Digital artery sympathectomy

A very distal sympathectomy at the level of the origin of the proper digital arteries has been devised. Four men and four women have been operated on for digital vascular insufficiency due to frostbite, crush injuries, scleroderma, and Raynaud's disease. The operation is done through a palmar approach and the adventitia removed, over a length of 3 to 4 mm, from the proper digital arteries distal to the junction of the distal perforating artery with the common digital artery. Three frostbite victims have done well; their ulcers have healed, pain symptoms have improved, and a skin temperature rise of 1.5° to 2.5°F has persisted over a 17-year follow-up. Two crushed fingers have shown some, but not impressive, permanent symptomatic improvement. Three women had four operations for Raynaud-type disease. Two of the women, 40 and 41 years of age, showed a permanent skin temperature rise of only 2° and 1° F., respectively. They showed significant, but not total, pain relief. The third woman, 22 years of age, had atrophic, curled index and thumb nails. After sympathectomy, the nails grew normally, there was significant pain relief, and the patient showed a permanent 3° F rise in skin temperature.

Adrian E. Flatt, M.D., F.R.C.S., Norwalk, Conn.

Over 25 years ago Ray wrote, "The accumulating bulk of evidence points strongly to the existence of a sympathetic supply to the upper limb so extensive that no practical operation, either preganglionic or postganglionic alone or in combination, can be relied on to effect an absolutely complete denervation. Complete denervation theoretically could be assured only by sectioning motor roots important to muscular function of the limb. . . . There is no need to abandon sympathectomy for appropriate cases of vascular disorders of the upper extremity but there is need for clear thinking on the matter of the most effective and practical way to perform the operation within the limits of the possibilities."

Even at this time the long-term results of sympathectomy performed in the proximal part of the upper limb are generally discouraging. Because of these disappointing results, a very distal sympathectomy has been devised for use in distal circulatory problems. Anatomic descriptions of the sympathetic pathways into the limb are still poor and agree only in the most general terms. Although the major distribution system of the sympathetic supply within the upper limb is known, detailed maps of its peripheral distribution are lacking. Despite this lack of knowledge, it is reasonable to assume that the more distal the sympathectomy, the more likely it is to last.

Anatomic features

Pick has written the most comprehensive text on sympathectomies in which he describes the morphologic, comparative, clinical, and surgical aspects of the autonomic nervous system. He points out that the brachial plexus does not receive its rami communicantes exclusively from the cervicothoracic sympathetic trunk; it is supplied also by the vertebral nerve. Additional sympathetic fibers may reach the brachial plexus over the sinuvertebral nerve, the carotid plexus, and the nerve of Kuntz. Intermediary sympathetic ganglia, placed in spinal nerve roots or rami communicantes, bypass the sympathetic trunk. These pathways, especially the intermediary ganglia, are often allowed to remain untouched during sympathectomy and later play an important role in residual sympathetic activity.

Pick agrees with Sunderland that the postganglionic fibers do not travel as distinct bundles in the trunks of the brachial plexus but are, as a rule, widely dispersed in the components of the plexus, especially where it crosses the first rib. Using the operating microscope, Pick dissected out the large number of possible routes of nerve supply to the vascular tree of the hand. The distal third of the radial artery is innervated by one filament from the superficial branch of the radial nerve and by eight additional twigs from the lateral cutaneous nerve of the forearm. The distal third of the ulnar artery

From the Department of Surgery, Norwalk Hospital, Norwalk, Conn. Received for publication Jan. 14, 1980.
Reprint requests: Adrian E. Flatt, M.D., Department of Surgery, Norwalk Hospital, Norwalk, CT 06856.
receives three direct branches from the ulnar nerve and a branch from the medial cutaneous nerve of the forearm.

Within the hand, the superficial palmar arterial arch receives nearly a dozen branches from the common digital nerves arising from the median and ulnar nerves. The deep palmar arch receives two branches from the deep branch of the ulnar nerve and one from the median nerve. The digital arteries themselves are said to receive anywhere from 3 to 12 twigs.

**Surgical considerations**

Previous attempts at operative ablation of the sympathetic supply to the upper limb have been based on the presumed anatomic pathways. Pick states that “the benefits, side effects and failures of surgery of the sympathetic nervous system have been evaluated by several writers at variable periods after operations ranging from a few hours to more than 10 years.”

“Several general conclusions emerged from these appraisals. In a large number of patients the lower extremity, especially the foot, remained free of symptoms over long periods; apparently, its blood vessels and sweat glands, as disclosed by objective tests, stayed denervated. Conversely, the upper extremity, especially the hand, was difficult or even impossible to sympathectomize. Early and late relapses of clinical symptoms and return of sympathetic function were very frequent. In these appraisals unsuccessful operations were usually ascribed to incomplete denervation, regeneration of autonomic nerve fibers, reorganization and activation of alternative pathways. The interruption of sympathetic pathways for the relief of hyperhidrosis in the upper and lower extremities was considered to be
control with a significant disturbance of the tissues within the digit.

The operative approach varies with the number of digits involved. A palmar incision centered at the distal palmar arch is used. A variety of approaches can be devised and all heal well in the palmar skin. Since the Y division of the common digital arteries supplies two fingers, it is possible to operate on four fingers with one central and two oblique incisions, although a transverse zigzag incision is more commonly used (Fig. 2).

After the palmar fat has been retracted, each digital artery is cleared around its circumference and its deep, or dorsal, surface is inspected to make sure that the clearance area is selected distal to the point of junction of a distal perforating artery.

Although the operating microscope can be used, I usually employ a 2× loupe and find that this is sufficient magnification to do the tedious but essential removal of the adventitia. It is impossible to state how much adventitia to remove. A longitudinal distance of at least 3 to 4 mm should be cleared, but how “deep” or thick a circumferential removal is necessary remains a judgment area. Certainly the vessel must not be perforated, but the more adventitia that is removed, the more likely it is that the sympathetic supply will be interrupted.

The wound is closed with interrupted 5-0 nylon sutures, and postoperative care is minimal. If a temperature rise occurs, it is usually apparent within 24 hours and shows little or no rebound. A rise that occurs tends to stay level for many weeks.

**Patients treated**

Over a 20-year period, only eight patients, four men and four women, have been treated with this operation: all have benefited—some more than others. The operation has been advised for circulatory failure within the digits secondary to such conditions as frostbite, trauma, and Raynaud’s disease. The patients’ ages have varied from the early twenties to the middle fifties; the follow-up ranges from 1 to 17 years (Table I).

Assessment of the results of surgery has been difficult. Subjective comments of my patients have been recorded in Table I. Pulse volume recordings have not been done routinely. Skin temperature monitoring of the selected digit(s) was done both preoperatively and postoperatively to provide some objective measurement. A portable, battery-powered YSI Tele-Thermometer was used (Fig. 3). The temperature probes were secured with a small piece of tape, and care was taken to not obstruct the circulation by using...
Fig. 3. A battery-powered, portable YSI Tele-Thermometer is used to measure and monitor digital skin temperatures. Probes are attached to both radial and ulnar sides of the subject digit and, where appropriate, adjacent digits are measured for control purposes.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (years)</th>
<th>Diagnosis</th>
<th>Duration of symptoms</th>
<th>Digit(s) affected</th>
<th>Operation</th>
<th>Follow-up time (yr)</th>
<th>Surgical result</th>
<th>Subjective result</th>
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</thead>
<tbody>
<tr>
<td>V. B.</td>
<td>56</td>
<td>Frostbite</td>
<td>7 years</td>
<td>R II; R III</td>
<td>1958</td>
<td>3</td>
<td>II 2.5°F gain; III 2.5°F gain, healed</td>
<td>&quot;Considerably better, out-of-doors&quot;</td>
</tr>
<tr>
<td>E. K.</td>
<td>51</td>
<td>Frostbite</td>
<td>4 years</td>
<td>R III</td>
<td>1961</td>
<td>6</td>
<td>III 2.5°F gain, healed</td>
<td>&quot;Returned to farming, worked all winter&quot;</td>
</tr>
<tr>
<td>C. C.</td>
<td>22</td>
<td>Frostbite</td>
<td>4 months</td>
<td>R II-V</td>
<td>1962</td>
<td>17</td>
<td>III 1.5°F gain</td>
<td>&quot;Warmer than other hand&quot;</td>
</tr>
<tr>
<td>T. S.</td>
<td>30</td>
<td>Trauma (crush)</td>
<td>1 year</td>
<td>R III</td>
<td>1977</td>
<td>2.5</td>
<td>III 4°F gain</td>
<td>&quot;Better but still sensitive&quot;</td>
</tr>
<tr>
<td>H. D.</td>
<td>31</td>
<td>Trauma (grenade explosion)</td>
<td>1 year</td>
<td>R III</td>
<td>1978</td>
<td>2</td>
<td>III 2.5°F gain</td>
<td>&quot;Now can get into freezer&quot;</td>
</tr>
<tr>
<td>J. H.</td>
<td>22</td>
<td>Raynaud's disease</td>
<td>2 years</td>
<td>L II</td>
<td>1976</td>
<td>4</td>
<td>II 2°F gain</td>
<td>&quot;Pain gone, nail normal&quot;</td>
</tr>
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<td>J. H.</td>
<td>22</td>
<td>Raynaud's disease</td>
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<td>R I</td>
<td>1976</td>
<td>4</td>
<td>I 3°F gain</td>
<td>&quot;Pain gone, nail normal&quot;</td>
</tr>
<tr>
<td>R. G.</td>
<td>40</td>
<td>Raynaud's disease</td>
<td>9 years (cerv. sym. failed)</td>
<td>R II-V; R II; R IV</td>
<td>1976</td>
<td>2</td>
<td>II 2°F gain; IV 2°F gain</td>
<td>&quot;Pain much less, some healing&quot;</td>
</tr>
<tr>
<td>C. S.</td>
<td>41</td>
<td>SLE and Raynaud's disease</td>
<td>17 years</td>
<td>R II-V</td>
<td>1978</td>
<td>1</td>
<td>II and III 7°F gain; IV and V 4.5°F gain; later temperature drop</td>
<td>&quot;Better, no pain, but some discomfort&quot;</td>
</tr>
</tbody>
</table>
circumferential taping. Two probes were used on the affected digit so that both radial and ulnar digital arteries could be monitored; adjacent digits were also measured for control purposes.

Three patients with aftereffects of frostbite have done well. Two men, both of whom had ulcerated fingertips, showed a persistent gain in skin temperature after sympathectomy with healing of the ulcers. Both had outdoor occupations and were able to work in subsequent Iowa winters without a recurrence of their previous pain (Fig. 4). The third frostbite victim was a woman 22 years of age who was operated on only 4 months after suffering severe frostbite. Immediate symptomatic improvement occurred, although the temperature rise stabilized at only 1.5° F. Seventeen years later she reports that she has recently abandoned a job which required handling of frozen turkeys for 8 hours a day. However, she can use her domestic refrigerator and freezer with impunity.

Two men had a sympathectomy of their right long finger about 1 year after cold sensitivity developed subsequent to crush injury to the digit. Each showed a significant postoperative skin temperature rise, but neither had a complete relief of symptoms. However, both were able to work a full day, and both could retrieve beverages from the refrigerator without precipitating symptoms.

Three women have had four digital sympathectomy operations for varying presentations of Raynaud-type disease. Two of these women, 40 and 41 years of age, had long-standing Raynaud-like symptoms complicated by the present of scleroderma and systemic lupus erythematosus (SLE) respectively. Symptoms in both patients were not controlled by medication and operative cervical sympathectomy had brought no relief to the woman with scleroderma. Her digital sympathectomy did not lead to complete healing of her ulcerated fingertips, but it did provide a persistent 2° F temperature rise and great relief of pain (Fig. 5). The women with SLE whose symptoms had been present for 17 years, had a dramatic early gain in skin temperatures which subsequently relapsed to a permanent 1° F rise and the conversion of her persistent pain to "some discomfort." The youngest patient, 22 years of age, had suffered from cold sensitivity on the radial side of both hands since her early teenage years. Cervical sympathetic blocks and a variety of medications had proved useless, and when the patient was first seen, the
Fig. 5. Raynaud’s disease and scleroderma. A, Both hands before digital sympathectomy. B, The right hand 6 weeks after sympathectomy. There was no obvious improvement in the index finger, but the ring finger showed early signs of healing. C, At 6 months the index finger is healed and ring finger is significantly improved. Considerable symptomatic relief persisted.

Nails of both index fingers and right thumb were atrophic, curled, and splintered (Fig. 6). The right index fingernail was totally removed, and the area was grafted with full-thickness skin. The graft failed to take, and subsequent healing was slow. Because of this

Fig. 6. Raynaud’s and nail growth failure. A, The left hand shows the distorted and atrophic index fingernail prior to sympathectomy. B, Six months later the left index fingernail is normal. The right thumbnail is shown prior to surgery. C, One year after sympathectomy of the right thumb, the thumbnail and the left index fingernail remain normal.
failure, a sympathectomy of the left index finger was
advised. Three months after this operation, the nail had
greatly improved in appearance, there was a persistent
temperature gain of 2° F, and there had been a sig-
nificant relief of pain. Three months later, a digital
sympathectomy of the right thumb subsequently yielded
a 3° F gain in temperature and the appearance of a new
normal nail.

Conclusion

This operation has been beneficial in this small series
of patients. Realizing its limitations in the management
of these difficult patients, I offer this procedure in the
care of digital vascular insufficiency.

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