Kryorhizotomy: an alternative technique for lumbar medial branch rhizotomy in lumbar facet syndrome

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Object. The authors conducted a prospective study to investigate the efficacy of kryorhizotomy, an alternative procedure for lumbar medial branch neurotomy, in the treatment of lumbar facet syndrome (LFS).

Methods. Fifty patients with chronic low-back pain, in whom pain was relieved by controlled diagnostic medial branch blocks of the lumbar zygapophyseal (facet) joints, underwent lumbar medial branch kryorhizotomy. Outcome was evaluated using the Visual Analog Pain Scales and assessment of work capacity. All outcome measures were repeated at 6 weeks, 6 months, and 1 year after surgery. At 1-year follow-up examination, 31 (62%) of 50 patients experienced a good response to lumbar facet kryorhizotomy. Good results with pain relief of 50% or more were obtained in 85% of patients without previous spinal surgery but only in 46% who had undergone previous spinal surgery. This difference was statistically significant. In five patients (16%) in whom a good initial benefit was observed but who experienced increased pain within 6 weeks after kryorhizotomy, the beneficial result was regained after an early repeated procedure. There were no side effects. Overall, 19 (38%) of 50 procedures were not considered successful. In six of these 19 cases a rigid stabilization of the involved segment provided permanent pain relief.

Conclusions. Based on this study, patients with LFS who have not undergone previous spinal surgery benefit significantly from percutaneous lumbar kryorhizotomy. Kryorhizotomy, which has virtually no risk, seems to be a valuable alternative technique to lumbar medial branch neurotomy.

Key Words • kryorhizotomy • kryotherapy • rhizotomy • lumbar facet syndrome

LOW-BACK pain is one of the most common complaints in our civilization and has become a major social and health problem.3,22,44 A potential source of low-back pain is lumbar zygapophyseal or facet joint degeneration resulting in mechanical pain, also called the LFS.

In 1933 Ghormly introduced the term “lumbar facet syndrome.”12 There is a typical pattern of pain distribution (Fig. 1). Patients characterize the pain as a dull, deep ache that may be difficult to localize. Pain is commonly aggravated by prolonged sitting and standing. Physical examination reveals reproduction of the patient’s pain by direct palpation of the suspected joints as well as during movements that produce loading of the facet joints, such as simultaneous lumbar hyperextension and lateral bending or rotation. Results of the neurological examination are normal unless there is a concomitant nerve root irritation. Pain is usually due to degenerative changes of the lumbar facet joints. As demonstrated by Bogduk and Twomey7 and others,13,26 the capsule and synovium of the lumbar facet joints are richly innervated with nociceptive nerve endings. Pain sensation is transmitted via the medial branches of the posterior ramus of the spinal nerve root.13,15 The lower pole of each facet joint is supplied by the medial branch of the exiting nerve root whereas the upper pole is innervated by the medial branch of the nerve root one level higher.9 There are no reliable means by which lumbar facet joint pain can be diagnosed clinically.18,39 Fundamental to the diagnosis of lumbar facet joint pain, therefore, is the use of diagnostic infiltrations. Lumbar medial branch nerve blocks have been proposed as a tool to diagnose LFS and to predict the success of RF denervation (thermocoagulation) of the lumbar facet joints. Percutaneous RF facet denervation was introduced in clinical practice in the early 1970s for treatment of LSF. Subsequently, highly variable success rates were demonstrated with beneficial outcome in 11 to 99% of cases reported in different series.2,8,10,14,19–21,23,29–32,34–36,38,42

The aim of this study was to assess clinical outcome of an alternative simple technique, percutaneous lumbar facet kryorhizotomy. To the best of our knowledge, this is the first prospective study on kryotherapy in the treatment of LFS.

Clinical Material and Methods

Patient Population

Between December 1998 and January 2000, kryorhizotomy was performed in 50 patients in whom an LFS was diagnosed based on positive medial branch nerve blocks. Thirty (60%) of these 50 patients had undergone previous spinal surgery. Cases involving radicular compression or overt segmental instability were excluded. Conservative treatment for low-back pain had been unsuccessful in all cases. In all 50 patients a positive diagnostic medial nerve branch block was demonstrated, rendering them either

Abbreviations used in this paper: LFS = lumbar facet syndrome; RF = radiofrequency; VAS = Visual Analog Scale.
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without pain or with a 50% or more reduction in pain. All diagnostic blocks and kryorhizotomy procedures were performed bilaterally and after administration of a local anesthetic. Patients attended regular follow-up examinations at 6 weeks, at 6 months, and at 1 year after the kryorhizotomy. A standardized questionnaire was completed by each patient. Furthermore, follow-up review included a physical examination and administration of a VAS to determine the average level of weekly pain.

There were 22 women and 28 men. At kryorhizotomy their mean age was 52.2 years (range 28–85 years). The mean preoperative duration of low-back pain was 35 months (range 1–120 months). Sixteen patients (32%) were retired, nine (18%) worked full time, and three (6%) worked part time. Twenty-two patients (44%) were not working because of their persistent low-back pain. Kryorhizotomy was performed at the following levels: L4–5 in 23 patients (46%), L5–S1 in 13 (26%), L3–4 in two (4%), and L4–5 and L5–S1 combined in 12 patients (24%).

Procedural Techniques

To perform the medial branch block, the patient was placed prone on the fluoroscopy table and an anteroposterior image was obtained to identify the desired spinal level and side. The target points for the blocks are shown in Fig. 2. A 20-gauge needle was advanced under intermittent radiographic guidance until bone was contacted. At the target points a 1- to 2-ml local anesthetic (0.5% bupivacaine and 1% mepivacaine) was injected. The injection of limited volumes of local anesthetic is imperative to minimize its spread and therefore to minimize the incidence of false-positive results.44 Often the well-known pain was provoked at the beginning of the injection. Approximately 2 hours postinjection, patients were asked to rate the percentage of relief of their pain. To proceed with kryorhizotomy, pain improvement of greater than 50% was required within active and passive motion during expected duration of the local anesthetic, without leg numbness and weakness.

Kryorhizotomy was performed with the Lloyd Neurostat console by using CO2 (Spembly Medical, Surgical Technology Group Ltd, Andover, Hampshire, UK). The patient was positioned prone with a pillow under the abdomen. Generally, all procedures were performed after injection of a local anesthetic. An intravenous line was used in only one case to allow administration of anxiolytics and mild sedation. The skin overlying the target point was anesthetized, and a cannulated needle was advanced toward the target point (Figs. 2 and 3). Kryorhizotomy was performed bilaterally in every instance. After the kryorhizotomy procedure the patient was provided with supplemental analgesic medications for postprocedure discomfort. Patients were instructed to return to work 2 days later. They were informed that the procedure could be repeated, if necessary.

Statistical Analysis

The Friedman nonparametric repeated-measures test followed by the Dunn multiple comparisons test were conducted to evaluate the postoperative pain improvement (VAS). The two-tailed Fisher exact test was used to compare outcomes in cases with and without previous spinal surgery.

Results

All 50 patients completed the 1-year follow up. There were no complications. One year after kryorhizotomy 31 patients (62%) experienced complete or greater than 50% reduction of pain (Table 1). Among the 30 patients who had undergone previous spinal surgery, 14 (47%) experienced successful pain relief. Among the 20 patients who had not undergone previous spinal surgery, 17 (85%) experienced successful pain relief. This difference in the response to kryorhizotomy was statistically significant (p < 0.01). Overall, in 19 patients (38%) the response to kryorhizotomy at 1-year follow up was not successful. Sixteen patients (84%) in whom kryorhizotomy failed to relieve pain had previously undergone spinal surgery (p < 0.01). Six (32%) of 19 patients in whom the procedure failed experienced successful relief of pain later, after undergoing stabilization of the involved lumbar segment. Any other pretreatment characteristics such as sex, age (≥
65 years), duration or severity of low-back pain, pain characteristics (only low-back pain or referred pain), degree of lumbar degenerative changes, employment status, time off work, and Workers’ Compensation compared with private insurance were not predictors for a successful procedure.

Fourteen patients, in whom there was a good response on Day 1 after kryorhizotomy but in whom the effect diminished within the next 6 weeks, underwent a repeated kryorhizotomy at a mean of 2.5 months after the initial procedure. The repeated procedure did not provide the same initial benefit in nine patients, including seven cases with previous spinal surgery. In five patients the beneficial response was reinstituted, and it remained stable thereafter until 1 year after the initial procedure. In all five of these cases there was no history of spinal surgery.

The improvement in the mean VAS scores in all 50 patients (responders and nonresponders) was significant at all postoperative visits (p < 0.001, Fig. 4 left). The corresponding scores were 7.8 ± 1.4 (preoperatively), 1.64 ± 1.35 (1 day), 3.64 ± 2.78 (6 weeks), 4.12 ± 2.99 (6 months), and 3.28 ± 2.37 (1 year postoperatively). In the responder group (31 patients [Fig. 4 center]), improvements in mean VAS scores were as follows: 7.55 ± 1.43 (preoperatively), 1.65 ± 1.43 (1 day), 2.45 ± 2.03 (6 weeks), 2.16 ± 1.73 (6 months), and 2.26 ± 1.69 (1 year postoperatively). Scores were not significantly different from each other on Day 1, at 6 weeks, 6 months, and 1 year. In the nonresponder group (19 patients [Fig. 4 right]), there was a significant improvement on Day 1 (p < 0.001) and at 6 weeks (p < 0.05) but not at 6 months and 1 year compared with preoperatively. In this group the mean VAS scores were 8.16 ± 1.3 (preoperatively), 1.63 ± 1.26 (1 day), 5.58 ± 2.8 (6 weeks), 7.32 ± 1.38 (6 months), and 4.95 ± 2.39 (1 year postoperatively). The improvement in VAS scores at 1 year in the nonresponder group was due to rigid stabilization in six patients.

At 1-year follow up, 29 patients were satisfied with their outcome and stated they would undergo the same procedure again. When we analyzed the response in an alternative fashion assessing the percentage of patients with a reduction of at least three points on the VAS at 1-year follow up, 38 (76%) of 50 patients would have been considered responders. Fourteen (64%) of the 22 patients who were off work before kryorhizotomy returned to work after the procedure.

Discussion

The prevalence of LFS ranges from 15% in younger to 40% in elderly patients.39,41 In their study, Schwarzer, et al.,39 refuted the “null hypothesis” that lumbar facet joint pain is an uncommon condition. The occurrence of facet pain seems to be a frequent source of low-back pain. Therefore, the diagnosis and treatment of facet pain is important. There are no clinical features, however, that reliably distinguish between cases of pain of facet joint origin and that of other sources.

Because lumbar facet joint pain cannot be diagnosed reliably by clinical examination, a positive lumbar medial
branch nerve block is mandatory prior to both RF and kryorhizotomy.39 Revel, et al.,37 found that the presence of five or more of seven clinical features (age > 65 years; pain well relieved by recumbency; and no pain exacerbated by coughing, forward flexion, rising from flexion, hyperextension, or extension rotation) indicated a greater than 90% chance that a response to facet joint injection would be 75% or greater relief of pain. Some of these criteria remain controversial. In patients with a history of spinal surgery, however, outcome is much more difficult to predict.17,18

Based on positive lumbar medial nerve blocks, RF thermocoagulation is considered the method of choice for treatment of LFS, although the reported results have been described to vary widely.2,8,10,14,19–21,23,29–32,34–36,38,42 Authors of the most recent studies have reported success rates ranging between 32 and 87%.10,35,43 Generally, patients with a history of spinal surgery seem to experience a significantly worse outcome than those with no such history.17,18,37

To our knowledge, this is the first prospective study of percutaneous kryorhizotomy for treatment of LFS based on positive diagnostic blocks. Kryorhizotomy is well tolerated in cases involving application of a local anesthetic and, if necessary, it may be repeated. Percutaneous lumbar facet kryorhizotomy appears to be a valuable alternative to RF thermocoagulation and is an easy-to-use technique. In this study, the overall success rate was similar to those reported in more recent RF studies. A history of spinal surgery also had a marked adverse impact on outcome. There appear to be no significant advantages of kryorhizotomy over RF thermocoagulation.

The first report on denervation of the facet joint for treating persistent lumbar facet syndrome was published by Rees in 1971.36 His technique consisted of cutting the nerve branches lateral to the facet joints. He reported that successful results were obtained in 99.8% of patients in more than 1000 procedures. More recently, Shealy42 suggested that RF thermocoagulation be used for lumbar medial branch rhizotomy. In subsequent publications authors reported varying success rates, indicating the need for preprocedure screening of possible candidates and for improved techniques.8,14,16,19–21,30–32,34,35,42 In 1979 and 1980, Bogduk and Long4,5 reported anatomical studies on the lumbar articular nerves, and they subsequently changed their technique to one of RF neurotomy. They believed that only a few authors had used the most appropriate target points for medial branch neurotomy and that the attendant poor results were often due to improper techniques and poor patient selection.21 Occasionally, patients with radicular pain were also included in the study protocols. Often, no diagnostic blocks were performed prior to permanent denervation. Table 2 provides a summary of the relevant studies and their overall success rates in lumbar facet joint denervation.

There are several possible explanations for the wide range of success rates. First, there are only a few prospective studies.11,14,23,42 Second, a variety of different study designs have been used. In addition, patient selection criteria varied widely. Dreyfuss, et al.,10 for example, excluded patients with a history of spine surgery. They reported a successful response in 87% of their patients who had not undergone prior low-back surgery. This result is comparable with that achieved in patients without a history of spine surgery. Another possible explanation for reported

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**TABLE 1**

Success rate of kryorhizotomy after 1 year

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<th>Successful Procedures (%)</th>
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<tr>
<td>total no.</td>
<td>31 (62) of 50</td>
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<tr>
<td>w/ previous spinal op</td>
<td>14 (46) of 30*</td>
</tr>
<tr>
<td>w/o previous spinal op</td>
<td>17 (85) of 20*</td>
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* Statistically significant difference (p < 0.01)
variation is the involvement of health insurance and Workers’ Compensation issues.\textsuperscript{19,35,43}

Another concern is the inclusion of patients in whom a false-positive response to facet blocks has occurred. Local anesthetic may spread beyond the intended target, thus relieving pain due to other causes than facet joint disease. Although diagnostic local anesthetic infiltration is an accepted standard, it has been performed in many different ways. The local anesthetic has been injected into the capsule of the facet joint space, adjacent to the facet joint, or directly into the facet joint. Marks, et al.,\textsuperscript{28} conducted a randomized comparative study of nerve blocks and joint blocks in 86 patients with chronic low-back pain, concluding that the two were of equal value. With regard to permanent denervation, however, it appears that anesthetic infiltration of the medial branch of the posterior ramus is the most appropriate method.

Discrepancies between reported results may be related

\begin{table}
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\caption{Summary of studies involving percutaneous treatment of LFS*}
\begin{tabular}{llllllllll}
\hline
Authors & Year & Study Design & No. of Cases & Method & Follow-Up Period & Diagnostic Anesthetic Infiltration & Overall & W/O Previous Op & W/ Previous Op \\
\hline
Rees, 1971 & retro & >1000 & NS & NS & 99.8 & 55 & 11 \\
Pawl, 1974 & retro & 50 & RF & 99.8 & 55 & 11 \\
Johnson, 1974 & retro & 87 & NS & 60–74 & 60–74 & 11 \\
Shealy, 1975 & prosp\dagger & 6–21 & NS & 27–41‡ & 27–41‡ & 11 \\
Burton, 1976 & retro & 126 & NS & 42 & 42 & 11 \\
King & Lagger, 1976 & retro & 207 & NS & 79 & 79 & 11 \\
Lora & Long, 1976 & prosp & 6–30 & yes & 41 & 41 & 11 \\
Ogbsury, et al., 1977 & retro & 70 & RF & 61 & 61 & 11 \\
Schaer, 1978 & retro & 71 & NS & 36 & 36 & 11 \\
Oudenhoven, 1979 & retro & 50 & RF & 43 & 43 & 11 \\
Anderson, et al., 1987 & retro & 47 & NS & 65 & 65 & 11 \\
Jerosch, et al., 1993 & retro & 93 & RF & 79 & 79 & 11 \\
North, et al., 1994 & retro & 82 & NS & 41 & 41 & 11 \\
Gocer, et al., 1997 & prosp\dagger & 46 & NS & 62 & 62 & 11 \\
Ray, 1999 & retro & 1020 & NS & 44 & 44 & 11 \\
Dreyfuss, et al., 2000 & prosp & 15 & RF & 46 & 46 & 11 \\
Tzaan & Tasker, 2000 & retro & 88 & RF & 46 & 46 & 11 \\
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\end{tabular}
\end{table}

*IA = intraarticular; kryo = kryorhizotomy; NS = not specified; prosp = prospective; retro = retrospective.
\dagger Unclear whether study design was prospective.
\ddagger Forty one percent after fusion, 27% after laminectomy.
§ Twenty five percent after 6 years, 38% after 3 months.
|| Thirty two percent female, Workers’ Compensation cases; 54% female, non-Workers’ Compensation cases.
** Sixty percent at least 90% pain relief, 87% at least 60% pain relief.
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to ineffective facet joint denervation procedures. Bogduk, et al.,6 studied the shape and size of the coagulum at the electrode tip obtained by RF ablation and concluded that if the electrodes are directly perpendicular to a nerve, the nerve may not be encompassed by the lesion generated. They concluded that it was better to approach the nerve longitudinally.

In patients with a good initial response to facet denervation but who experience a recurrence of pain within the next 6 weeks, the lesion may not have been adequate to provide long-term relief. In particular, in patients who did not undergo previous spinal surgery a repeated denervation may be warranted. Duration of benefit after facet denervation has only rarely been well investigated. Pain relief may be seen to diminish in studies with very long follow-up periods. Lord, et al.,24 demonstrated that nerve regeneration can lead to pain recurrence only a few months after the procedure.

A possible explanation for the more modest results of kryorhizotomy and RF thermocoagulation after previous disc surgery could be that postexcision disc space narrowing results in constant pressure on the articular facets. Furthermore, destabilization with increased motion of the surgically treated segment might be another potential source for continued pain.

Conclusions
Based on the results obtained in this prospective study, kryorhizotomy is a safe, easy-to-use, and effective procedure for lumbar medial branch neurotomy in the treatment of LFS. It appears to be similarly effective as RF thermocoagulation. Success rates in patients without a history of spinal surgery are significantly higher. In experienced hands, the procedure has virtually no risks. We favor performing the procedure after administration of a local anesthetic, which shortens operative time and allows the procedure to be performed on an outpatient basis.

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References