

Kiteboarding Induced Abdominal Wall Pain: Intercostal Neuroma versus Anterior Cutaneous Nerve Entrapment (ACNES)

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Summary: Abdominal wall pain can be challenging to diagnose and treat, as many etiologies can have similar presentations. Anterior cutaneous nerve entrapment syndrome has been reported to be a significant cause of AWP. Here, we report the case of a patient who was initially diagnosed with anterior cutaneous nerve entrapment syndrome and ultimately found to have intercostal neuromas-in-continuity. The patient was a healthy 36-year-old man who presented with debilitating, chronic abdominal wall pain. The pain began after a time period when the patient was regularly kiteboarding, and it impacted the ability to exercise and perform activities of daily living. The patient had undergone extensive testing and attempted many treatments, including medication, nerve blocks, and anterior cutaneous nerve entrapment syndrome surgery. Examination was significant for 2 near-symmetric areas that were persistently tender to palpation in the subcostal abdomen. The patient underwent excision and reconstruction with two 2-cm segments of processed nerve allograft. At 1-year follow-up, the patient reported complete alleviation of the pain, discontinuation of pain medication, and a return to all normal activities. While managing patients with abdominal wall pain, physicians must consider neuroma in their differential diagnoses and be aware of its treatment options, as the patient underwent a substantial delay in treatment. Kiteboarding is a unique mechanism of peripheral nerve injury that has not been previously reported in the literature. This report demonstrates the efficacy of processed nerve allograft in the management of neuromas-in-continuity of the abdominal wall, as well as the importance of being aware of unusual manners of nerve injury. (*Plast Reconstr Surg Glob Open* 2021;9:e3487; doi: [10.1097/GOX.0000000000003487](https://doi.org/10.1097/GOX.0000000000003487); Published online 15 March 2021.)

Anterior cutaneous nerve entrapment syndrome (ACNES) is postulated to be the underlying cause of many cases of abdominal wall pain (AWP).¹ ACNES is caused by entrapment of the anterior cutaneous branch of an intercostal nerve at the lateral border of the rectus as the nerve traverses a fibrous canal between the rectus sheaths.² In contrast, abdominal wall intercostal neuroma is a distinct condition causing AWP.^{3,4} Due to the similar location of the pain, diagnosis of the 2 conditions can overlap.

Kiteboarding, also known as kitesurfing, involves the use of a large kite and wind-power to propel across water (Fig. 1). It is a high-risk sport that can cause serious injuries, including fracture, vascular dissection, and visceral laceration.⁵⁻⁷ Here, we describe the presentation and management of a patient with AWP that began after kiteboarding. The patient was initially diagnosed with ACNES, later diagnosed with intercostal neuromas-in-continuity, and successfully treated with resection and nerve reconstruction.

CLINICAL REPORT

The patient was an otherwise healthy 36-year-old man with 2 years of disabling AWP that began around a period when the patient was regularly kiteboarding. The pain was “intermittent, dull, aching, and burning” in the bilateral subcostal abdominal wall. The patient

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Fig. 1. Representative photograph of kiteboarding harness in use. Credit: Dimitris Vetsikas (Pixabay).

was evaluated by multiple physicians and underwent many unremarkable diagnostic procedures. Diagnoses included muscle strain, hernia, thoracic radiculopathy, and herpes zoster. Treatments included physical therapy, lidocaine patches, anti-inflammatory and anti-viral medication, pregabalin, transcutaneous electrical nerve stimulation, acupuncture, and nerve blocks. Abdominal wall ultrasound was significant for “focal echogenicity adjacent to the anterior cutaneous nerve suggesting fibrosis in the region of the neurovascular channel in the rectus muscle.” The patient was subsequently diagnosed with ACNES and underwent neurectomy of bilateral anterior cutaneous nerves 5 months before presentation. In the procedure, 3-cm vertical incisions were made. The nerves were identified in the subcutaneous fat and traced to the fascial opening. Approximately 2.8 cm of nerve was resected, and the cut end was allowed to retract beneath the fascia. Pathology was consistent with normal peripheral nerve. However, there was absolutely no change in the character or magnitude of symptoms, and the patient continued to require nerve blocks. At presentation, the physical examination was notable for 2 near-symmetric areas tender to palpation at the T11 dermatome at the level of the semilunar line. The patient had temporary amelioration of pain with nerve blocks; thus, the decision was made to pursue neuroma excision and reconstruction.

SURGICAL PROCEDURE

Preoperative markings were made over the painful areas. The painful areas were inferior and lateral to the previous neurectomy incisions. It was assumed that different intercostal nerves needed to be treated; so new incisions were made. Under general anesthesia, a 6-cm horizontal incision was made over the left semilunar line and through the anterior rectus sheath. The rectus muscle was pulled medially, and immediately under the area of greatest tenderness, an affected intercostal nerve was visualized and confirmed with a handheld nerve stimulator. The neuroma was yellow and firm to

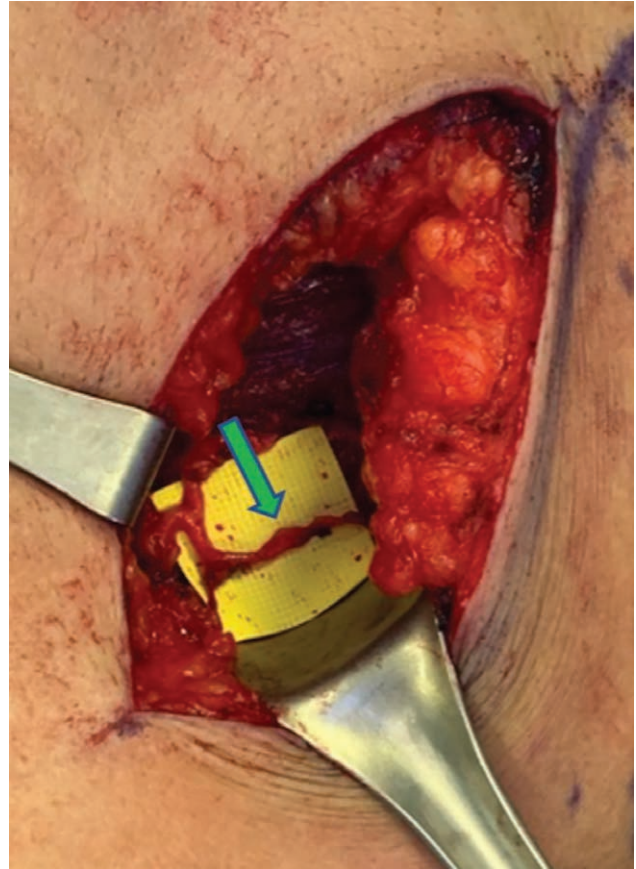


Fig. 2. Representative intraoperative photograph of neuroma of a painful left intramuscular intercostal nerve. A normal-appearing intercostal nerve is seen at the left border of the yellow background. The small nerve section identified with the green arrow was resected and reconstructed with allograft. The skin marking outlines the border of the left anterior rib cage.

palpation over a 1.5-cm area (Fig. 2). The neuroma was excised, and the nerve was reconstructed with a 2 cm × 3 mm Avance (AxoGen, Alachua, Fla.) processed nerve allograft. Each end of the graft was coapted with interrupted 7-0 Prolene suture under loupe magnification to the proximal and distal ends of the intercostal nerve. The fascia was closed with 2-0 polydioxanone suture. An identical resection and interposition graft reconstruction were performed on the right side (Fig. 3). An artery was visibly thrombosed near the right neuroma. Pathology report described both specimens as peripheral nerve tissue with fibrosis and hyperplastic change consistent with neuroma.

RESULTS

At 6 weeks after surgery, the patient reported that the localized nerve pain was entirely gone. The patient was taking Advil for mild flank and back pain. At 1 year post-operative, the patient reported the complete resolution of pain in the treated areas. The patient was no longer taking any pain medications and had resumed working full time and all normal daily activities.



Fig. 3. Intraoperative photograph of the patient's bilateral surgical sites. Healed vertical scars are from the prior distal anterior cutaneous nerve resections for treating ACNES.

DISCUSSION

AWP can be challenging to manage, as evidenced by this patient, who was initially diagnosed and treated for ACNES. Neuroma-in-continuity was suspected based on clinical examination and confirmed by an inflamed section of nerve between sections of normal-appearing nerve and the histopathological diagnosis of neuroma. The intercostal arterial thrombosis supports the theory that nerve injury occurred due to local trauma. Neuroma-in-continuity has been demonstrated to develop after traction or compression injury.⁸ The patient's history, in addition to surgical and pathological findings, led to the conclusion that trauma from the kiteboarding harness was the mechanism of injury. While kiteboarding, the harness is worn tightly to prevent slippage or rotation (Fig. 1). During regular sessions, participants experience whole-body vibration and mechanical stress to abdominal muscles while turning, jumping, and landing.⁹ The combination of compression, vibration, and stress via shearing or traction forces likely led to the development of neuroma-in-continuity.

It is unlikely that the patient ever had ACNES or that the deep neuromas were due to the prior surgery. The resection sites were distant from the neuroma sites (Fig. 3), and the pain was unchanged after the procedure. In addition, nerves affected by ACNES have degenerative changes, unlike the hyperplastic changes seen here.¹⁰ Thus, what distinguishes the patient's condition from ACNES is the involvement of the main body of an intercostal nerve (as opposed to the anterior cutaneous branch) and the finding of neuroma in the operating room and upon histology.

Autograft and allograft can provide high rates of sensory recovery with low complication rates for nerve reconstruction.^{11–14} For this patient, processed nerve allografts

(PNA) were selected over autografts due to the short length of the nerve gaps, the multiple grafts required, and the desire to avoid donor site morbidity. The senior author has used PNA to treat multiple patients with abdominal wall neuroma.¹⁵ Patients have not reported significant dysesthesia during the recovery process, and most have recovered sensation to the affected dermatome. Additional study is warranted to comprehensively assess the postoperative outcomes of abdominal wall neuroma reconstruction with PNA.

In this report, bilateral abdominal wall neuromas-in-continuity caused by kiteboarding were successfully treated with excision and reconstruction with PNA. Chronic AWP, in general, and intercostal neuroma, in particular, are difficult to diagnose, and they often lead to excessive testing, multiple procedures, and significant financial and physical burden for the patient.^{1,3,4,16} Intercostal neuroma can be distinguished from ACNES with a thorough history to understand the inciting mechanism, a detailed physical examination, and the use of anesthetic injections to localize the injured nerve. Surgeons should be aware of unique manners of nerve injuries throughout the body, the distinction between ACNES and intercostal neuroma, and the surgical interventions available to decrease neuropathic pain.

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PATIENT CONSENT

The patient provided written consent for the use of his image.

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