

# Surgical Management of Abdominal Anterior Cutaneous Nerve Entrapment Syndrome: Case Report, Surgical Technique, and Literature Review

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**Background:** Abdominal anterior cutaneous nerve entrapment syndrome (ACNES) is an emerging diagnosis, with estimated incidence of 13%–30% of the adult population. It is a syndrome characterized by chronic abdominal pain caused by entrapment of cutaneous branches of thoracoabdominal nerves at the lateral border of the rectus abdominis muscle. If conservative treatment with pain medication, botulinum toxin, or lidocaine injections is inadequate, surgical management is indicated.

**Methods:** We present a case of a 40-year-old woman presenting with a 1-year history of daily right anterior abdominal wall pain, consistent with a diagnosis of ACNES. We describe our approach for an anterior neurectomy of the intercostal nerve with closure of its fascial foramen.

**Results:** Three months after surgery, she remained pain free and was back to work full time. At a 13-month follow-up, the patient reported that her pain had resolved completely following surgery.

**Conclusions:** Results are encouraging following anterior neurectomy for ACNES. Surgical descriptions in the literature are brief, with limited pictorial account. Our detailed surgical approach is provided along with a review of the existing literature on the management of ACNES. (*Plast Reconstr Surg Glob Open* 2021;9:e3453; doi: 10.1097/GOX.0000000000003453; Published online 26 March 2021.)

## INTRODUCTION

Abdominal anterior cutaneous nerve entrapment syndrome (ACNES) is defined as the entrapment of one or more intercostal nerves (T7–T12) as they turn sharply from their course between the internal oblique and transversus abdominis muscles anteriorly toward the rectus abdominis on their way to terminate in the skin (Fig. 1).<sup>1,2</sup>

ACNES has been described as the “forgotten diagnosis,” as it is commonly overlooked when investigating cases of undifferentiated abdominal wall pain.<sup>3</sup> Since it was first described in early 1900s by Carnett and Bates,<sup>4,5</sup> ACNES continues to be a controversial pain entity with regards to its management and even to its mere existence.<sup>4</sup> Boelens et al<sup>6,7</sup> published a randomized controlled trial on ACNES,

bringing greater awareness to the condition, establishing criteria on its diagnosis, and elucidating the role of surgery for its treatment.

Diagnosing ACNES is challenging, and a high index of clinical suspicion is critical. Although surgical trauma, including adhesions, hernia, and scars are known causes of peripheral nerve entrapment, most patients with ACNES do not have such events in their medical history. Five to 10 percent of patients referred to gastroenterologists have somatic pain diagnoses consistent with chronic abdominal wall pain, as opposed to a visceral cause.<sup>8</sup>

Multiple authors have described a range of subjective and objective methods to narrow down the diagnosis. These include the location of pain, with the right lower quadrant more commonly affected than the left, in a 4:1 ratio.<sup>9</sup> The quality of the pain often has both dull and sharp components with the presence of a trigger point at the border of the rectus abdominis muscle.<sup>10,11</sup> Carnett’s test has been heralded as the central test to distinguish between parietal and visceral origins of abdominal pain and is important to the diagnosis of ACNES. To perform

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this assessment, once the clinician has identified the area of maximal tenderness localized by their fingertip, the patient is asked to raise their head or extend their legs. This causes the patient's abdominal muscles to tense. If the pain is at least the same or worse, the test is considered positive and to originate from the abdominal wall.<sup>9</sup> The diagnosis of ACNES is also supported when the patient has negative laboratory and imaging tests for intraabdominal pathology, rectus abdominis denervation signs on electromyography, and temporary relief of pain >50% of baseline at trigger points following lidocaine infiltration.<sup>1,6,9,12-14</sup>

Management of ACNES includes medical and interventional options. A variety of medications, including nonsteroidal anti-inflammatory drugs, neuroleptics, tricyclic antidepressants, and benzodiazepines can be considered, but reported efficacy is low and most patients continue to have persistent symptoms.<sup>15,16</sup> Interventional techniques include lidocaine trigger point infiltration with or without corticosteroids, chemical neurolysis, radiofrequency ablation, and botulinum toxin injections.<sup>6,7,10,12-14,17-18</sup> Surgical management, in the form of anterior neurectomy, has been described in the literature with one study reporting resolution of symptoms in 71% of treated patients.<sup>10</sup> To treat the anatomic impingement of the intercostal nerve(s) in ACNES, we

perform an anterior neurectomy of the intercostal nerve with closure of its fascial foramen.

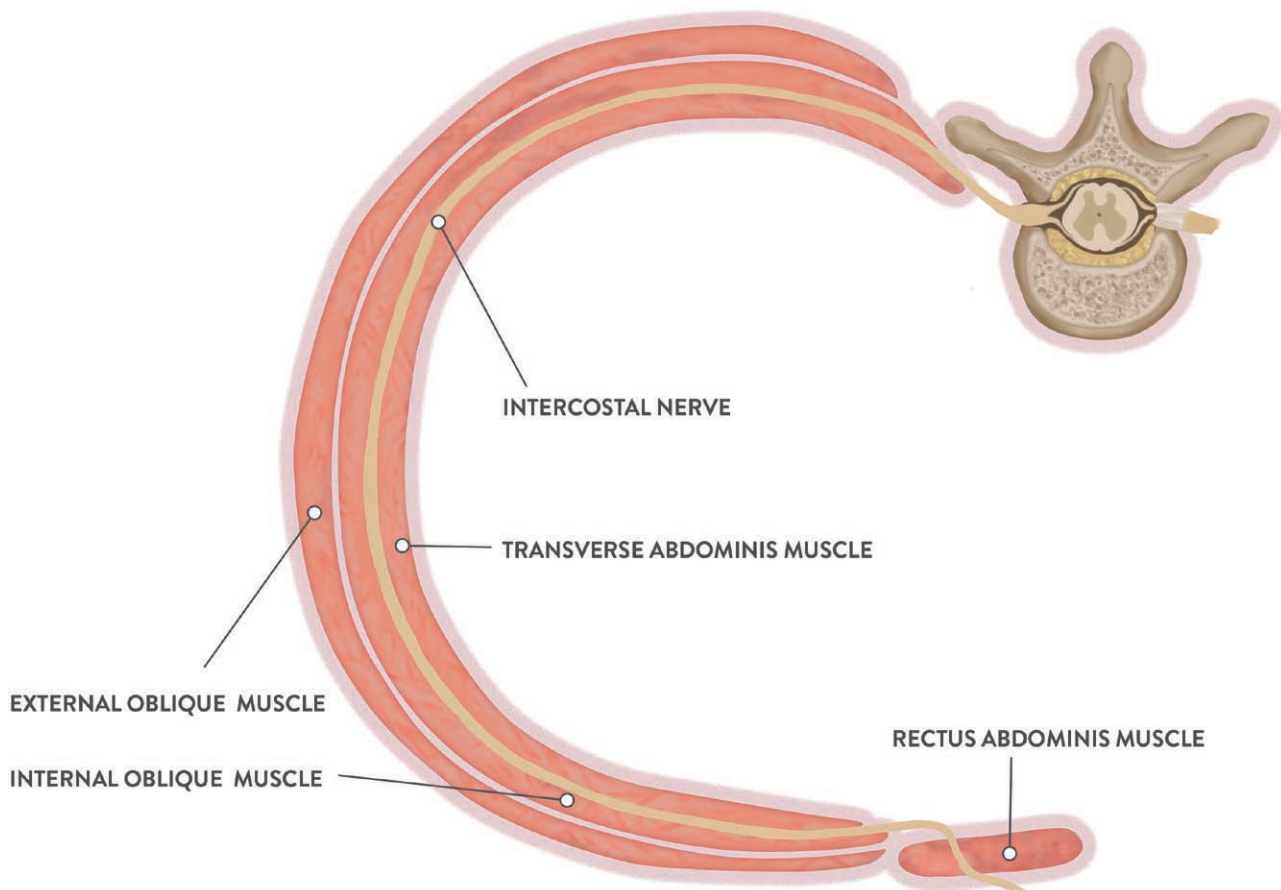
### CASE PRESENTATION

A 40-year-old woman presented with a 1-year history of daily right anterior abdominal wall pain, described by the patient as severe and shooting. The pain initially began after a strenuous abdominal workout. She had already been investigated by general surgery and gastroenterology for diverticulitis for which she was treated with multiple courses of intravenous antibiotics with no improvement of symptoms.

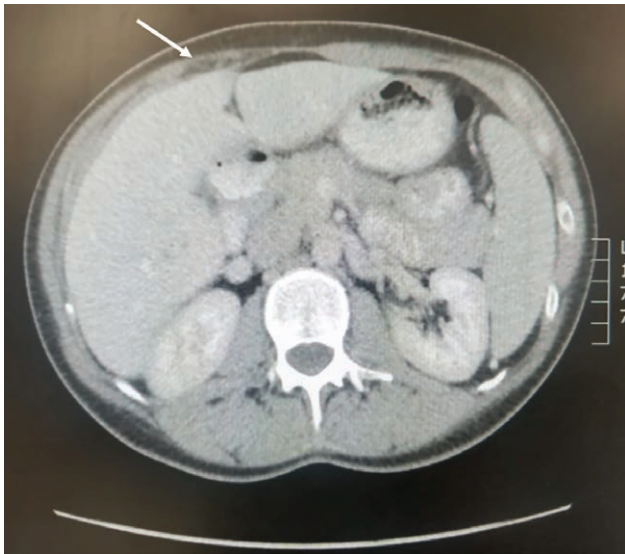
Diagnostic anterior abdominal wall lidocaine injections were performed. The patient responded positively with pain relief lasting 2 weeks. She was trialed on gabapentin, which reduced her abdominal wall pain but was discontinued secondary to side effects of fatigue.

On physical examination, her pain was localized along the border of the right rectus abdominis, lateral to the umbilicus, and she had a positive Carnett sign. The addition of abdominal muscle tension exacerbated her symptoms, for example, when doing sit-ups or sitting up from a supine position.

Needle electromyography was performed. Three centimeters lateral to the umbilicus and over the right rectus abdominis, fibrillations and positive sharp waves were noted. There was an increase in polyphasic units. The



**Fig. 1.** Cross section of thorax showing course of intercostal nerve as it turns sharply from its course between the internal oblique and transversus abdominis muscles anteriorly toward the rectus abdominis.



**Fig. 2.** Cross section of abdomen: computerized tomography showing atrophy of right rectus abdominis muscle.

left rectus abdominis showed simple units with a normal recruitment pattern and firing rate, and there were no fibrillations or positive sharp waves. The electrodiagnostic findings demonstrated denervation of the right rectus abdominis muscle. Furthermore, her previous abdominal computed tomography, which had identified diverticulitis, demonstrated atrophy of the right rectus abdominis relative to the left (Fig. 2). Muscle atrophy is an infrequent finding under this condition. This can occur with repeated steroid injection at the site of discomfort, although our patient did not have this intervention. In most cases, rectus abdominis muscle atrophy in ACNES is the result of disuse of the muscle secondary to pain. A diagnosis of ACNES was made at the T9–T10 right rectus abdominis and surgical intervention was pursued given her ongoing symptoms.

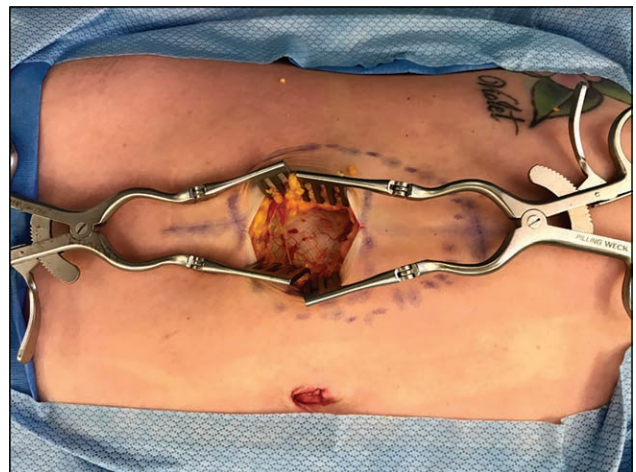
### SURGICAL APPROACH

The area of maximal pain was identified using the Carnett test and marked preoperatively. A 5-cm radius was marked on the skin where the patient described radiation of the maximal pain. A longitudinal incision was designed centered at the point of maximal tenderness at the lateral border of the right rectus abdominis muscle (Fig. 3). Alternatively, a lower abdominoplasty incision could have been used to conceal the scar when in clothing. Undermining of the skin flap along the rectus abdominis fascia would then have to be performed superiorly toward the region of maximal discomfort. Our patient did not have a preference for incision placement, and therefore, the most direct approach was used.

The patient was positioned supine on the operating room table. General anesthesia was used, and paralytics were avoided to permit for intraoperative nerve stimulation. The skin was incised vertically, and the underlying anterior rectus sheath fascia was identified (Fig. 4). The fascia was incised to expose the rectus abdominis muscle (Fig. 5).

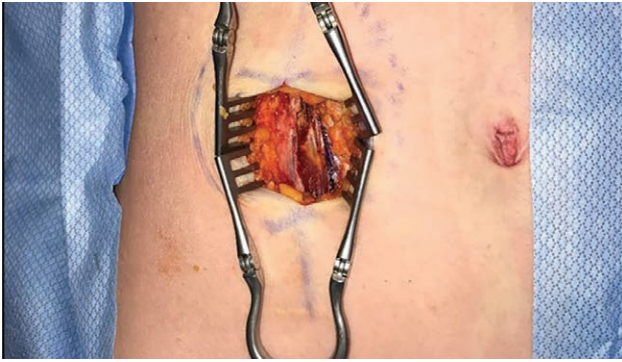


**Fig. 3.** Preoperatively, the point of maximal tenderness was marked with an X. The broader circular area of tenderness was marked with a dotted line (upper arrow pointing to the dotted circle). The lateral border of the right rectus muscle was marked with a straight longitudinal line (lower arrow, pointing to the straight purple line); the planned incision was between the second and third vertical hash marks.



**Fig. 4.** The initial incision was performed through skin and subcutaneous fat to the level of the anterior rectus sheath fascia as shown here.

The rectus abdominis was retracted medially and segmental neurovascular bundles, containing the intercostal nerve, artery and 2 venae comitantes, were identified<sup>2</sup> (Fig. 6). At T9 and T10, the intercostal nerves were isolated from their associated intercostal artery and vena



**Fig. 5.** After opening the anterior rectus sheath fascia, the right rectus abdominis muscle was visualized.



**Fig. 6.** The right rectus abdominis muscle was retracted toward the midline, exposing the neurovascular bundles of T9 (black arrow) and T10 (white arrow).

comitantes and followed laterally to their fascial foramina. Here, the neurovascular bundle was encircled by a fibrous ring, composed of fibers from both the anterior and posterior rectus sheaths. At T9 and then at T10, traction was applied to the intercostal nerve and it was transected. The nerve was then followed distally (medially) and excised. The proximal (lateral) nerve stump was permitted to retract posteriorly into the plane between the internal oblique and transversus abdominis muscles. The fascial foramen was then closed with a figure-of-eight vicryl suture to prevent the development of a symptomatic neuroma to the skin. The anterior rectus sheath and overlying skin were closed in layers using absorbable sutures (Fig. 7). Local anesthetic was infiltrated to minimize immediate postsurgical pain and to help prevent later neuropathic pain<sup>20,21</sup> (Fig. 8) (Video 1). (See Video [online], which displays the impinged intercostal nerve on traction and completion of neurectomy.)



**Fig. 7.** T9 intercostal as it emerges through the fascial foramen to exit through the rectus abdominis. Here, the nerve is on traction around the red vessel loop, before neurectomy.



**Fig. 8.** The anterior rectus sheath was closed using absorbable polydioxanone sutures.

## RESULTS

The patient was discharged home on postoperative day 1 with complete resolution of pain in the symptomatic area. As expected, she did have a patch of numbness in the T9 and T10 dermatomes distal to the neurectomy site. At her 6-week postoperative visit, she reported maintained resolution of pain and complete discontinuation of pain medication. Three months after surgery, she remained pain free and was back to work full time as a police officer. At a 13-month follow-up, the patient reported that her pain had resolved completely following surgery.

## DISCUSSION

ACNES should be considered in the setting of chronic undifferentiated abdominal pain. Surgical management has been described in the literature as a potential treatment, when conservative measures have failed. van Assen et al<sup>21</sup> published a retrospective study reviewing the outcomes of 195 patients treated with anterior neurectomy. Pain scores were obtained preoperatively and postoperatively. They reported a 70% short-term operative success

rate and a 61% long-term success rate with a mean follow-up of 32 months.<sup>21</sup> Although the formation of neuroma following neurectomy is a possible long-term complication, this study with long-term follow-up of greater than 2 years provides data to suggest that incidence of neuroma or recurrence of pain is low. No other long-term data are available.

Similar data have been reported in the pediatric literature. A publication on refractory ACNES in patients 14–18 years of age reported a success rate of 78% at 4–6 weeks postoperatively. For the late follow-up, at median of 15 months, an 88% success rate was reported.<sup>22</sup> Scheltinga et al<sup>23</sup> reported on 8 pediatric patients who were treated with an anterior neurectomy. In all cases, the patients were pain free at their first postoperative visit at 2 weeks and at the median 6-month follow-up and had resumed all daily and physical activities.<sup>23</sup>

Results are encouraging following anterior neurectomy for ACNES. Surgical descriptions in the literature are brief, with limited pictorial account. In studies that describe their approach, our surgical technique has similarities. Preoperative markings are essential to identify the area(s) of maximal tenderness where the intercostal nerve(s) makes a sharp turn at the lateral border of the rectus abdominus muscle.<sup>18</sup> Other approaches in the literature describe a transverse incision overlying the Carnett point. We prefer a longitudinal (vertical) incision to expose the segmental intercostal branches. This incision allows for exploration from T7 to T12 as indicated.<sup>17–18,23</sup>

Not all published surgical descriptions involve closure of the fascial foramina through which the neurovascular bundle emerges. Of 7 articles identified in the literature,<sup>6,9,17–18,21–23</sup> which include brief descriptions of surgical approach, only 1 article specifically mentions closure of the fascial foramina with a running absorbable suture.<sup>22</sup> This step is worthwhile to minimize the risk of a symptomatic painful neuroma of the divided anterior intercostal nerve near the skin.

Mol et al<sup>11</sup> has published the largest series on anterior neurectomy, having treated 495 patients over a 5-year period. Their study sought to determine factors which would negatively influence the outcome of anterior neurectomy. They found that a history of pain medication use, abdominal surgery, a negative response to a diagnostic rectus sheath block, and the presence of paravertebral tender points along the nerve tract were predictors of a poor response to anterior neurectomy for ACNES.<sup>11</sup> This information helps the surgeon identify which patients are better candidates for surgical intervention and how to counsel patients preoperatively when considering an anterior neurectomy.

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## PATIENT CONSENT

*The patient provided written consent for the use of her image.*

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