Percutaneous Lumbar Sympathectomy: A Comparison of Radiofrequency Denervation Versus Phenol Neurolysis

Robert F. Haynsworth, Jr., M.D.*, Carl E. Noe, M.D.†

A new percutaneous approach to sympathectomy using radiofrequency denervation has seemed to offer longer duration and less incidence of postsympathetic neuralgia as compared to phenol sympathectomy blocks. To compare these techniques, 17 patients underwent either phenol lumbar sympathectomy blocks (n = 9) or radiofrequency denervation (n = 8). Duration of sympathetic block was followed by a sweat test and temperature measurements. Results indicate that 89% of patients in the phenol group showed signs of sympathetic blockade after 8 weeks, as compared to 12% in the radiofrequency group (P < 0.05). Although the incidence of post sympathetic neuralgia appears to be less with radiofrequency denervation, further refinement of needle placement to ensure complete lesioning of the sympathetic chain will be required before the technique can offer advantages over current phenol techniques. (Key words: Autonomic nerve block; radiofrequency sympathectomy, chemical.)

NEUROTOMIC LUMBAR SYMPATHETIC BLOCKADE is used frequently in the treatment of intractable pain and peripheral ischemia.1-4 The most common technique involves use of a phenol solution injected anterior to the psoas muscle along the lumbar sympathetic chain. Despite multiple variations on this basic technique, there remain several limitations, including limited duration and a high incidence (5-40%) of postsympathetic neuralgia.5-7 A recently introduced method of percutaneous sympathetic blockade using radiofrequency coagulation may offer considerable advantages over currently available phenol techniques.8 The purpose of the study was to compare these two techniques with regard to duration of sympathetic blockade, incidence of postsympathetic neuralgia as well as other possible complications, and ease of administration.

Materials and Methods

The study protocol was approved by the Institutional Review Board, and informed consent was obtained from all patients. ASA physical status 1, 2, or 3 patients referred to the pain center for sympathetic blocks were randomized to one of the two investigators and subsequently received percutaneous lumbar sympathectomy by either phenol neurolysis or radiofrequency coagulation, after one to three bupivacaine (0.25%) lumbar sympathetic blocks provided temporary relief of symptoms. Patients were excluded from the study if they had previous percutaneous or surgical sympathectomy or if they were receiving vasodilators that might affect temperature measurements.

Sweat chloride tests and temperature measurements were performed by either investigator preoperatively, postoperatively, and bimonthly afterward to assess objective change in sympathetic function. Surface temperatures of the great toes of both lower extremities were measured using a Mon-a-Therm dual channel monitor (accuracy ± 0.1 °C). After this, sweat chloride tests were done by pressing cobalt-chloride-impregnated filter papers to both great toes. If no sweat was present, both extremities were heated with a 100-W bulb for 7 min to stimulate sweating. Loss of normal sympathetic function was implied by a change from positive to negative with the sweat test or an increase in temperature on the affected extremity of greater than 1 °C as compared to the unaffected extremity. Return of normal sympathetic function was implied by a sweat test change from negative to positive or decrease in the difference of temperatures between great toes of less than 1 °C.9-11

Patients in both groups were taken to the operating room and placed in the prone position. Intravenous sedation with midazolam (1-3 mg) and fentanyl (50-100 μg) was given immediately prior to blockade. Phenol neurolysis was done by one investigator experienced in this technique, and radiofrequency neurolysis was performed by one investigator experienced with the procedure.

In the phenol group, needles were placed approximately 7 cm lateral to the spinous processes of the L2, L3, and L4 vertebral bodies according to fluoroscopy and were advanced until the tips were approximately at the anterior vertebral body according to lateral fluoroscopy. Anterior posterior fluoroscopy showed needle tips approximately equal to the lateral vertebral margin (fig. 1). Each needle was then injected with 0.5 ml Renografin 60 to confirm proper spread. This was followed by 3 ml 6% phenol in Renografin through each needle. One half milliliter of air was injected through each needle prior to removal. The patients were kept in the prone position for 30 min to help decrease posterior spread of solution into the psoas muscles.12-14

Patients in the radiofrequency group were positioned in a similar fashion. Three 15-cm Sluijter-Metha needles (Radiotics Sales, Burlington, MA) were inserted lateral to the L2, L3, and L4 vertebral bodies. The needle tips were directed to the junction of the middle and lower thirds of the vertebral body at L2, and at the junction of

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the middle and upper thirds at L3 according to lateral fluoroscopy. The midvertebral body was targeted at L4. The radiofrequency probe was then placed after the stylets were removed, and coagulation was performed at 70°C for 120 s using a Radionics lesion generator. This was done approximately 0.5 cm posterior to the anterior vertebral edge as judged by lateral fluoroscopy and then was repeated after pulling the needle back 2–3 mm.

Chi-squared analysis with the Yates correction was used for statistical analysis of differences between phenol and radiofrequency groups.

Results

Seventeen consecutive patients participated in this study, 8 in the radiofrequency group and 9 in the phenol group. Patients were similar in age, diagnosis, and duration of symptoms (table 1). Intraoperative complications did not occur with either technique, and time from insertion of the first needle to removal of the last needle was 24 min for the radiofrequency group and 12 min for the phenol group.

Data for the two groups are shown and summarized in tables 2, 3, and 4. All patients initially showed a marked temperature increase immediately postoperatively; however, only three of eight patients (37%) in the radiofrequency group had greater than 1°C temperature difference between the extremities at 4 weeks. Only one patient

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (yr)</th>
<th>Group</th>
<th>Diagnosis</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>32</td>
<td>RF</td>
<td>Knee injury/RSD</td>
<td>&gt;1 yr</td>
</tr>
<tr>
<td>2</td>
<td>46</td>
<td>RF</td>
<td>Leg pain/RSD</td>
<td>&gt;1 yr</td>
</tr>
<tr>
<td>3</td>
<td>56</td>
<td>RF</td>
<td>Leg pain/RSD</td>
<td>&gt;1 yr</td>
</tr>
<tr>
<td>4</td>
<td>24</td>
<td>RF</td>
<td>Knee injury/RSD</td>
<td>4 mo</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>RF</td>
<td>Ankle injury/RSD</td>
<td>6 mo</td>
</tr>
<tr>
<td>6</td>
<td>38</td>
<td>RF</td>
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<tr>
<td>7</td>
<td>30</td>
<td>RF</td>
<td>Spinal injury/RSD</td>
<td>&gt;1 yr</td>
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<tr>
<td>8</td>
<td>56</td>
<td>RF</td>
<td>Leg pain/RSD</td>
<td>&gt;1 yr</td>
</tr>
<tr>
<td>1</td>
<td>31</td>
<td>PH</td>
<td>Leg injury/RSD</td>
<td>4 mo</td>
</tr>
<tr>
<td>2</td>
<td>33</td>
<td>PH</td>
<td>Knee injury/RSD</td>
<td>&gt;1 yr</td>
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<tr>
<td>3</td>
<td>42</td>
<td>PH</td>
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<tr>
<td>4</td>
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<td>Leg pain/RSD</td>
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<tr>
<td>5</td>
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<td>PH</td>
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<td>8 mo</td>
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<tr>
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<td>PH</td>
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<tr>
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<tr>
<td>9</td>
<td>29</td>
<td>PH</td>
<td>Leg injury/RSD</td>
<td>&gt;1 yr</td>
</tr>
</tbody>
</table>

RF = radiofrequency group; PH = phenol group; RSD = reflex sympathetic dystrophy.
showed evidence of sympatholysis by temperature difference or sweat test at 8 weeks (12%).

In the phenol group, all patients showed a marked increase in temperature postoperatively, and eight of nine (89%) showed increased temperature as well as negative sweat chloride tests at 8 weeks. This difference between groups at 8 weeks was statistically significant ($P < 0.05$).

The incidence of postsympathectomy neuralgia of marked to moderate severity was 33% in the phenol group and 11% in the radiofrequency group (not statistically different). Postsympathectomy neuralgia was diagnosed by a deep diffuse pain localized to the thigh occurring 1–2 weeks after the sympathectomy. In the phenol group, two of nine patients (22%) developed pain that required supplementation of their usual analgesics for treatment. One of nine (11%) described moderate pain, which responded to a slight increase in their usual dose of analgesic. Three patients described mild pain, which required no treatment, and three patients developed no pain.

In the radiofrequency group, only one patient developed postsympathectomy neuralgia; it required an increase in dosage of his usual analgesic.

### Discussion

Radiofrequency destruction of nervous tissue is an established technique that has recently been applied to the sympathetic chain.\(^8,^{16,17}\) Despite initial reports indicating long duration and low complication rate, the technique has not been compared prospectively to phenol techniques of denervation. This study was an attempt to compare duration of blockade, incidence of postsympathectomy neuralgia, and other complications between the two techniques.

One of the difficulties of this type of study is determining the presence of complete sympathetic blockade in patients whose underlying conditions are characteristic of varying vascular states. Sympathetic blockade is essentially assessed by four methods: increase in skin temperature (skin temperature measurements and thermography), increase in pulse amplitude (plethysmography), abolition of the sympathogalvanic response, and absence of sweating (starch–iodine, cobalt chloride, and ninhydrin). Benzon et al. in 1985 compared sympathogalvanic response to sweat tests and determined that sweat tests were more reliable indicators of sudomotor sympathetic activity.\(^9\) Skin temperature and pulse amplitude measurements show similar results and reflect sympathetic vasmotor activity. Therefore, for this study we used skin temperature as an indirect reflection of sympathetic vasmotor function and the cobalt chloride test as an indirect reflection of sympathetic sudomotor function. These methods of measurement are objective rather than subjective,
and therefore, although data in this study were collected by the physician performing the procedure during each patient's follow-up visits, observer bias probably was minimized.

One of the most notable differences between the two groups was duration of sympatholysis. According to the assessment of sympatholytic blockade by increased temperature and inability to produce sweat, only 37% in the radiofrequency group showed sympatholysis that lasted greater than 4 weeks, and only one patient (12%) showed evidence of sympatholysis at 8 weeks. In the phenol groups, all patients showed evidence of sympatholysis at 4 weeks, and in 89% it lasted longer than eight weeks.

This discrepancy can best be explained by the type of radiofrequency lesion produced. Radiofrequency produces a very small lesion at the tip of the probe and coagulates an area only several millimeters in diameter. This means that the needle tip has to be within several millimeters of the sympathetic chain to achieve complete sympatholysis. If the tip lies further away, then incomplete sympatholysis will result. Umeda et al., in 1987, studied the anatomy of the sympathetic chain and concluded that the best location for needle placement is the lower third of the second vertebral body, the upper third of the third vertebral body, and the midportion of the fourth vertebral body. Although we followed these guidelines for needle placement, there was still a high incidence of incomplete sympatholysis in the radiofrequency group. This might be explained by the variation in anatomy that exists along the sympathetic chain.
In the phenol group, precision in needle placement is not as important because of the large volume of solution injected. Cousins et al. demonstrated that only 1 ml of solution through each needle resulted in complete coverage of the L2, L3, and L4 vertebral bodies. In the current study, 3 ml was injected at each level, a quantity that allows complete spread of solution along the entire prepsosas area.

The primary complication of phenol sympatholysis has been the occurrence of postsympathectomy neuralgia. This is a syndrome characterized by persistent thigh pain beginning 1–2 weeks after the sympathectomy and lasting anywhere from weeks to years. It was originally believed to be caused by irritation of the L1 or L2 nerve roots, with pain occurring in the genitofemoral distribution. Other theories suggest possible activation of peripheral sensory receptors by a hyperfunctioning sympathetic nervous system through residual fibers spared by sympathectomy, or possible shunting of current at damaged nerve endings from sympathetic efferent to afferent fibers.

The incidence of postsympathectomy neuralgia does appear to correlate with the volume of solution injected as well as with the type of solution. Although the exact etiology still remains unknown, it is possible that posterior spread of solution reaches the nerve roots and causes a chemical irritation. Therefore, it is not surprising that in the current study, the incidence of severe postsympathectomy neuralgia was 22% with phenol as compared to 0% with radiofrequency denervation.

Treatment of postsympathectomy neuralgia usually consists of analgesics and assurance, since pain often resolves in several weeks. However, in cases in which pain persists, diphenhydantoin or carbamazepine may be useful either alone or in combination. More recently, oral lidocaine derivatives such as mexiletine have shown to be effective.

Both techniques of sympathectomy were easy to administer, although the time required was slightly longer with the radiofrequency group (24 min per patient vs. 12 minutes per patient in the phenol group; not statistically significant). There were no other adverse effects or complications associated with either technique.

In summary, radiofrequency denervation of the sympathetic chain does offer the advantage of decreased incidence of postsympathectomy neuralgia. However, extra precision is required in needle placement because of the very small area of destruction, as opposed to chemical techniques. Because of variation in the anatomy of the sympathetic chain, multiple lesions may be required to ensure complete sympathectomy. Further work exploring exact needle placement and the number of lesions will be required before radiofrequency denervation becomes a viable alternative to chemical sympathectomy.

References