	2	5/1	+	2	2
10	M	30	IDD	2	4/5	+	3	2
11	F	49	IDD	2	4/5	+	3	2
12	F	25	IDD	1	5/1	+	3	2
13	M	27	IDD	1	3/4	+	3	2
14	M	36	IDD	1	4/5	+	3	1
15	F	35	IDD	1	5/1	+	3	1
16	F	33	IDD	4	4/5	+	2	1
17	M	36	IDD	4	5/1	+	3	1
18	F	32	IDD	6	4/5	+	2	1
19	F	27	IDD	2	3/4	+	3	1
20	M	33	IDD	2	5/1	+	3	1
21	F	31	IDD	3	5/1	+	2	1
22	F	39	IDD	4	4/5	+	3	1
23	F	26	IDD	1	4/5	+	3	1
24	M	25	IDD	1	4/5	+	3	1
25	F	30	IDD	1	3/4	+	3	1

Level, L-lumbar; 1-1st sacrum.

Disco, finding of discogram.

*Thompson's degeneration of disc grade.

[†]Duration of symptoms (years).

Minimum 1 year follow up (1-2 years).

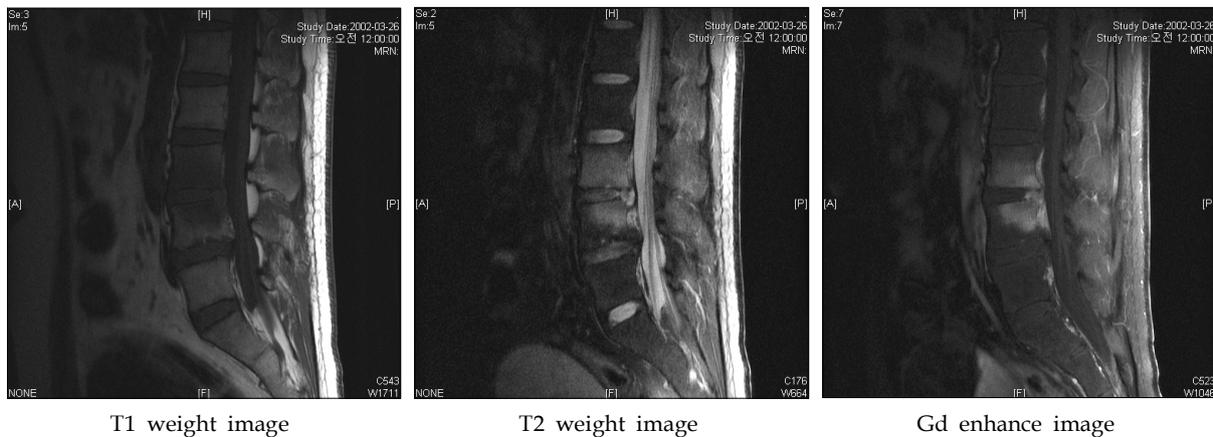


Fig. 1. Post IDET MRI films show end plate edema and erosion of L3 and L4. These findings are compatible to iatrogenic discitis.

Table 4. Clinical Outcomes

#	Back pain	VAS		Recovery		Complication
		Pre*	Post [†]	Rate (%)	Satisfaction [‡]	
1	less	7.3	4.5	30	U	
2	less	7.7	3.8	70	S	
3	more	6.8	7.3	0	D	Fusion surgery
4	less	7.3	3.5	60	S	
5	less	7.3	4.7	60	S	
6	less	7.1	3.2	70	S	
7	less	7.8	3.6	70	S	
8	less	7.6	5.0	20	U	
9	more	7.0	7.5	0	D	
10	more	7.0	7.8	10	D	Fusion surgery
11	same	6.5	5.3	10	D	
12	less	7.8	3.1	70	S	
13	more	7.3	6.8	10	D	Infection
14	less	7.7	2.6	80	S	
15	less	7.4	3.6	70	S	
16	less	8.3	2.4	80	S	
17	more	7.2	6.9	10	D	
18	less	7.8	3.9	60	S	
19	same	7.3	6.9	30	D	
20	less	6.4	2.3	70	S	
21	more	7.0	7.5	0	D	Fusion surgery
22	more	6.9	7.3	0	D	
23	less	7.4	2.9	80	S	
24	same	6.7	4.6	10	D	
25	more	7.2	7.4	0	D	Fusion surgery
Mean		7.3	4.9	38.8%		

*Pre-IDET VAS.

[†] Post-IDET VAS.[‡] S, satisfied; D, unsatisfied; U, undecided.

fusion surgery by the posterior approach and 2 by the anterior approach.

DISCUSSION

Chronic discogenic lower back pain is a difficult condition to treat, even as methods for diagnosing the pain's source improve. A provocative discogram was developed as a less subjective method for pinpointing an internal discal disruption as the source of pain, and despite some controversy, a painful sensation during discography was used as an indication for surgery.^{19,20} Whereas lumbar

fusion surgery was long used to treat discogenic lower back pain, noninvasive and minimally invasive treatments have recently come into favor.^{7,8} Saal et al. introduced IDET for treating discogenic lower back pain in 1997,⁹ and interest in this minimally-invasive substitute for lumbar fusion surgery has only increased in the ensuing years. Consequently, several studies have sought to evaluate the efficacy and mechanics of IDET since its introduction.¹⁰⁻¹⁵

Innervation of the annulus fibrosus and disc has been the topic of considerable research. In a normal intervertebral disc, the sensory nerve endings are confined to the outer third of the annulus

fibrosus by the sinuvertebral nerve.^{21,22} Freemont et al. demonstrated an association between nerve ingrowth, substance P expression, and discal degeneration, and suggested that the extent of what they termed neoneurotisation was greatest at the intervertebral discs responsible for pain generation.²³ Similarly, Coppes et al. noted that disc degeneration and perhaps injury were associated with centripetal ingrowth of nerve fibers into that disc.²⁴ These findings led to the speculation that a physiological basis for true discogenic pain existed and that the annulus fibrosus, in particular its posterior aspect, was the source of back pain.^{23,24}

The mechanisms by which IDET controls pain from an internal disc disruption are theorized to be functional deafferentation of the disc through ablation of the annular nociceptors.²⁵ Deafferentation is indeed the goal, and the use of thermal energy to produce a wider lesion directed toward the site of lower back pain, in particular toward the posterior annulus fibrosus, seems plausible.²⁶ Although deafferentation has the theoretical advantage of producing prompt pain relief, long-term follow up studies have not been promising.¹⁴ An increase in annular stability via coagulation of annular collagen fiber to the disc is believed to be another mechanistic advantage of IDET,²⁷ yet no alteration of the annular morphology was observed when IDET-treated regions were compared with non-heated regions of the same disc in a cadaver study.¹⁴ The same study also found no difference in stability before and after IDET.¹⁴ In reviewing the literature published to date on IDET, no clear consensus emerges regarding its effects on neuronal deafferentation, collagen modulation, or spinal stability. The mechanisms of IDET by which discogenic pain is controlled remain uncertain.

Not only are the mechanisms of IDET unknown, but the success rate of the procedure varies significantly from study to study.^{10-13,15,16} Some authors have reported high success rates for relieving chronic discogenic lower back pain with IDET, while others have not. Yet other authors have reported several complications of IDET, including thermal osteonecrosis, large herniated discs, and infected discitis.^{13,28,29} Despite the small cohort in the present study, 21 of the 25 patients

(84%) complained of some amount of back pain after IDET. While the overall pain score was lower on the visual analog scale after IDET as compared with their pre-IDET status, nearly half of the patients were dissatisfied with the procedure because of remaining back pain. Four patients also had to undergo lumbar fusion surgery due to unfavorable results of IDET, with one case requiring fusion as a consequence of infection.

A significant number of patients were dissatisfied with IDET in our study, despite most reporting lessened back pain. This result was markedly different than previous studies for which positive results were reported for parameters such as the visual analog scale, SF35, and ODI. Positive findings might also be seen for these parameters in our study, but we believe that the patient self-satisfaction rate with the procedure is a more important parameter for comparing with other treatment modalities. It should be noted that we could not identify any factors contributing to the negative effect of IDET, such as age, sex, weight, symptom duration, or disc degeneration grade.

In conclusion, although other results of IDET in internal disc disruption patients might appear hopeful, potential IDET candidates should undergo a thorough evaluation before this treatment method is recommended. Also, a large prospective randomized long-term study should be carried out to confirm the efficacy of IDET for treating chronic lower back pain and internal disc disruptions.

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