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CASE HISTORY

A 47-year-old man presents to his family physician with a 4.5-mm nodule located along the volar aspect of his right small digit (**Figure 1**). The patient describes a sharp, excruciating pain whenever the involved finger is touched. Three months prior to presentation, the patient suffered a minor laceration in this area that was uneventfully repaired in the emergency department. Thereafter, pain persisted and prevented any functional use of the right hand. On physical examination, the patient is afebrile. No erythema or warmth is present; however, a complete blood count reveals a leukocyte count of 13,500/mm³ with a differential of 65% segmented neutrophils, no band forms, and 22% lymphocytes.



Figure 1. Photograph of a finger nodule on the right small digit.

WHAT IS YOUR DIAGNOSIS?

- A) Subcutaneous abscess
- B) Suture granuloma
- C) Reflex sympathetic dystrophy
- D) Neuroma
- E) Felon

WHAT IS THE APPROPRIATE TREATMENT?

- A) Incision and drainage
- B) Amputation
- C) Steroids
- D) Physical therapy
- E) Surgical resection

ANSWERS

The patient's nodule has the typical appearance of a neuroma (D) and surgical resection (E) is the appropriate course of treatment. The nerve injury was not recognized at the time of initial repair and the severed nerve was unknowingly sutured into the skin closure. Because the location of the neuroma is prone to re-

peated trauma, leading to increased size, edema, fibrosis, and increased sensitivity of the neuroma,¹ the patient's symptoms will continue without surgical intervention.

DISCUSSION

Pathophysiology

A neuroma occurs when the regenerating fasciculi of a damaged nerve grow distally and form a disordered glioma rather than proceeding down their respective distal Schwann sheaths. Histologic signs of a neuroma include perpendicular nerve bundle growth, increased collagen deposit, and fibrosis (**Figures 2 and 3**). Any transected nerve can form a neuroma at the severed proximal end of the nerve as part of the normal healing process.² A neuroma does not form in all cases of nerve damage, but there is potential for this tumor growth.

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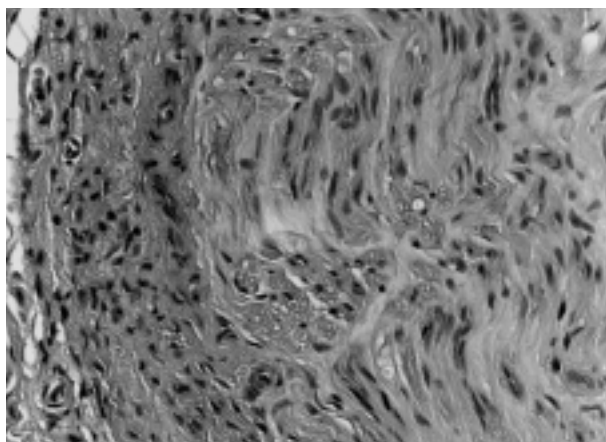


Figure 2. Histologic cross-section of abnormally directed nerve bundles as depicted by perpendicular direction of nerve bundle growth. Perpendicular growth is best appreciated by varied orientation of nuclei (circular and cigar shaped), which is suggestive of a neuroma.

Clinical Signs and Symptoms

Without surgical intervention, the initial tenderness and irritation caused by a neuroma subside throughout several weeks and the patient experiences a loss of distal sensation or motor function in the damaged appendage. With proper nerve regrowth, Tinel's sign, tingling elicited by percussion on a nerve end, can be expected to progress distally at approximately 1 to 3 mm/day, with a simultaneous decrease in Tinel's sign at the injury site.² Tenderness at the neuroma increases if the nerve experiences traction by being anchored to bone, skin, or connective tissue via scar tissue formation or surgical manipulation. Repeated pressure or trauma to the skin overlying the nerve ending also increases irritation at the neuroma.

In cases of surgical intervention, a painful neuroma can occur if the severed nerve is not rejoined, if the nerve is incorrectly reattached to a tendon or blood vessel, if the repair is complicated by infection or hematoma, if excessive scarring prevents proper nerve growth, or in the case of an amputated digit or limb. A painful neuroma can be diagnosed by the persistence of Tinel's sign and the presence of a palpable tender mass.¹ Nerve endings left in a wound appear as smooth, shiny, sensitive nodules.²

Treatment

Emergent treatment. When a patient presents with a finger laceration, the possibility of neurovascular injury must be considered. In particular, a digital nerve transection may not be immediately obvious. The digital nerves

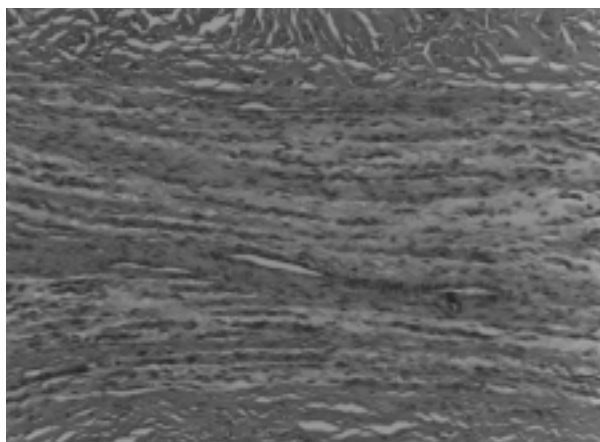


Figure 3. Histologic longitudinal section of abnormal nerve growth depicted by fibrosis with increased collagen deposit suggestive of neuroma formation.

that run to the thumb through the radial aspect of the ring finger originate in the median nerve and continue along both sides of each finger. The medial aspect of the ring finger and both sides of the little finger are innervated by the ulnar branches. The lack of two-point discrimination as well as the loss of sweating on one side of a finger reliably indicate an isolated digital nerve laceration. Fascicular nerve reapproximation is most successful when performed under microscopic magnification; emergency room repair should not be attempted. When only a nerve laceration is suspected and tendon damage is not present, the patient can be observed for several days to determine if distal sensation returns. If sensation is still lost or the area becomes more painful, prompt referral to a hand surgeon is required.³

Nonemergent treatment. Many treatments, both surgical and nonsurgical, have been attempted for painful neuromas, but no option is universally successful. Nonoperative techniques include massage, percussion, local anesthetic injection, and ultrasonography.

Surgical options are varied in both approach and success rate. In a simple neurectomy, the damaged nerve is transected and allowed to retract into a bed of healthy tissue. This procedure reports a success rate of 65%, increasing to 78% following a second surgical procedure.⁴ Another surgical option is to leave the neuroma and its capsule intact and to transfer the set to an area of less tension where no scarring will occur.¹ In the finger, a neuroma can be buried in the web space or on the dorsum of the hand. This method may be preferable if the distal end of the neuroma cannot be identified. Several authors have attempted to transect and transfer the nerve into a muscle or bone where increased pressure

or friction will not occur.^{4,5} This method has yielded a 42% to 90% success rate.^{4,5} However, because of small nerve size and significant movement of the hand muscles,⁴ this technique has not been successful in digital nerve injuries. An optional repair is placing the nerve in a less mobile forearm muscle (eg, brachioradialis).

If the distal end of the nerve is intact, a primary repair of the epineurium corrects the neuroma (**Figure 4**). If the two nerve pieces cannot be joined, a sural nerve graft can be used to bridge the distance.⁶ Good prognostic factors include an accessible tumor, a good blood supply, and an absence of thick scarring.⁶ Pain resolution is likely in cases of discrete nerve syndrome, in which all neurologic damage and pain can be attributed to a single nerve, and assuming the patient is not dependent on narcotics prior to nerve repair.⁵

Postoperative care. Postoperative care is important to the success of neuroma repair. Management should include immediate massage, desensitization, and rehabilitation. Narcotic medications should be avoided because of the risk of addiction.⁶

Differential Diagnosis

Subcutaneous abscesses, suture granulomas, reflex sympathetic dystrophy, and felons are all clinically similar to a neuroma. Although each diagnosis reflects a unique clinical entity, the physical appearance (ie, irritated superficial lesions) and symptoms (ie, pain and disuse) overlap. Differentiation is important because treatments differ radically.

Subcutaneous abscess. A subcutaneous abscess (ie, carbuncle) develops from a cutaneous abscess that has penetrated through the dermis. This gram-positive infection of skin and subcutaneous tissue manifests superficially as a boil and may result in sepsis. Diagnosis involves incision of the abscess followed by Gram stain and culture. Treatment involves pus drainage, appropriate antibiotic therapy, and proper wound care including irrigation and débridement.⁷

Suture granuloma. A foreign body granuloma secondary to retained, nonabsorbable sutures typically presents as a nodule in the dermis-subcutaneous area. The nodule is formed by a collection of specialized macrophages, termed *epithelioid cells*, and a surrounding rim of T lymphocytes both sensitized to the retained suture material. The lesion, which contains granulomatous tissue, adheres to surrounding tissue. Treatment involves curettage and drainage of the granuloma and removal of the suture material.⁸

Reflex sympathetic dystrophy. Patients with reflex sympathetic dystrophy present with severe pain, swelling, skin discoloration, and stiffness, resulting



Figure 4. Intraoperative view of lesion with exposure of the damaged nerve (opaque region).

from dysfunction of peripheral nerves containing sympathetic axons.⁹ Abnormal sympathetic discharge may result in vasodilation or vasoconstriction, increased skin redness or pallor, sweating or dryness, and coolness or fever depending on the amount of various catecholamines released and the target organ response.⁹

Felon. A felon is an infection of the distal digital pulp. Fibrous septa within the pulp compartmentalize the area of swelling with a noticeable build-up of pressure. If left untreated, a felon can cause deep ischemic necrosis and infection as well as osteomyelitis. Severe pain out of proportion to observed inflammatory findings is appreciated. Treatment includes incision and drainage prior to tissue necrosis.⁷ **HP**

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