

# RECURRENT INTERDIGITAL NEUROMA: CURRENT CONSIDERATIONS AND TREATMENT APPROACHES

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In several large studies, the success rate for the *first time* excision of an interdigital neuroma ranges from 76% to 96%.<sup>1-8</sup> Recurrent interdigital neuroma pain, also commonly called intermetatarsal neuroma pain or stump neuroma pain, is occasionally seen after resection of an interdigital neuroma, and is considered a common complication resulting in continued pain following the original procedure. Recurrent interdigital neuroma pain can be an agonizing and perplexing clinical problem for both the patient and surgeon. Classically, the pain is felt to emanate from the amputated end of the remaining common digital nerve. However, careful evaluation of the intermetatarsal space and surrounding forefoot are necessary in many instances to determine the exact etiology of the persistent pain. Although conservative treatment can be attempted, these recurrent problems often necessitate further surgery.

### **ETIOLOGY/DIFFERENTIAL DIAGNOSIS**

It is the author's belief that there are many potential causes of recurrent interdigital neuroma pain. Misdiagnosis or diagnosis of the neuroma in the wrong intermetatarsal space will lead to direct failure of the surgical procedure and continued pain. The third intermetatarsal space is generally considered to be the most common area for neuroma formation, although the second intermetatarsal space has been recognized by some as having an equal or greater prevalence.<sup>7,8</sup> Entrapment in other intermetatarsal spaces or multiple intermetatarsal spaces is less common. If these areas are felt to be involved, the clinician should carefully evaluate the diagnosis and the patient's response to conservative treatment prior to proceeding with surgical intervention. Every effort should be made to localize the neuritic symptoms to a single intermetatarsal space.

Often, after surgery, the unrelenting pain is a direct result of continued irritation or entrapment of the resected end of the common digital nerve. If excessive scar tissue occurs in the healing phase, or

if the nerve stump is left in an area where it will be subjected to mechanical irritation, the probability of recurrent interdigital nerve pain increases. In their series of surgeries to explore recurrent interdigital neuromas, Mann and Reynolds<sup>9</sup> noted that their patient's symptoms were routinely brought about by the adhesion of the stump neuroma to the plantar aspect of one of the metatarsal heads. In no case, did they find a recurrent neuroma to present as a bulbous, traumatic neuroma lying free within the intermetatarsal space or proximal to the metatarsal heads. Similarly, Young and Lindsey<sup>9</sup> theorized that a recurrent stump neuroma should be found adherent to the posterior plantar aspect of the metatarsal, medial to the intermetatarsal space from which the original neuroma was removed. They reported performing six cases which they felt confirmed this hypothesis.

The surgical extirpation of an interdigital neuroma requires sound surgical technique and attentive postoperative management. All too often, recurrent neuroma pain is directly related to poor technique. For example, the inexperienced surgeon often fails to resect the nerve proximally enough, thus allowing the nerve ending to become re-entrapped. The author has previously stated that he feels that this is the most common cause of recurrent stump neuroma pain.<sup>10</sup> If this re-entrapment occurs in an area where the nerve stump will be exposed to the mechanical forces of weight bearing (e.g., under a metatarsal head), the patient will relate a recurrence of the neuritic pain syndrome. When performing *first time* neuroma surgery it is imperative that the nerve trunk be sectioned proximal to the level of the deep transverse intermetatarsal ligament and metatarsal heads. Ideally, the resection should allow the nerve trunk to retract and come to rest within the intrinsic musculature of the foot.

At the time of surgery, the intermetatarsal space should be fully explored and the neuroma and/or appropriate nerve branches identified and excised. An "Interspace-Ectomy," or resection of

nerve tissue and significant amounts of surrounding soft tissue and/or fat, should be avoided. Additional nerve branches which have not been identified and resected can lead to recurrent nerve pain. After the main common digital nerve trunk or neuroma has been resected, the intermetatarsal space should be re-explored carefully to identify any remaining nerve branches or unusual anatomical variations. Amis et al.<sup>11</sup> identified numerous plantar directed nerve branches (PDNB) which, if not resected, could contribute to recurrent neuroma pain. These PDNBs were found to be greatest in number distally at the level of the deep transverse intermetatarsal ligament, or just proximal to it. They recommended proximal resection of the common digital nerve branch to decrease the likelihood of recurrent interdigital neuroma pain. Other authors have similarly discussed accessory nerve branches and implicated them as a cause of recurrent interdigital neuroma pain.<sup>8,9,12</sup>

Further, the likelihood of the re-entrapment of the nerve end can be increased if the patient develops a postoperative infection or hematoma. Meticulous surgical technique is mandatory to prevent excessive bleeding and scar tissue formation. Obviously, any postoperative complication which results in a greater amount of scar tissue formation can result in stump neuroma pain.

Postoperatively, patient non-compliance or lax postoperative care can lead to excessive bleeding, swelling and postoperative scar tissue formation. Typically, following *first time* neuroma surgery through a dorsal incisional approach, the patient is maintained in a surgical shoe for the first 10 to 14 postoperative days. Although the patient is permitted to walk, they are strongly discouraged from returning to occupations which require prolonged standing or walking and they are encouraged to elevate their extremity and limit their activities.

Regardless of the initial surgical approach, the surgeon should follow several basic fundamentals, as outlined by Miller<sup>13-15</sup> to minimize complications. These principles include 1. Gentle handling of tissues at all times; 2. Meticulous hemostasis (a tourniquet can be used, but is not mandatory); 3. Identification of the digital branches before completing the resection; 4. Removal of the neuroma without damaging the intermetatarsal artery or tendons of the lumbricales; 5. Clean

transection of the nerve proximally to prevent irritation or adhesions to the stump; 6. Closure of the dead space as necessary, and if this is not possible, insertion of a closed suction drain; and 7. Use of a firm, even, compression dressing to prevent postoperative hematoma formation. The attentive surgeon will note that adherence to these tenets of interdigital neuroma surgery will directly decrease the probability of stump neuroma pain.

## CLINICAL PRESENTATION

The typical patient presenting with recurrent interdigital neuroma pain has minimal or only temporary relief of their initial symptomatology after neuroma surgery. In most instances, the patient's symptoms become apparent between 3 and 12 weeks after the initial surgery, as the patient's postoperative pain continues and again becomes primarily neuritic in nature. Less frequently, a late or delayed return of symptoms occurs. Beskin and Baxter<sup>16</sup> found two main clinical groups in their follow-up study of recurrent interdigital neuroma pain; the first group never obtained significant relief from their initial operation, while the second group obtained satisfactory relief from their first surgery for as long as 10 years before a recurrence of pain was related. Why some patients obtain complete relief only to redevelop symptomatology at a later date remains unknown.

The patient's symptomatology may or may not be similar to those experienced before their first surgery. Typically, exquisite tenderness is present, with palpation at the site of the nerve entrapment. The pain is usually neuritic in nature, with the patient complaining of sharp, burning, or electrical-type pain. Frequently, the patient continues or begins to complain of a painful plantar "lump" or sensation of "a wrinkled stocking." Most patients relate persistent difficulty with weight bearing and difficulty with shoes.

Careful examination should be performed to pinpoint the area of maximum tenderness and to ensure that the continuing pain is not coming from another source. If the pain is dull in nature, the astute clinician should carefully rule-out metatarsalgia or mechanical pain due to loss of the plantar fat pad or fat pad atrophy. Neuritis or neuroma formation in contiguous intermetatarsal spaces must also be considered as possible causes of the continued pain when the evaluation is done. If

a dorsal incision was used for the first surgery, the clinician must differentiate potential dorsal cutaneous nerve entrapment from plantar stump neuroma pain. If a plantar incision was used for the initial surgery, the possibility of a painful plantar scar must be entertained. Pinpointing the area of maximum tenderness can often provide the surgeon with valuable information as to where the amputated end of the nerve is situated.<sup>10</sup>

The diagnosis of a recurrent interdigital neuroma is generally made based upon the patient's reported symptomatology and the clinical findings of a thorough examination. Occasionally, a diagnostic nerve block may aid in the diagnosis. Although they can be performed, there have been no well-documented studies to show that electrodiagnostic studies and advanced imaging studies (e.g., MRI studies) have been helpful in this condition.

### CONSERVATIVE TREATMENT

When recurrent interdigital neuroma pain is suspected, aggressive conservative treatment, similar to that used for a primary Morton's neuroma, should be initiated immediately. This treatment can include modification of shoes, corticosteroid injections, oral anti-inflammatory medication, physical therapy including phonophoresis or iontophoresis, and biomechanical support with padding, strappings, or orthoses. Topical capsaicin might also be tried, but the author has not found this medication to be effective for recurrent interdigital neuroma pain. Similarly, the author has found that injections with sclerosing agents, such as phenol, alcohol, or vitamin B12, have had less predictable or unsatisfactory results. Malay<sup>17</sup> accurately noted that conservative treatment of recurrent interdigital neuroma pain rarely reduces the patient's symptomatology to a satisfactory or tolerable level. When reasonable attempts at conservative treatment have failed, surgical intervention should be considered.

### SURGICAL TREATMENT

Prior to performing surgery for a suspected recurrent neuroma, the surgeon should fully inform the patient as to the diagnosis, suspected etiology, proposed surgical procedure, postoperative course and plan, and the realistic goals and prognosis of

the treatment. Any differences in the revisional surgical approach from the initial surgical approach should be emphasized to the patient. If either the patient or surgeon desires, second opinion consultation should be sought.

Revisional interdigital neuroma surgery may be approached through either a dorsal or plantar approach. Mann and Reynolds<sup>8</sup> advocated a dorsal approach, while Beskin and Baxter<sup>16</sup> primarily used a proximal plantar transverse approach. Most other authors have espoused a plantar longitudinal approach.<sup>6,9,10,14,15,17-20</sup> Proponents of the dorsal approach cite it as the least traumatic approach with the advantage of avoidance of a potentially painful plantar scar. Advocates of the plantar longitudinal approach argue that painful plantar scars are rare, and that the plantar approach gives unequivocally the most direct and best exposure. The author has utilized both a dorsal longitudinal and plantar longitudinal approach, but currently recommends a plantar longitudinal approach.

The patient is typically placed on the operating table in the supine position for this surgery. The patient can be placed in the prone position if desired, but the author has not found this to be necessary. If, during the procedure, visualization is limited by the supine attitude of the patient, tilting the operating table into a small amount of Trendelenburg (i.e., with the head of the table lower than the foot of the table) usually allows adequate visualization. Suitable local, regional, spinal, or general anesthesia is administered, and an ankle tourniquet is inflated.

Preoperative localization of the recurrent neuroma forms the basis for the incision site. A skin marker is helpful to accurately place the planned incision (Fig. 1). A longitudinal incision measuring between 4 and 8 centimeters is made over the suspected site of the entrapment. The incision is carefully placed *between* the metatarsal heads of the affected interspace to be approached. The incision is started distally at the digital sulcus and extended proximally between the metatarsals to the midshafts of the metatarsals. Occasionally, the incision is extended even more proximally to the bases of the metatarsals. The incision is carried deep, with sharp dissection and the subcutaneous tissues and fat are carefully retracted (Fig. 2). The deep transverse intermetatarsal ligament is not sectioned.

Once adequate exposure has been achieved, exploration for the stump neuroma is begun.



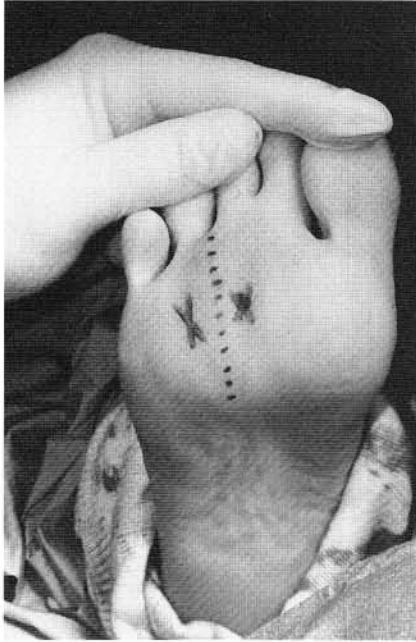


Figure 1. Plantar longitudinal incisional approach for a recurrent interdigital stump neuroma of the third intermetatarsal space. Note the third and fourth metatarsal heads are palpated, and are each clearly delineated with an "X". The incision is then carefully placed between the metatarsal heads.



Figure 2. Sharp dissection is carried deep through the skin and subcutaneous layers. Minimal undermining is done in these more superficial layers.

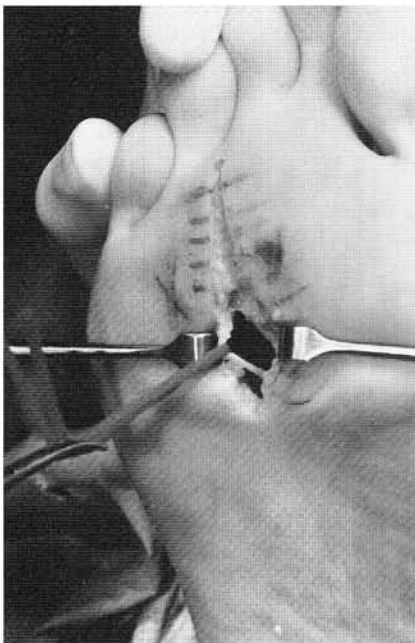


Figure 3. The proximal portion of the interdigital nerve is identified and retracted. Dissection is then carried distally to identify the traumatic neuroma and any other involved branches.



Figure 4. In this case, a traumatic neuroma is identified with its stump under the fourth metatarsal head. Once freed from the surrounding scar tissue, the nerve and neuroma are sectioned proximally.

A traumatic neuroma is typically identified lying against one of the metatarsal heads (Fig. 3). Rarely, a traumatic bulb neuroma is found lying freely between the metatarsals. If the neuroma is not easily identified, the dissection is carried more proximally, until the interdigital nerve is identified. Once identified, the interdigital nerve can be traced distally until the traumatic neuroma is seen. The interdigital nerve and traumatic neuroma are dissected free from any surrounding scar tissue (Fig. 4).

The interdigital nerve is then severed, under gentle traction, as far proximally as possible. The severed end of the nerve should come to rest within the intrinsic musculature away from the weight bearing area of the forefoot. Prior to severing the nerve, the nerve ending can be infiltrated with a small amount of soluble steroid if desired. Additionally in recalcitrant cases, the severed nerve end can be directly implanted into the body of an intrinsic muscle or into bone. The author has implanted the nerve end into both muscle and bone. Under loupe magnification, the severed end of the nerve is tagged with a small-gauge absorbable or non-absorbable suture. A small trephine hole can then be made into one of the metatarsals or a small hole can be made into one of the intrinsic muscles (i.e., typically an interosseous muscle or lumbrical). The severed nerve ending is then sutured into the hole created. If desired, the tourniquet may be deflated prior to closure to aid in achieving hemostasis. If significant bleeding is anticipated, a closed-suction drain may be inserted prior to closure.

Closure is then accomplished in layers. The subcutaneous layer is typically closed with 3-0 absorbable suture, and the skin is closed with 3-0 and 4-0 Nylon simple interrupted sutures. A compressive dressing and Jones' compression dressing are then applied.

Postoperatively, the patient is kept non-weight bearing for three weeks. At the end of three weeks, the skin sutures are removed and progressive weight bearing with a compressive stocking is permitted to tolerance. In some instances, a soft orthotic (e.g., plastizote or aliplast) is utilized to give additional shock absorption and mechanical support. Vitamin E cream or Cocoa butter are recommended to the patient to help soften the plantar scar. If the scar forms any hyperkeratotic tissue, it is readily debrided. Full activity is usually achieved after 8 to 12 weeks.

## RESULTS

The incidence of recurrent interdigital neuroma pain following *first time* neuroma surgery is estimated to be between 6% and 14%. This correlates closely with the generally accepted overall failure rate of up to 24%. Several authors have published their success rates following reoperation for recurrent interdigital neuroma pain.

Bradley et al.<sup>2</sup> did not describe their incisional approach, but did report their results in 5 patients undergoing repeat operation. They reported 1 (20%) patient with a satisfactory result (some pain but happy that the surgery was done) and 4 (80%) patients with unsatisfactory results (continued pain sufficient to limit activity significantly). These authors advised extreme caution when considering reoperation for residual neuroma pain.

Mann and Reynolds<sup>8</sup> advocated a dorsal longitudinal incision for revisional neuroma surgery. They performed 11 reoperations and noted significant improvement in 9 (81.8%) of those patients. One patient (9.1%) related marginal improvement, and 1 patient (9.1%) related complete failure of the second surgery. In each case, a recurrent traumatic neuroma was identified and histologically confirmed. Of interest, these authors noted that the deep transverse intermetatarsal ligament, which had been sectioned in each case during the original surgery, had completely reconstituted and had to be sectioned again. The authors felt that this finding might suggest that sectioning of the ligament alone, as has been suggested by some, might not give lasting relief.

Nelms et al.<sup>20</sup> reported their findings in 27 patients. All of the reoperations were performed through a plantar longitudinal incision. In each case, the neuroma was excised and the remaining nerve stump was implanted into a drill hole created in the third metatarsal. The drill hole was made perpendicular to the shaft of the metatarsal through a separate dorsal longitudinal incision with a 5/64" drill bit. A 4-0 Nylon suture was placed into the nerve stump, and the nerve stump was then routed from plantar to dorsal through the drill hole. The suture was then tied to the dorsal periosteum to ensure against plantar migration of the nerve stump. These authors reported an 89% success rate with 11 (40.7%) excellent results (complete relief of symptoms and no restriction of activity or shoes),

13 (48.1%) good results (marked improvement of symptoms, but occasional restriction of activity and shoes), and 3 (11.1%) poor results (no change from preoperative status). These authors advocated non-weight bearing postoperatively for three weeks, and local care of the healing incision with vitamin E cream and topical corticosteroids after weight bearing had begun. In their series, they reported no painful plantar scars and no stress fractures of the third metatarsal secondary to the drill hole.

In 1988, Johnson et al.<sup>19</sup> reported on their study of 34 patients undergoing 37 reoperations. In the study, 33 of the revisional surgeries were done through a plantar longitudinal incision and 4 were done through a dorsal web-splitting approach. One patient with a plantar incision was subsequently lost to follow-up, leaving 36 procedures and 33 patients in their study. Eighteen patients (50%) reported complete satisfaction (essentially pain-free, no restrictions in activity, and only minor restrictions in footwear), 7 patients (19.4%) resulted in satisfaction with minor reservations (occasional mild pain in the web space, minor restrictions in activity, and minor or moderate restrictions in footwear), 3 patients (8.3%) resulted in satisfaction with major reservations (mild or moderate residual pain, moderate restrictions in activity, and major restrictions in footwear, but overall improvement), and 8 patients (22.2%) resulted in dissatisfaction (no improvement in pain or worse pain, major restrictions in activity or footwear, and would not consider having this surgery again).

Of the 8 dissatisfied patients, 4 had no change in their pain and continued to have major restrictions in function and footwear. Two complained of worsening of their symptom complex, with pain radiating into the arch of the foot and the posterior calf. In the remaining 2 patients, a reflex sympathetic dystrophy syndrome developed. Only one of the 32 plantar incisions was associated with a painful plantar scar which formed intermittent callus at the proximal end of the scar. The specimens obtained at the time of surgery revealed 21% with a primary interdigital neuroma, 21% with a traumatic neuroma, 46% with a primary interdigital neuroma and a traumatic neuroma, and 12% with no neuromatous tissue. These findings suggest that those patients with a specimen demonstrating a primary interdigital neuroma, either in total or in part, had recurrent symptomatology due to incomplete excision of their neuroma at their

initial surgery. The non-neuromatous specimens were found to be fibrofatty tissue in three specimens and foreign-body reactive tissue secondary to silicone-rubber caps in two specimens.

Beskin and Baxter<sup>16</sup> reported their success with both a dorsal incisional approach and a plantar transverse incisional approach. The plantar incision was directed over the affected intermetatarsal space and was placed proximal to the metatarsal heads and the primary weight bearing area of the forefoot. The authors evaluated 38 procedures in 30 patients. Each patient was asked to subjectively rate their improvement as 100%, 75%, 50%, 25%, or 0%. The authors found 17 (44.7%) of their procedures had resulted in 100% improvement, 8 (21.1%) had resulted in 75% improvement, 8 (21.1%) had resulted in 50% improvement, 2 (5.3%) had resulted in 25% improvement, and 3 (7.9%) had resulted in 0% improvement. The overall results of the two surgical approaches were similar.

DiNapoli<sup>18</sup> also advocated a plantar approach, but utilized a curvilinear or modified "Z" incision. He evaluated 13 cases of revisional neuroma surgery - 11 through a plantar incision and 2 through a dorsal longitudinal incision. In most of his cases, DiNapoli resected the traumatic neuroma, performed an epineuroplasty, and relocated the nerve end into the intrinsic musculature. He reported a total resolution of the patient's symptoms in 12 of the 13 patients (92.3%). The one failure in this study developed a recurrence of their pain and also developed reflex sympathetic dystrophy. One patient continued to have a painful plantar scar with hyperkeratotic build-up, which existed after the initial surgery as well.

In summarizing the data from these studies, the author has attempted to differentiate excellent and good results (defined as results where the patient is completely satisfied or at worst satisfied with only minor reservations, and at least a 50% reduction in symptomatology) from fair and poor results (defined as results where the patient continues to have major complaints, greater than 50% of their pain, is dissatisfied, is unimproved, or is worse). Using excellent and good results as the criteria in this fashion, the success rates range from 20% to 92% with an average success rate of 74% in the 130 cases reviewed. Of the 125 procedures where an incisional approach could be determined,

70 (56%) were performed through a plantar longitudinally oriented incision, 31 (25%) were performed through a dorsal incision, and 24 (19%) were performed through a plantar transverse incision. The incisional approach was not reported in the 5 cases described by Bradley et al.<sup>2</sup>

Only 2 (3%) of the 70 procedures performed through a plantar longitudinal incision were reported to result in painful scars. Both of these scars were associated with hyperkeratotic tissue formation, and several authors advised caution when considering a plantar approach in a patient with preexisting plantar tylomas. There were 3 (2%) reported cases of reflex sympathetic dystrophy (RSD) developing following revisional neuroma surgery. Clearly, since this is a dreaded sequelae, the surgeon must be very attentive to the clinical signs and symptoms suggesting this syndrome. If RSD is felt to be present, treatment should be aggressive and timely.

### SUMMARY

Recurrent interdigital neuroma pain can be frustrating to both the patient and surgeon. None of the surgical approaches for stump neuroma resection results in a higher success rate than surgical approaches for the *first time* excision of an interdigital neuroma. Therefore, careful consideration to the accurate diagnosis of a new interdigital neuroma and, when indicated, meticulous surgical technique to excise the neuroma followed by attentive postoperative care, will diminish the likelihood of stump neuroma formation. When a recurrent neuroma does occur, approaching the neuroma through a plantar longitudinal incision, prudently placed between the contiguous metatarsal heads, appears to be the most reliable surgical approach.

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