Partial wrist denervation is a useful palliative procedure for chronic wrist pain when reconstructive procedures are not feasible or desirable. We reviewed 19 patients who had 20 isolated anterior and posterior interosseous neurectomies with no previous or concurrent wrist surgery in a 5-year period at our institution. At an average of 2.5 years postoperatively, 80% of patients reported a decrease in pain, 45% reported normal or increased grip strength, and 73% of employed patients had returned to work. Three patients required additional procedures for pain relief (2 arthrodesis, 1 radial styloidectomy). Failure tended to occur in the first postoperative year. Poor preoperative range of motion and workers’ compensation status were predictive of failure. Failure also occurred in the single patient with rheumatoid arthropathy. Two patients had subsequent arthrodeses. There were no complications related to the surgery. Overall, 85% of patients reported satisfaction with this procedure; 90% retrospectively would choose the same treatment for their chronic wrist pain. Partial denervation of the wrist via the anterior and posterior interosseous nerves is a technically easy procedure and may provide pain relief sufficient to markedly delay the need for more extensive salvage procedures in patients with wrist arthritis. (J Hand Surg 2002;27A:833–839. Copyright © 2002 by the American Society for Surgery of the Hand.)

Key words: Wrist, denervation, arthritis, outcomes.
tient, transient, and less efficacious than total denervation for chronic wrist pain.\textsuperscript{6,11,13}

The current literature on partial wrist denervation is insufficient for clinical decision making. In some studies conclusions were drawn from data on 4 or fewer patients.\textsuperscript{6,7,13,14} Other studies with large patient cohorts had great heterogeneity in surgical technique used and nerves selected for neurectomy.\textsuperscript{2,3} Few studies have evaluated isolated denervation preservation for chronic wrist pain.\textsuperscript{6,11,13} Studies conclusions were drawn from data on 4 or fewer patients.\textsuperscript{6,7,13,14} Other studies with large patient cohorts had great heterogeneity in surgical technique used and nerves selected for neurectomy.\textsuperscript{2,3} Few studies have evaluated isolated denervation preservation for chronic wrist pain.\textsuperscript{6,11,13}

Materials and Methods

A retrospective review of surgical dictations identified patients who had a wrist neurectomy at our institution between June 1993 and June 1998. Patients who had combined neurectomy of the anterior interosseous nerve (AIN) and posterior interosseous nerve (PIN) were selected to form the study cohort. Those who had concurrent surgical procedures on the same upper extremity were excluded, as were those who had isolated posterior interosseous neurectomy. Our search identified 144 denervation procedures performed in 140 patients in the 5-year period reviewed. Twenty wrists in 19 patients met the entry criterion of isolated neurectomies of the AIN and PIN.

Demographic and clinical data were extracted from patient records. Average patient age was 52 years (range, 21–71 y; median, 29 y). Fifteen patients (79%) were men and 4 were women. Seventeen patients were right-handed. Fourteen patients had surgery on their right side. Two patients had bilateral neurectomies of the AIN and PIN (1 synchronous and 1 staged). Denervation was performed on the dominant side in 14 cases and the nondominant side in 6 cases. Seven patients (8 cases) were employed as active laborers. Four patients (5 cases) were retired, and the remaining 6 patients (7 cases) held sedentary jobs. Five patients (6 cases) had active workers’ compensation claims related to their wrist pain. Demographic data and preoperative diagnoses are detailed in Table 1.

Dorsal wrist pain was present at initial presentation in all patients. The pain was located centrally or radially in 12 of 20 cases (60%). Two patients had ulnar-sided symptoms. In 14 of 20 cases (70%) the pain was of moderate intensity. The pain was constant in 12 of 20 cases (60%) and involved nocturnal awakening in 7 of 20 cases (35%). All patients reported that their wrist pain was exacerbated by activity. The pain was present for more than 5 years in 9 of 20 cases (45%). The majority of cases presented with complaints of wrist weakness (17 of 20 cases; 85%) and wrist stiffness (16 of 20 cases, 80%). More than half of the cases required the use of medication daily to reduce their wrist pain; 2 of 20 cases (10%) were narcotic dependent.

On physical examination all patients had focal tenderness. Most patients (89%) had central or radial-sided tenderness. Two patients had ulnar-sided tenderness. Total active motion in flexion and extension (TAM F/E) averaged 104° on the surgical side and 126° on the nonsurgical side. Total active motion in radial deviation and ulnar deviation averaged 48° on the surgical side and 64° on the nonsurgical side. Grip strength was weaker on the surgical side (28 kg) than on the nonsurgical side (37 kg), as were appositional pinch (6.6 kg vs 8.9 kg) and oppositional pinch (4.8 kg vs 6.8 kg). All patients had anteroposterior and lateral wrist radiographs performed. Static carpal instability was found in 12 patients.

Preoperative diagnostic AIN/PIN blocks were performed according to a previously described technique.\textsuperscript{16} A 25-gauge needle was inserted 5 mm below the skin at a site 2 cm proximal to the distal radioulnar joint. Two milliliters of local anesthetic was injected into this region to block the PIN. The needle was then advanced an additional 5 mm, penetrating the interosseous membrane, where 2 mL of anesthetic was injected to block the AIN. Subsequent objective measures of grip strength and subjective measures of pain relief were recorded.

Three surgeons performed the denervations. In 12 cases (60%), the procedure was performed by one of the authors. All patients had resection of the terminal AIN and PIN branches through a single dorsal incision under a regional anesthetic or local anesthesia with parenteral sedation.\textsuperscript{16} Briefly this resection was performed as follows. A pneumatic tourniquet was
applied to the arm. Beginning distally 2 cm proximal
to the ulnar head a 3- to 5-cm longitudinal incision
was made dorsally over the interval between the
distal radius and ulna (Fig. 1). The deep antebrachial
fascia was incised longitudinally, exposing the mus-
culotendinous junction of the digital extensor ten-
dons. The digital extensor tendons were retracted to
expose the PIN lying on the dorsal surface of the
interosseous membrane. It is typically immediately
adjacent to the posterior division of the anterior
interosseous artery (Fig. 2). Two centimeters of the
PIN was sharply resected. With the artery protected,
a 3- to 4-cm longitudinal incision was made in the
distal aspect of the interosseous membrane, exposing
the insertion of the deep head of the pronator quad-
tratus muscle. Between the interosseous membrane
and the pronator quadratus muscle are the anterior
interosseous artery and the AIN (Fig. 3). The AIN is
typically 2 to 3 times greater in diameter than the
PIN. After it was certain that no motor branches were
affected, a 2-cm length of the AIN was sharply
resected. A layered wound closure was done and a
soft, sterile dressing was applied.

All patients were mailed a 2-part survey. The first
part contained questions about current wrist pain,
grip, range of motion, return to work, satisfaction
with the surgery, and need for additional wrist pro-
dcedures. The second part was the Disabilities of the
Arm, Shoulder, and Hand (DASH) questionnaire.
Patients who did not respond were contacted by
telephone to complete the survey. All patients were
invited back for additional clinical assessment and
radiographs. Consent to participate in the investiga-
tion was obtained from all patients. The Institutional
Review Board of our institution approved this study.

Statistical analysis was performed by using SAS
version 6.12 (SAS Institute, Cary, NC), assuming a
level of $p = .05$ for significance. Multiple outcome
measures were tested against the results of the diag-
nostic block by using rank sum tests and Spearman
correlation coefficients. Chi-square tests were used
to evaluate factors prognostic of treatment failure.
Preoperative and postoperative ranges of motion
were compared by using paired $t$-tests; patients who
had had arthrodesis in the interim were excluded
from this analysis.

Results

Preoperative diagnostic nerve blocks were per-
formed in all cases. Grip strength was recorded be-
fore and after block. The average improvement in grip strength was 34% (range, 0% to 128%; median, 15%). Pain relief was calibrated on a scale from 0% to 100%, with 100% signifying complete relief. The average reported relief was 83% (range, 0% to 100%; median, 95%). Analgesic response after block correlated poorly with ultimate pain frequency (p = .50) and severity (p = .13) determined at follow-up evaluation. Pain relief after block and grip improvement were not correlated with DASH scores at follow-up evaluation (p = .67 and p = .20, respectively).

In the early postoperative period (10–14 d) complete pain relief was reported by 6 of 20 cases (30%) and some relief was noted in 12 of 20 cases (60%). One patient reported no pain relief and one was worse after the procedure. Early postoperative pain relief did not correlate with ultimate pain frequency (p = .23) or severity (p = .44) as recorded at follow-up evaluation.

Questionnaire data were available for all cases at an average of 31 months postoperatively. Most patients reported residual wrist pain, but on a case basis 16 of 20 cases (80%) reported it as less severe than preoperatively. Twelve of 20 cases (60%) now reported the pain as rare or occasional instead of constant. Nine of 20 cases (45%) believed that their grip strength had improved or was now normal, and 5 believed that it was equal to the preoperative state. Six cases (30%) indicated that their grip strength was weaker. Among the 15 employed patients with follow-up data, 11 (73%) had returned to work.

Three patients required additional procedures for pain relief. One patient with scapholunate instability had a radial styloidectomy 5 months after the denervation. The single rheumatoid patient in the cohort required a total wrist fusion 1 year after the denc-
Failure, defined as the need for subsequent procedures for pain relief, was independently associated with workers’ compensation claims (p < .01) and preoperative TAM F/E of 80° (p < .01). Failure was not associated with chronicity of symptoms (p = .46), age (p = .24), occupation (p = .18), or previous wrist procedures (p = .23).

The average DASH score was 31 (range, 6–58; median, 32; SD, 13.1). DASH scores were not predicted by workers’ compensation status (p = .31), age (p = .94), or occupation (p = .87).

Fourteen of 20 cases were somewhat or very satisfied with the results of the denervation and 18 of 20 cases (90%) would retrospectively choose the same treatment for management of their chronic wrist pain.

Figure 3. Exposure of the anterior interosseous nerve (AIN) and artery (AIA) after longitudinal division of the thin interosseous membrane (IOM). The AIN and AIA are posterior to the deep head of the pronator quadratus muscle (PQ). A 2-cm length of the AIN is sharply resected, as marked. (From Berger RA. Partial denervation of the wrist: a new approach. Tech Hand Upper Extrem Surg 1998;2:25-35. By permission of Mayo Foundation for Medical Education and Research.)
Previous investigators have commented on the transient nature of pain relief after both total and partial wrist denervation. In this series, sustained pain relief was evident at the time of questionnaire follow-up in most cases. Eighty percent of patients described their pain as less severe, 67% noted it less frequently, and 44% did not require medication for it. Most patients had some residual pain but it had receded to an acceptable level. These findings are to be expected because AIN/PIN neurectomy does not alter the underlying disease process or completely denervate the wrist.

Functional outcome assessment was performed with the DASH questionnaire. The average score was relatively high (31), and the SD was large (13.1). In general, responses indicated greater levels of disability with higher-demand tasks (heavy household chores, carrying objects heavier than 4.5 kgf) and wrist-loading activities (opening a tight jar). DASH scores were not predicted by workers’ compensation status, patient age, or occupation. As shown in Table 2, correlations between DASH scores and overall satisfaction are imprecise at best. In this patient population, serial DASH testing may be useful.

Three patients required additional procedures for pain relief. Most procedures were performed within 1 year of denervation. Failure was independently associated with poor preoperative TAM F/E and workers’ compensation status (both p < .01; Figs. 4, 5). The single patient with rheumatoid arthropathy required arthrodesis. Failure was not associated with chronicity of symptoms, previous wrist surgery, patient age, or occupation. One patient had a radial styloidectomy and one had a successful limited intercarpal arthrodesis. As expected for partial denervation, neuropathic changes were not observed on the serial radiographs.

Despite occasional pain and functional limitations, 14 of 20 cases reported satisfaction with partial wrist denervation. As shown in Table 2, this included all 3

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**Table 2. Outcome of Neurectomies of the Anterior Interosseous Nerve and Posterior Interosseous Nerve**

<table>
<thead>
<tr>
<th>Case</th>
<th>Follow-Up (mo)</th>
<th>Subsequent Procedures (Months After Neurectomy)</th>
<th>DASH Score</th>
<th>Satisfaction</th>
<th>Retrospectively Choose Same Treatment?</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>10</td>
<td>None</td>
<td>22</td>
<td>Very satisfied</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>2</td>
<td>46</td>
<td>None</td>
<td>18</td>
<td>Neither</td>
<td>Probably not</td>
</tr>
<tr>
<td>3*</td>
<td>13</td>
<td>None</td>
<td>46</td>
<td>Somewhat satisfied</td>
<td>Probably yes</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
<td>Total wrist fusion (12)</td>
<td>30</td>
<td>Somewhat satisfied</td>
<td>Probably yes</td>
</tr>
<tr>
<td>5</td>
<td>32</td>
<td>None</td>
<td>58</td>
<td>Very satisfied</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>6</td>
<td>16</td>
<td>None</td>
<td>24</td>
<td>Very satisfied</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>7†</td>
<td>32</td>
<td>None</td>
<td>44</td>
<td>Neither</td>
<td>Probably not</td>
</tr>
<tr>
<td>8*</td>
<td>33</td>
<td>None</td>
<td>42</td>
<td>Somewhat dissatisfied</td>
<td>Probably yes</td>
</tr>
<tr>
<td>9</td>
<td>15</td>
<td>None</td>
<td>44</td>
<td>Very satisfied</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>None</td>
<td>30</td>
<td>Neither</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>11</td>
<td>28</td>
<td>None</td>
<td>40</td>
<td>Somewhat satisfied</td>
<td>Probably yes</td>
</tr>
<tr>
<td>12</td>
<td>18</td>
<td>None</td>
<td>12</td>
<td>Very satisfied</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>13</td>
<td>57</td>
<td>Four-corner fusion (4)</td>
<td>42</td>
<td>Very satisfied</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>14</td>
<td>44</td>
<td>None</td>
<td>32</td>
<td>Very satisfied</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>15*</td>
<td>58</td>
<td>None</td>
<td>20</td>
<td>Very satisfied</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>16†</td>
<td>41</td>
<td>None</td>
<td>31</td>
<td>Somewhat satisfied</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>17†</td>
<td>12</td>
<td>Styloidectomy (5)</td>
<td>24</td>
<td>Very satisfied</td>
<td>Definitely yes</td>
</tr>
<tr>
<td>18</td>
<td>48</td>
<td>None</td>
<td>36</td>
<td>Neither</td>
<td>Probably yes</td>
</tr>
<tr>
<td>19</td>
<td>32</td>
<td>None</td>
<td>6</td>
<td>Neither</td>
<td>Probably yes</td>
</tr>
<tr>
<td>20</td>
<td>16</td>
<td>None</td>
<td>18</td>
<td>Very satisfied</td>
<td>Definitely yes</td>
</tr>
</tbody>
</table>

*Bilateral procedure, nondominant hand.

†Bilateral procedure, dominant hand.
patients who required additional surgical procedures. Retrospectively, 18 of 20 cases, or 18 of 19 patients (95%) would have selected partial wrist denervation instead of arthrodesis or other procedures for management of their chronic wrist pain.

Several questions regarding the safety of denervation are continuously raised. First, there is a concern that denervation of a joint, partial or total, will lead to Charcot changes in the joint. In the present study, no patients exhibited any radiographic changes that could not be attributed to the progressive nature of their arthritic condition without the denervation procedure. Second, there is concern about what effect on normal joint mechanics resection of the nerve will produce. There may be some role that the AIN and PIN play in the neurologic monitoring of the wrist under normal circumstances; however, no direct evidence exists to support this. No patient in this series complained that his or her sense of joint position was negatively altered. Resection of these nerves under normal circumstances would not be warranted and may indeed produce some measurable deficit in mechanoreception. In patients with pain caused by a permanent condition such as arthritis, resection of these nerves as a means of palliating the patient's pain should offset any perceived alteration of proprioception. Independent work in our laboratory is currently underway to determine the normal and pathologic roles of these nerves as they relate to wrist joint mechanics. It will be interesting to determine if proprioception in patients with arthritis is a naturally occurring comorbidity of the arthritic process. The third and final concern with this specific denervation procedure is that resection of the AIN will denervate the pronator quadratus muscle. As with the original description of the procedure, the AIN is resected distal to the majority of motor fibers supplying the pronator quadratus muscle.

The efficacy of partial denervation of the wrist through the AIN and PIN as an adjunct to other procedures (radial styloidectomy, limited intercarpal fusions, additional denervation, and so forth) was not addressed in the current study. It would seem logical that when warranted, combinations of procedures would increase the overall efficacy of the procedures, which should be studied in the future.

References