Retrospective Study

Intradiscal Pulsed Radiofrequency Application Duration Effect on Lumbar Discogenic Low Back Pain

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Background: Discogenic pain is recognized as the most important and most common cause of low back pain (LBP). Intradiscal pulsed radiofrequency (ID-PRF) is used for the treatment of chronic discogenic pain.

Objectives: We investigated the effects of the duration of percutaneous monopolar ID-PRF application on chronic discogenic LBP.

Study Design: Retrospective study.

Setting: Department of Anesthesiology and Pain Medicine, Neurosurgery at Wooridul Spine Hospital.

Methods: Forty-five patients were included in this retrospective study. The patients were assigned into 2 groups according to the duration of the PRF procedure they underwent (7-minute group = 17 patients vs. 15-minute group = 28 patients). The main outcome measures tested were pain score, as determined by the Numeric Rating Scale (NRS-11) and the Oswestry Disability Index (ODI), at baseline, at 2-week, and 6-month follow-up visits. Success was defined as a reduction in NRS-11 of 50% or more or an ODI reduction of 40% or more.

Results: The mean posttreatment pain scores at 2 weeks and 6 months were significantly lower ($P < 0.05$) in both groups, but the differences between the groups were not significant. ODI scores were also significantly lower compared with the baseline, but the differences between the groups were not significant. At the 6-month follow-up, 12 patients (70.6%) in the 7-minute group and 20 patients (71.4%) in the 15-minute group reported more than 50% reduction in the pain score ($P = 0.16$), and there was no significant difference between the 2 groups in the number of patients with more than 40% reduction in ODI score ($P = 0.23$).

Limitations: This study was performed with a small sample size and there was no control group. Additional well-designed and well-controlled studies that include parameters such as the stimulation duration, mode, and intensity of PRF are needed to fully assess the efficiency of ID-PRF.

Conclusions: ID-PRF was shown to be effective for the treatment of discogenic LBP regardless of duration of ID-PRF application (7 vs. 15 minutes).

Key words: Discogenic pain, pulsed, radio frequency, duration, pain, reduction

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Chronic low back pain (LBP) is a common clinical problem among patients. Chronic LBP can be caused by structure-specific etiology, including facet joint abnormality, disc pathology, and sacroiliac joint dysfunction, and discogenic pain has been postulated as an important and common cause (1).

Abnormal nerve ingrowth and the expression of pain nociceptors are reported to be the primary etio-

logical factors in discogenic pain (2). Thus despite the treatment challenges, the modulation of in-growing nociceptors originating from the outer annulus fibrosus for patients with discogenic back pain shows promising results. Numerous studies have investigated the efficacy of the minimally invasive intradiscal procedures, such as intradiscal electrothermal therapy (3,4), laser-assisted annuloplasty (5), and radiofrequency (RF) ablation (6), for chronic discogenic LBP.

Percutaneous RF ablation treatment was first introduced in the 1980s (7). These treatments are divided into continuous RF stimulation (8) and pulsed RF (PRF) (9) stimulation using an electromagnetic field.

PRF consist of a high-intensity electromagnetic current delivered in pulses, which allows heat to dissipate during the latent period so that neurodestructive temperatures cannot be reached (10), and is used for the treatment of several diseases (11-13). Teixeira and Sluijter (14) reported the application of intradiscal PRF (ID-PRF) for the treatment of discogenic LBP. It has been suggested that percutaneous ID-PRF may reduce nociceptive input from the intervertebral disc (15). In addition, several studies have reported the beneficial effects of ID-PRF on discogenic LBP (14-18). For discogenic pain, a high-voltage and long-duration PRF was recommended (14) with a duration of 15 to 20 minutes (14,18).

Nevertheless, the optimal application duration for ID-PRF has not been fully established and remains variable. Hence in the current study, we investigated the effect of the application duration of percutaneous monopolar ID-PRF for the treatment of chronic discogenic LBP.

Methods

A total of 45 patients who underwent the treatment between June 2018 and June 2019 were included in this retrospective study. The patients were divided into 2 groups based on the duration of the procedure they underwent: 7- or 15-minute groups.

The study protocol was approved by the institutional review board, and all patients provided with written informed consent. The inclusion criteria were (1) axial LBP; (2) single level; (3) sitting intolerance; (4) extension catch; (5) single level degenerative disc as a high-intensity zone (HIZ), and/or Modic change on spinal magnetic resonance imaging (MRI); (6) positive response to provocative discogram; and (7) back pain that had not responded to conservative treatments (pharmacotherapy and physical therapy) within the previous 4 to 6 weeks. The exclusion criteria were (1) LBP elicited by pressure on the paraspinal muscles; (2) herniated intervertebral disc; (3) spinal stenosis; (4) spondylolisthesis; (5) pain due to infection; and (6) bleeding tendency.

Data collected included patient age, gender, and duration of pain. The main outcome measures were the pain score using the Numeric Rating Scale (NRS-11) and the Oswestry Disability Index (ODI) at baseline, at the 2-week, and 6-month follow-up visits. Success was defined as a reduction in NRS-11 of 50% or more or an ODI reduction of 40% or more.

Procedure

All patients received intravenous injections of antibiotics before the procedure. The ID-PRF was a single needle placement procedure and was performed on the patients while they lay on the fluoroscopy table in the prone position. The disc level treated was selected on clinical grounds based on the MRI finding. The skin entry site was disinfected with betadine. The point of entry was determined prior to the procedure by measuring from the midline (usually 12 to 14 cm) using MRI. A conventional posterolateral approach on the side of the pathology was used. The skin entry site was infiltrated with 1% lidocaine. Under fluoroscopic guidance, the PRF needle (20G, 15-cm length, 20-mm active tip; NeuroTherm, Middleton, MA) was percutaneously advanced and placed on the affected disc using a posterior oblique approach. Proper placement of the introduced needle was confirmed with anteroposterior and lateral fluoroscopic projections (Figs. 1, 2). The insertion depth into the annulus and nucleus insertion was decided based on the MRI finding. We applied ID-PRF with a frequency of 5 Hz, a pulse width of 5 ms, the amplitude of 60V, and a maximum temperature of 42°C, for either 7 or 15 minutes using the NT1100 generator (NeuroTherm). After the end of the procedure, the PRF needle was removed and the patients were transported to the recovery room.

The Wilcoxon signed-rank test was used to evaluate the improvement in NRS-11 and ODI scores before and after the procedure. A P value of < 0.05 was considered statistically significant.

Results

The study included 45 patients who were divided into 2 groups based on the duration of PRF application (7-minute group, 17 patients; 15-minute group, 28 patients). A summary of the patient characteristics is pro-

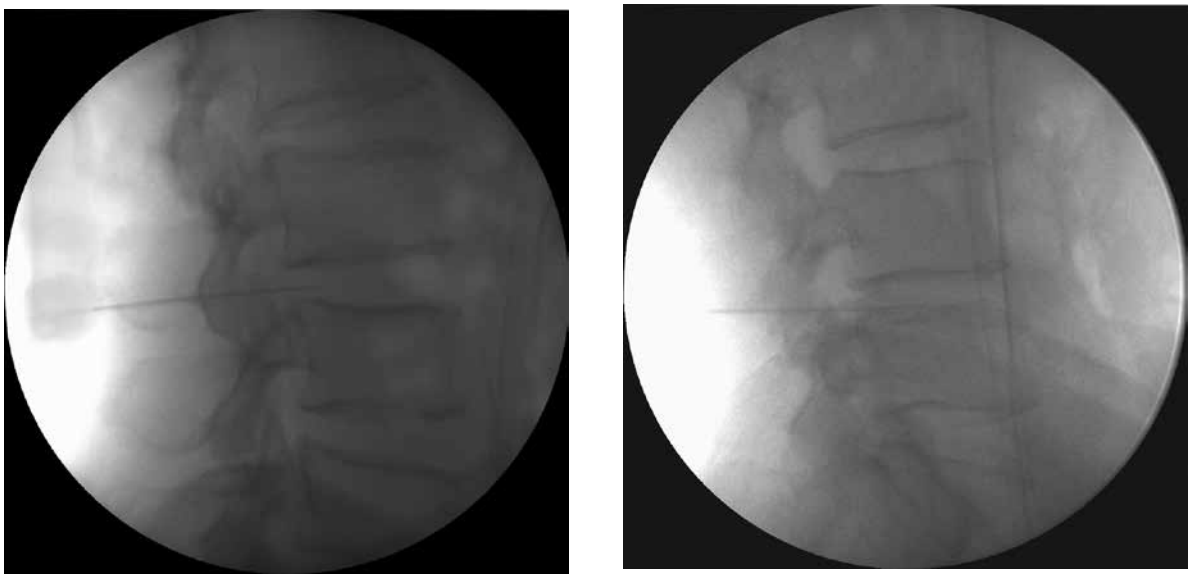

Fig. 1. *Lateral view. PRF needle was placed into the annulus and one-third outer nucleus of L34 (Left) and whole annulus and nucleus of L45 (Right) according to MRI finding.*

vided in Table 1. After both procedures, NRS-11 and ODI scores were significantly decreased in a time-dependent manner (Tables 2, 3). Mean posttreatment pain scores were significantly lower (P = 0.000) in both groups at the follow-up period of 2 weeks and 6 months, whereas the differences between the groups were nonsignificant (Table 2). The ODI scores were also significantly lower compared with the baseline scores; however, the differences between the groups were nonsignificant (Table 2). At the 6-month follow-up examination, 12 patients (70.6%) in the 7-minute group and 20 patients (71.4%) in the 15-minute group reported more than 50% reduction in their pain score (P = 0.16). No significant difference was identified between the groups in terms of the reduction in ODI score (P = 0.23) (Table 3).

No serious complications, including epidural bleeding, dural or neural injuries, or infection, were recorded in either group.

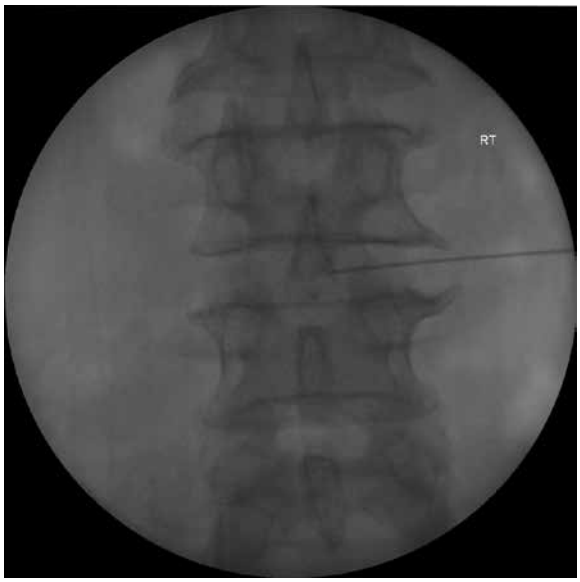

Fig. 2. *Anteroposterior view after placed needle L34.*

Discussion

The results of this study indicate that significant pain relief can be achieved with either 7- or 15-minute application of ID-PRF. These results agree with previously reported data (15,16,18-20). Jung et al (16) reported that patients treated with ID-PRF had achieved decreased Visual Analog Scale score, ODI score, and sitting intolerance time during the 12 months after treatment.In the study of PRF involving 76 patients with discogenic pain confirmed by MRI imaging and provocative discography, 56% reported more than 50% reduction of pain 1 year after the first treatment (20).

Table 1. *Summary of patient's characteristics.*

N = 45	7 min (n = 17)	15 min (n = 28)	*P* Value
Age (yrs)	50.2 ± 9.3	52.3 ± 8.7	0.56
Gender (M:F)	7:10	9:19	0.96
Pain duration (months)	14.2 ± 13.3	16.7 ± 11.3	0.23
Procedure			
L23 L34 L45 L5S1	0 (4.2%) 1 (8.3%) 13 (66.7%) 3 (20.8%)	1 (3.6%) 2 (7.1%) 19 (67.9%) 6 (21.4%)	0.45

Table 2. *Changes of NRS-11 and ODI.*

	Pain	Pretreatment	2 Weeks	6 Months	P Value
7 min (n = 17)	NRS-11	7.6 ± 0.8	3.0 ± 1.6	2.9 ± 1.3	0.000
	ODI	58.1 ± 5.8	23.7 ± 7.8	23.6 ± 6.8	0.000
15 min (n = 28)	NRS-11	7.3 ± 0.3	2.8 ± 1.9	2.5 ± 1.3	0.000
	ODI	55.3 ± 4.9	22.5 ± 8.1	23.5 ± 7.2	0.000
P value		0.68	0.93	0.76	

Table 3. *The number of patients who obtained a percentage of improvement in pain at 6 months postprocedure.*

N = 45	Reduction	7 min (n = 17)	15 min (n = 28)
NRS-11	<49	5 (29.4%)	8 (28.6%)
	≥50	12 (70.6%)	20 (71.4%)
	P value	0.157	
ODI	<39	3 (17.6%)	7 (25.9%)
	≥40	14 (82.4%)	21 (74.1%)
	P value	0.234	

The precise mechanism of ID-PRF remains to be fully elucidated. Damaged nerves are usually located in the outer third of the annulus fibrosus, potentially extending into the inner third of the annulus fibrosus and the nucleus (2,21), and formed vascularized granulation tissue from the nucleus to the outer part of the annulus fibrosus was presented (22). The possible suggested mechanism for ID-PRF is the reduction of nociceptive input from the intervertebral disc and the induction of a cellular and immune response (23).

Biacuplasty is another minimally invasive therapy similar to convectional RF used to treat discogenic pain (19,24). This procedure was designed to control the intradiscal nerve endings from the outer one-third of the annulus fibrosus using thermal energy. In contrast, a needle is placed in the annulus and neovasculized nucleus during ID-PRF. Therefore we hypothesized that ID-PRF would be more effective than biacuplasty. In a comparison study between intradiscal electrothermotherapy and ID-PRF for discogenic pain, no difference was observed in the level of pain reduction in the 2 groups (19). There was no comparison study between the 2 procedures in our study; thus further studies are needed for direct comparison between ID-PRF and biacuplasty.

In our study, application of the pulse with 2 different durations results in similar effects on pain relief. The electrical field for ID-PRF is affected by the voltage, the pulse width duration, and repetition frequency pulse (25). In previous studies, the duration of the ID-PRF application was 15 to 20 minutes. Unlike the application of PRF in the dorsal root ganglion, a high-voltage and long-duration pulse is used for intradiscal procedure (14). Long-duration electrical pulse can have a biological effect on the nerve endings in the annulus fibrosus (14). However, the optimal pulse has not been not established. We postulated that the application of a longer duration electrical field to the degenerated

nucleus/annulus fibrosus would be more effective for alleviating the pain. However, no significant difference in the pain reduction was detected in 2 different pulse application durations. More studies specifically focused on the duration of the pulse will be required.

The major limitations of this study are the small sample size and the lack of a control group. Additional well-designed and well-controlled studies that include parameters such as different stimulation duration, mode, and intensity of PRF are needed to fully assess the efficiency of ID-PRF. In addition, follow-up screening with MRI should be conducted to assess the potential of ID-PRF to prevent or to aggravate disc degeneration. Single level pathology and HIZ in MRI were included in our study, but further studies are needed to assess multilevel pathology in discogenic LBP. If other discs are affected and not treated, the outcome is expected to differ. Finally, facet joint pain was excluded during history taking and examination but not during controlled diagnostic blocks. This may have reduced the treatment efficacy of ID-PRF.

Conclusions

The application of ID-PRF is effective for the treatment of discogenic LBP regardless of ID-PRF application duration (7 vs. 15 minutes). However, to fully assess the effectiveness of the procedure, further studies to evaluate stimulation duration, mode, and intensity of PRF, as well as studies to uncover the underlying mechanisms of reducing discogenic pain reduction, are required.

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