Efficacy of conventional and pulsed radiofrequency for treating chronic lumbar facet joint pain

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KEYWORDS
conventional radiofrequency; facet joint; low back pain; medial branch block; pulsed radiofrequency; radiofrequency denervation

Summary Background: The efficacy of PRF for lumbar facet joint pain is not well established because comparative studies with other modes of management are sparse.

Aim: The purpose of this study was to compare the efficacy of conventional radiofrequency (CRF) and pulsed radiofrequency (PRF) denervation in the treatment of lumbar facet joint pain.

Methods: Lumbar facet joint pain was confirmed in 40 patients undergoing double medial branch blocks. Among them, 16 patients received CRF for pain management and 18 patients were offered PRF. Outcome was assessed before treatment and 3 months and 6 months after treatment. Changes in pain intensity were evaluated using a visual analog scale (VAS). Physical functioning was evaluated using a Revised Oswestry Disability Index (ODI).

Results: In the CRF group, the VAS scores after treatment were significantly lower than before treatment at 3 months (p < 0.001) and 6 months (p = 0.001). The revised ODI scores after treatment were lower at 3 months (p < 0.001) and 6 months (p = 0.001). In the PRF group, the VAS scores after treatment were also lower at 3 month (p < 0.001) and 6 months (p < 0.001). The revised ODI scores after treatment were lower at 3 months (p < 0.001) and 6 months (p < 0.001). The VAS scores in the CRF group were significant lower than scores in PRF group at 3 month (p = 0.01) and 6 months (p = 0.03). The differences in revised ODI scores between the two groups at 3 months and 6 months were not significant.

Conclusions: Both PRF and CRF resolved low back pain from lumbar facet joints. However, CRF was more effective than PRF.

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1. Introduction

Lumbar zygapophysial or facet joint pain has been suggested to be an important cause of chronic low back pain.1,2 Lumbar medial branch blocks are used to test if a patient’s pain stems from a given lumbar facet joint. The diagnosis of facet joint pain is probable when there is at least 50%–75% relief of the targeted pain after lumbar medial branch blocks of the posterior rami of the spinal nerves that supply the painful joints on two separate occasions.3 Percutaneous conventional radiofrequency (CRF) denervation of the medial branches of the dorsal rami has been used for facet joint pain management for many years.3–5 However, CRF is a neurodestructive procedure in which a constant high frequency and high-temperature electrical current is applied to target tissue.6 Thus, the procedure is not risk-free and irreversible nerve injury has been reported.7

Pulsed radiofrequency (PRF) lesioning is a new method in radiofrequency treatment of pain. It is a non-neurolytic lesioning method for pain relief and can relieve pain without evidence of neural damage. Although its mechanism of action is not completely understood, some preliminary reports support its long-term efficacy and safety in pain relief.8–12 The efficacy of PRF for lumbar facet joint pain is not well established because comparative studies with other modes of management are sparse.13,14 We performed a retrospective analysis of 16 patients with chronic lumbar facet joint pain treated by CRF and 18 patients managed by PRF who declined CRF. Clinical outcomes and complications were then compared between the CRF and PRF groups.

2. Methods

Adult patients (age > 18 years of age) were included in this study whose main problem was axial lumbar pain with or without radiating pain into the upper leg for at least 3 months. Other criteria included focal tenderness over the lumbar facet joints, pain on hyperextension, a lack of obvious neurological deficits, of the radicular syndrome, and of indications for low back surgery. Other serious causes of lumbar spine pain, such as infection, fracture, tumor, and vascular disease, were also excluded. Prior to diagnostic medial branch blocks, coagulation disturbances, allergies to radiopaque contrast media or local anesthetics, malignancy, major psychiatric problems, secondary gain legal issues, language problems, and pregnancy were the exclusion criteria.

2.1. Medial branch block

It was not possible to diagnose lumbar facet joint pain based on historical, clinical, and radiological evaluation alone. Before CRF or PRF treatment, patients underwent diagnostic medial branch blocks4 using 0.5–1 mL 2% lidocaine or 1% bupivacaine. Only patients who had at least 75% relief of pain following diagnostic blocks of the relevant medial branches on two separate occasions were considered to have a true lumbar facet joint pain. The treating levels were selected according to the results of medial branches blocks.

2.2. Patient selection of therapy

From May 2007 to September 2008, 40 patients were confirmed to have lumbar facet joint pain based on clinical evaluation, radiological studies, and dual medial branch blocks. Among them, 16 patients received CRF for pain management, and 18 patients who declined CRF were offered PRF. These three patients refused CRF or PRF and only received conservative treatment. Three had pain reduction prior to treatment (Fig. 1).

2.3. CRF and PRF procedures

To perform the CRF and PRF procedure under strict sterile conditions, PC Liliang performed all procedures in the operating room. The patient was lying prone on a radiolucent table when the radiofrequency procedure was performed via a posterior approach. No sedation or systemic analgesic or premedication was used. The image intensifier was positioned to obtain an anteroposterior pillar view, with the target point located in the center of the screen to avoid distortion of the image.

In the CRF group, after local anesthesia (with 2% lidocaine) and sterile preparation, a 22-gauge, 10-cm length, 10-mm exposed tip radiofrequency (RF) needle was placed adjacent to the medial branch. The electrode tips were positioned parallel to the target nerves at the angle between the superior articular process and the transverse process (Figs. 2 and 3).15 After optimizing the anatomical position of the needle, sensory stimulation (frequency, 50 Hz; pulsed width, 1 millisecond; voltage, up to 0.5 V) and motor stimulation (frequency, 2 Hz; pulsed width, 1 millisecond; voltage, up to 0.5 V) were performed using a RF lesion generator (NeuroTherm® JK25T). It was postulated that the sensory stimulation should elicit patients’ tingling sensation, and the motor stimulation should elicit contractions of multifidus muscle. Subsequently, 1 mL of 2% lidocaine was injected through the RF needle to obtain profound local anesthesia. Two cycles of CRF (80 C, 90

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**Figure 1** Flow diagram showing how patients were included in or excluded from the study.
seconds) were performed after localization. The patient was observed for 30 minutes after the CRF procedure. If there were no significant complications (including pain, bleeding, and neurological deficits), then the patient was discharged.

In the PRF group, after local anesthesia (2% lidocaine) and sterile preparation, the RF needle was placed directly toward the medial branch at the angle between the superior articular process and the transverse process under fluoroscopic guidance (Figs. 4 and 5). After optimizing the anatomical position of the needle, sensory stimulation (frequency, 50 Hz; pulsed width, 1 millisecond; voltage, up to 0.5 V) and motor stimulation (frequency, 2 Hz; pulsed width, 1 millisecond; voltage, up to 0.5 V) were performed using a RF lesion generator (NeuroTherm® JK25T). Two PRF cycles (20 milliseconds, 45 V) of 180 seconds were performed after localization, and the temperature was maintained below 42°C. The patient was observed for 30 minutes after the PRF procedure. If there were no significant complications, the patient was discharged.

2.4. Outcome and follow-up

After PRF/CRF treatment, the patients were prescribed pain medication (acetaminophen) if needed. Pain intensity and physical functioning were assessed before PRF/CRF treatment and 3 months and 6 months after treatment. Changes in pain intensity were recorded using a visual analog scale (VAS) ranging from 0 to 10 (0: ‘no pain’ and 10: ‘the most severe pain ever experienced’). Physical functioning was evaluated using a Revised Oswestry Disability Index (ODI). The VAS scores and ODI questionnaire were completed by the patients, and scores (0–100) were reported prior to and after PRF or CRF.

2.5. Statistical analysis

Descriptive statistics were used to characterize the patients. Pre- and postradiofrequency ranges, means, and standard deviations (SDs) were ascertained. The Wilcoxon matched-pairs signed-ranks test was performed to compare the differences within groups pre and post-treatment. Differences between groups were evaluated using χ², Fisher’s exact test, or Mann-Whitney U test, as deemed appropriate. IBM used two-tailed tests of significance (p < 0.05). Data were analyzed using SPSS v. 13.0 (IBM).

3. Results

3.1. Patient characteristics

Fig. 1 shows a flow diagram of how patients were included or excluded in the study protocol. Of the patients with presumptive lumbar facet joint pain, dual medial branch blocks confirmed lumbar facet joint pain in 40 patients. Of these 40 patients, six did not receive CRF or PRF. Three refused CRF/PRF and there three had pain reduction prior to PRF/CRF. Fifty-nine CRF lesions were made in make lesions 16 patients during 16 denervation procedures. Sixty-five PRF lesions were made in 18 patients during 18
3.2. Clinical outcome after PRF/CRF

Table 3 presents outcome data for patients in both groups. In the CRF group, the VAS scores before treatment were $7.3 \pm 0.7$. The VAS scores were significantly lower at 3 months ($1.6 \pm 1.1$, $p < 0.001$) and 6 months ($2.6 \pm 1.9$, $p = 0.001$). The revised ODI scores before treatment were $36.4 \pm 11.3$. Revised ODI scores were lower at 3 months ($17.0 \pm 8.6$, $p < 0.001$) and 6 months ($19.8 \pm 10.3$, $p = 0.001$). In the PRF group, the VAS scores before treatment were $7.3 \pm 0.5$. The VAS scores were also lower at 3 months ($2.9 \pm 1.6$, $p < 0.001$) and 6 months ($4.0 \pm 2.0$, $p < 0.001$). The revised ODI scores before treatment were $37.0 \pm 11.4$. Revised ODI scores were lower at 3 months ($20.7 \pm 11.8$, $p < 0.001$) and 6 months ($25.4 \pm 12.4$, $p < 0.001$). Comparisons between 3 months and 6 months were also made. In the PRF group, the pain scores at 6 months were higher than scores at 3 months ($p = 0.004$). In the CRF group, the pain scores at 6 months were also higher ($p = 0.03$).

3.3. Clinical outcome between two groups

There were no significant differences in VAS scores and revised ODI scores prior to treatment. Three months after treatment, the VAS scores in the CRF group became significantly lower than in PRF group ($p = 0.01$). There were no differences in revised ODI scores between two groups ($p = 0.44$). Six months after treatment, the VAS scores in the CRF group were also lower than in the CRF group ($p = 0.03$); however, the differences in revised ODI scores between two groups were not significant ($p = 0.21$).
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3.4. Complications

Two patients (13%) in the CRF group presented localized pain at the CRF lesion sites for more than 1 week. There were no major complications in the PRF group during the follow-up period.

4. Discussion

Lumbar zygapophysial or facet joint pain has been suggested to be an important cause of chronic low back pain.\(^1,2\) Although the articular branches to the lumbar facet joints could not be accurately targeted for percutaneous procedures, their parent nerves, medial branches of the dorsal rami, could constitute a valid target.\(^15\) Lumbar medial branch blocks are a diagnostic procedure to test if the pain stems from one or more given facet joints. Clinical treatment has been directed towards lesioning the medial branches of the dorsal rami, could constitute a valid target.\(^15\) Lumbar medial branch blocks are a diagnostic procedure to test if the pain stems from one or more given facet joints. Clinical treatment has been directed towards lesioning the medial branches of the dorsal rami with CRF to disrupt pain transmission from the facet joint to the central nervous system. Shealy\(^18\) first introduced the use of CRF for the treatment of chronic facet joint pain. Since then, its efficacy and safety have been established in multiple clinical trials.\(^3,5,19,20\)

PRF lesioning is a new method in radiofrequency treatment of pain. Although the mechanism of action is not completely understood, some reports support its long-term efficacy and safety in pain relief.\(^8,12,21\) The efficacy of PRF for the treatment of chronic facet joint pain has not been well established. There are not enough studies demonstrating the efficacy for the chronic facet joint pain. Some retrospective studies\(^11,22\) demonstrated that PRF successfully provided pain relief for chronic lumbar facet joint pain. These studies had some limitations such as patient selection and the lack of a control group. Although some prospective controlled trials have been reported comparing the efficacy of CRF and PRF in the treatment of lumbar facet joint pain,\(^13,14\) these studies represented conflicting results. Kroll and colleagues\(^13\) conducted a prospective trial comparing the efficacy of CRF with PRF. Their study showed that PRF was not effective. Tekin and colleagues’ study\(^14\) showed both PRF and CRF were effective; however, the effect of PRF was not as long lasting as CRF.

Our study showed that both PRF and CRF decreased pain intensity at 3 and 6 months. However, the VAS scores were lower in the CRF group than in the PRF group. The results indicated that CRF was more effective than PRF in terms of pain reduction. Both PRF and CRF improved physical functioning at 3 and 6 months. The differences in revised ODI scores between CRF and PRF groups were not significant at 3 and 6 months. In both groups, the pain scores at 6 months were higher than the scores at 3 months. This indicated that the beneficial effects of neither CRF nor PRF were long lasting. After 6 months, the efficacy of PRF and CRF was exhausted. However, the efficacy of CRF at 6 months seemed to be better than that of PRF.

CRF is a therapeutic procedure in which a Teflon-coated electrode (NeuroTherm\(^\underline{21}\)) with an exposed tip is inserted onto a target nerve. The electrode heats the surrounding tissue and coagulates them, including the target nerve. The lesion made by the electrode does not extend distal to the tip of electrode, but instead it spreads radially along the long axis of the electrode.\(^15\) The lesion made by the CRF is maximal around the electrode shaft and smallest ahead of the tip. This would mean that the electrodes placed perpendicular to the target nerve would fail to coagulate the nerve adequately. In the technique introduced by Shealy the electrode is not inserted parallel to the target nerve.\(^18\) A modification for electrode placement requires that the electrode lie parallel to the nerve.\(^15\) Using adequate modification for electrode placement, the CRF group in our study was in line with Dreyfuss and others’ study\(^4\) and showed a good outcome in pain reduction and physical functioning.

By contrast to the CRF technique, the electrode in PRF should be positioned perpendicular to the nerve with some distance left between the nerve and the electrode tip.\(^22\) The lesion of PRF is maximal ahead of the tip and smallest around its electrode shaft. This consideration is important when considering whether to use the tip or shaft of the electrode during CRF or PRF.

It is not exactly known how the PRF lesioning resolves the symptoms. Many experimental works have examined the exact analgesic mechanisms of PRF lesioning. Some studies have studied electrical fields with up-regulation of intermediate early gene (IEG) and c-fos.\(^23,24\) One theory is that c-fos proteins, products of IEG expression, somehow alter neuronal transmission. The electrical fields of PRF disrupt the transmission of impulses across small unmyelinated fibers without destroying them, while larger myelinated fibers remain unaffected.\(^14,25\) A recent laboratory study\(^25\) showed that unmyelinated nerve fibers were ultrastructurally normal in both the CRF and PRF groups. In the PRF group, none of the myelinated axons showed findings of severe degeneration. By contrast to PRF, most of

<table>
<thead>
<tr>
<th>Treating levels in both groups.</th>
<th>Single facet</th>
<th>Two facets</th>
<th>Three facets</th>
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<tbody>
<tr>
<td>CRF (n = 16)</td>
<td>2 bilateral/</td>
<td>4 bilateral/</td>
<td>1 unilateral</td>
</tr>
<tr>
<td></td>
<td>4 unilateral</td>
<td>5 unilateral</td>
<td></td>
</tr>
<tr>
<td>PRF (n = 18)</td>
<td>3 bilateral/</td>
<td>4 bilateral/</td>
<td>1 unilateral</td>
</tr>
<tr>
<td></td>
<td>5 unilateral</td>
<td>5 unilateral</td>
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CRF: total 59 lesions; PRF: total 65 lesions. CRF = conventional radiofrequency; PRF = pulsed radiofrequency.

<table>
<thead>
<tr>
<th>Outcomes comparison between both study groups.</th>
<th>CRF (n = 16)</th>
<th>PRF (n = 18)</th>
<th>p</th>
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<tbody>
<tr>
<td>VAS scores</td>
<td></td>
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</tr>
<tr>
<td>Before treatment</td>
<td>7.3 ± 0.7</td>
<td>7.3 ± 0.5</td>
<td>0.97</td>
</tr>
<tr>
<td>3 mo</td>
<td>1.6 ± 1.1</td>
<td>2.9 ± 1.6</td>
<td>0.01</td>
</tr>
<tr>
<td>6 mo</td>
<td>2.6 ± 1.9</td>
<td>4.0 ± 2.0</td>
<td>0.03</td>
</tr>
<tr>
<td>ODI scores</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Before treatment</td>
<td>36.4 ± 11.3</td>
<td>37.0 ± 11.4</td>
<td>0.77</td>
</tr>
<tr>
<td>3 mo</td>
<td>17.0 ± 8.6</td>
<td>20.7 ± 11.8</td>
<td>0.44</td>
</tr>
<tr>
<td>6 mo</td>
<td>19.8 ± 10.3</td>
<td>25.4 ± 12.4</td>
<td>0.21</td>
</tr>
</tbody>
</table>

CRF = conventional radiofrequency; ODI = Oswestry Disability Index; PRF = pulsed radiofrequency; VAS = visual analog scale.
the myelinated axons in the CRF group showed severe degeneration. Perhaps the PRF interrupts only unmyelinated C fiber signals. Myelinated delta fibers remain functional. In patients with a pain signal transmission through delta fibers, CRF will be more effective.14

CRF is believed to carry low risk, but Abbott and coauthors’ reported irreversible lower limb pain attributed to thermal injury of the spinal nerve root. PRF has some advantages over CRF.6 First, PRF is virtually painless. Second, there is no thermal tissue damage associated with PRF, thus eliminating the potential for inadvertent damage to adjacent nerve roots. Experience in the use of PRF recently has rapidly been accumulating, and up to now, no neurological complications have been reported.

This study has several limitations. The present study was a retrospective study with a relative small sample size. Besides, the patients were allowed to choose their preferred surgical intervention when both procedures were an option, and this created an inevitable bias. It is, however, our sincere hope that our study will contribute to the future development of PRF.

5. Conclusions

Both PRF and CRF resolved low back pain from lumbar facet joints. However, CRF was more effective than PRF. The efficacy for CRF and PRF was not long lasting. After 6 months, the efficacy in some cases was exhausted. Although this study demonstrated significant and successful results, caution is required in drawing conclusions from a single study. Controlled, randomized investigations involving a larger sample size are necessary to further clarify this issue.

References


