Abdominal cutaneous nerve entrapment syndrome

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Key points
Abdominal cutaneous nerve entrapment syndrome is a frequently overlooked diagnosis in patients with abdominal pain. The syndrome is often associated with a characteristic history and physical examination findings. Significant pain relief after nerve block is considered to establish the diagnosis. An early diagnosis may prevent the development of central sensitization and spare the patient extensive investigation, including psychiatric consultation and surgery. The condition can potentially be treated successfully by using one of several treatment options.

Chronic abdominal pain is a frequently presenting condition in the pain clinics. Patients have often undergone a plethora of investigations, including diagnostic surgery and psychiatric review, before referral to Pain Management Services. Ongoing pain leads to development of central sensitization, which is heightened sensitivity to pain and touch, because of the effect of persistent pain on the neuroplasticity of the central nervous system. It can result in significant anxiety, distress, and loss of work days for the patient.

Up to 30% of patients with chronic abdominal pain have pain originating in the abdominal wall1,2 and abdominal cutaneous nerve entrapment syndrome (ACNES) is the most frequent cause of pain in these cases.3 This diagnosis can be established from the patient’s history, physical examination, and positive response to local anaesthetic injection.4 More awareness among clinicians of the abdominal cutaneous nerve entrapment syndrome could lead to earlier diagnosis and prevent the consequences of prolonged investigation and pain.

Clinical presentation
Patients with ACNES can present with acute or chronic pain. The nature of the pain can vary between individuals, but ACNES usually results in well localized, unilateral with features of neuropathic pain. Retrograde radiation of pain from an entrapment neuropathy is known as the Valleix phenomenon and has been well documented, particularly in cases of carpal and tarsal tunnel syndromes. In the setting of anterior cutaneous nerve entrapment, this retrograde radiation of pain may mimic a thoracic radiculopathy. Radiation in the upper abdomen is along the horizontal course of the thoracoabdominal (T7–11) and subcostal (T12) nerves. Peripheral nerve entrapment occurs at points where a nerve either changes its direction to enter a tunnel or pass over a fibrous or muscular band.5 Applegate5 described the course of anterior cutaneous branches in his publications on ACNES. They change direction by nearly 90° while entering the rectus channel, and pass through a fibrous ring in the channel to exit via a hiatus in the overlying fibrous rectus sheath. These combined factors make them vulnerable to entrapment.

Applied anatomy
The sensory supply to the abdominal wall is via the anterior and lateral cutaneous branches of the anterior rami of the 7th–12th thoracic nerves (Fig. 1). T7 supplies the infrasternal area and T10 the level at the umbilicus. The anterior ramus of L1 is also involved, supplying the area above the pubis as the iliohypogastric nerve (T12, L1).

These sensory nerves run in a plane between the internal oblique and transverses abdominis muscles. The thoracic nerves advance to the posterior wall of the rectus sheath and each enters a neurovascular channel in the rectus muscle to supply the skin. Each of the neurovascular channels in the rectus muscle contains a fibrous ring which should allow the anterior cutaneous nerve to pass through freely; this ring however can also become a site of nerve compression and ischaemia resulting in symptoms of ACNES.

The anterior cutaneous branches of the thoracoabdominal (T7–11) and subcostal (T12) nerves are the most susceptible to entrapment because of their passage through the neurovascular channels in the rectus muscle. Peripheral nerve entrapment occurs at points where a nerve either changes its direction to enter a tunnel or pass over a fibrous or muscular band.5 Applegate5 described the course of anterior cutaneous branches in his publications on ACNES. They change direction by nearly 90° while entering the rectus channel, and pass through a fibrous ring in the channel to exit via a hiatus in the overlying fibrous rectus sheath.

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in females. Factors that potentially stretch the neurovascular bundle within the rectus muscle either from behind or pulling from the front have been noted in patients with ACNES. Previous abdominal surgery, laparoscopic surgery, pregnancy, and sports activity involving rectus muscle are some of the commonly identified factors. Cutaneous branches can also become entrapped in scar tissue; therefore, the dermatomal distribution of abdominal wall pain should be considered in relation to the site of any abdominal scars.

**Diagnosis**

**Clinical findings**

On clinical examination, patients can usually lie still without significant distress and locate the point of pain with a fingertip. Deep palpation of the abdomen does not elicit the tenderness associated with peritoneal involvement. Carnett’s sign, first described by John B. Carnett in 1926, is useful in identifying the abdominal wall as the source of pain. It is positive if splinting of the abdominal muscles while pressing on the painful point increases the pain. In the supine position, the patient is asked to lift either their head and shoulders or their straight legs off the bed while the examiner presses over the tender area. Contraction of the rectus muscle constricts the neurovascular channel and worsens the compression neuropathy in patients with ACNES. Other conditions resulting in a positive Carnett’s sign are abdominal hernias, abdominal wall haematomas, and rib tip syndrome. The Hover sign has also been described in cases of ACNES. If the anterior openings in the rectus sheath are palpable, pressure over the nerve passage will cause pain in a patient with ACNES and this is a positive Hover sign.

Sensory disturbance such as hypaesthesia, hyperalgesia, or allodynia around the area of pain also supports a diagnosis of ACNES. Sensory abnormalities around the point of maximal tenderness have been noted in as high as 75% of these patients.

**Diagnostic interventions**

ACNES can be diagnosed by local anaesthetic injection into the neurovascular channel in the rectus muscle. The local anaesthetic injection blocks sensory transmission, but it is hypothesized that it also reduces any compressive herniation through the fibrous channel by hydro-dissection of tissue causing nerve entrapment. A recent single-centre randomized double-blind controlled trial validated the use of local anaesthetic infiltrations against the saline injections in the diagnosis of ACNES.

Landmark techniques have been used to position the needle for local anaesthetic injection. Oval-shaped depressions may be palpated on the lateral edge of the rectus muscle corresponding to the aponeurotic openings for T8, 9, 10, 11, and 12 anterior cutaneous nerves. At the depression, the needle is advanced through the skin, subcutaneous tissue, and just past the aponeurosis into the fatty plug surrounding the nerve and blood vessels emerging from the channel in the rectus. This is the point of injection. Others have used a nerve stimulator to identify the nerve.

Ultrasound-guided local anaesthetic injection is increasingly recommended in the literature. It allows accurate placement of the local anaesthetic, with minimal discomfort to the patient. The ultrasound probe is positioned in the anatomic transverse plane medial to the painful point. A high-frequency transducer in the range of 10–15 MHz is preferable for visualization of superficial nerves, but this high frequency may limit the depth of penetration and the full thickness of the rectus muscle must be visualized. A broad bandwidth allows the operator to select the examination frequency best matched to the patient’s anatomy. A broad bandwidth 38 mm linear array transducer is ideal. The medial border of the rectus muscle and the linea alba is visualized, with the rectus appearing as a hypoechoic area enclosed in a hyperechoic fascia. Moving the ultrasound probe laterally brings the lateral border of the rectus and the linea semilunaris into view. Approximately 0.5–1 cm medial to the hyperechoic semilunaris, the nerve can be located as a hyperechoic oblique line within the rectus muscle (Fig. 2). Visualization of the nerve or the tunnel is optimized by cephalocaudad movement or tilting of the probe to allow the array of ultrasound beam to travel as much parallel to the nerve as possible. This usually coincides with the point of maximal tenderness elicited on examination and is the anterior cutaneous nerve passing through the rectus. Under aseptic conditions, the ultrasound needle is advanced in the longitudinal axis of the probe from medial aspect to reach channel and the nerve in the rectus. The needle can be gently advanced within the rectus muscle to reach the posterior rectus sheath. The needle tip should be visualized all the time to avoid penetration of peritoneum. A 22 G...
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50 mm needle is suitable in slim patients, but a 90 mm needle may be required in patients with more subcutaneous tissue. A volume of up to 3 ml is injected while checking for spread of the hypoechoic injectate into the rectus channel.

The probabilities of missing more serious visceral disease are small with careful use of diagnostic criteria and follow-up of patients. Quantitative sensory testing is being developed for use in neuropathic pain states and may prove a useful diagnostic tool, but it requires further validation.

Management

Establishing the pathoanatomical diagnosis may, in itself, be a positive intervention for patients who have long suffered with abdominal pain of unknown aetiology. The accurate diagnosis has the potential to alleviate some of the unpleasant implications of this abdominal pain of presumed psycho-somatic origin. A multidisciplinary approach involving education, rectus muscle stretch exercises, and reduction in identified precipitating activities should be instituted for all patients with ACNES.

Application of heat or cold, use of abdominal binders, and transcutaneous electrical nerve stimulation machine may be useful in managing the acute flare-ups of ACNES. Although non-specific pharmacological therapies such as paracetamol, non-steroid anti-inflammatory, anti-convulsants, anti-depressants, and opioids are commonly used, their efficacy is unclear in established cases of ACNES. Topical treatments such as 5% lidocaine plasters, and capsaicin cream (0.025–0.075%) have also been used in the management. In spite of paucity of evidence for these medications in nerve entrapment syndromes, they are useful in the treatment of some patients.

Minimally invasive techniques have been successfully used to manage this type of nerve entrapment syndromes. A combination of local anaesthetic and corticosteroids is the most commonly used injectate. Traditionally, these injections were done using the landmark technique. At least six separate case series involving a total of 538 patients have been reported in the literature using landmark technique. In a cohort of 139 patients with suspected ACNES, 44 (33%) patients were successfully treated exclusively with injections. In this cohort, nearly one-third of patients needed a second infiltration for prolonged pain relief. In spite of these reports, some doubted the existence of this condition because of the intricate fallacies of the landmark technique and attributed the success to placebo.

Introduction of ultrasound to identify these nerves has not only imparted precision and safety to the procedure but also allayed some of the fears exhibited by the critics. The first report of ultrasound-guided abdominal cutaneous nerve injections was published in 2011. It found the median duration of pain relief to be 12 weeks.

Ever since, there have increasing reports of ultrasound-guided injections.

Neurolytic agents such as phenol and ethyl alcohol have been injected in place of local anaesthetic for recurrent abdominal pain in the past. Owing to complications, the use of neurolytic techniques for management of chronic non-malignant pain has declined.

In an attempt to prolong the pain relief, neuromodulation using pulse radiofrequency lesion have been attempted successfully in a variety of chronic non-malignant pain conditions involving peripheral nerves. In spite of lack of robust evidence and unclear mechanism, pulsed radiofrequency of abdominal cutaneous nerves are used in some centres with variable success.

With these injection procedures, inflicting a second nerve injury resulting in iatrogenic source of neuropathic pain presents a small but significant risk. In our experience of 84 ultrasound-guided injections in 60 patients with ACNES, one patient developed post-procedural neuropathic pain. Clinically, this patient presented with burning pain around the site of injection, presumably corresponding to the sensory innervation of these nerves and was successfully managed with topical 5% lidocaine plasters.

Like other peripheral nerve entrapment syndromes, surgical options are available for ACNES. Unlike the release of entrapment in carpal tunnel or tarsal tunnel syndromes, the existing literature suggests surgical neurectomy for ACNES. Boelens and colleagues carried out a double-blind, randomized, controlled trial on surgical neurectomy for refractory pain in patients treated conservatively for ACNES. They reported that the number of patients demonstrating a positive response (a reduction of at least 50% in the visual analogue scale, 2 points on the verbal rating scale, or both) was significantly higher in the group undergoing neurectomy when compared with the group undergoing sham surgery (neurectomy, n=16/22 vs sham, n=4/22; P=0.001). Another group have reported the success of similar surgical neurectomy in five children over a period of 5 yr.

Long-term outcome including complications of surgical neurectomy is yet to be known.

Summary

Early recognition and intervention in cases of ACNES is important if patients are to be spared unnecessary anxiety, pain, loss of time, and
expense. It may potentially prevent the development of central sensitization and more complex pain. Diagnosis can be made based on history, examination, and the response to local anaesthetic infiltration. When conservative measures fail, the current treatment paradigm predominantly involves minimally invasive injection therapies. Further research should focus on the non-invasive methods of diagnosis such as Quantitative Sensory Testing and entrapment release surgeries.

Declaration of interest
None declared.

References