

Comprehensive Review

Treatment and Management of Twelfth Rib Syndrome: A Best Practices Comprehensive Review

Ivan Urits, MD¹, Nazir Noor, MD², Nathan Fackler, BS³, Luc Fortier, BS³,
Amnon A. Berger, MD, PhD¹, Hisham Kassem, MD², Alan D. Kaye, MD, PhD⁴,
Marc A. Colon, MD⁵, Sumitra Miriyala, PhD⁵, and Omar Viswanath, MD^{4,6-8}

From: ¹Department of Anesthesiology, Critical Care and Pain Medicine, Beth Israel Deaconess Medical Center, Harvard Medical School, Boston, MA; ²Department of Anesthesiology, Mount Sinai Medical Center of Florida, Miami, FL; ³Georgetown University School of Medicine, Georgetown University Hospital, Washington, DC; ⁴Department of Anesthesiology, LSUHSC School of Medicine, Shreveport, LA; ⁵Department of Cellular Biology and Anatomy, LSUHSC School of Medicine, Shreveport, LA; ⁶Department of Anesthesiology, Creighton University School of Medicine, Omaha, NE; ⁷Department of Anesthesiology, University of Arizona College of Medicine-Phoenix, Phoenix, AZ; ⁸Valley Pain Consultants—Envision Physician Services, Phoenix, AZ; ⁹Department of Psychiatry and Behavioral Medicine, LSUHSC School of Medicine, Shreveport, LA

Address Correspondence:
Ivan Urits, MD
Department of Anesthesia, Critical Care,
and Pain Medicine
Beth Israel Deaconess Medical Center
330 Brookline Ave.
Boston, MA 02215
E-mail: iurits@bidmc.harvard.edu

Disclaimer: There was no external funding in the preparation of this manuscript.

Conflict of interest: Each author certifies that he or she, or a member of his or her immediate family, has no commercial association (i.e., consultancies, stock ownership, equity interest, patent/licensing arrangements, etc.) that might pose a conflict of interest in connection with the submitted manuscript.

Manuscript received: 06-13-2020
Revised manuscript received:
06-28-2020
Accepted for publication:
07-27-2020

Free full manuscript:
www.painphysicianjournal.com

Background: Twelfth rib syndrome, or slipping of the 12th rib, is an often overlooked cause for chronic chest, back, flank, and abdominal pain from irritation of the 12th intercostal nerve. Diagnosis is clinical and follows the exclusion of other causes of pain. This syndrome is usually accompanied by long-suffering, consequent psychiatric comorbidities, and increased health care costs, which are secondary to the delayed diagnosis.

Objectives: This manuscript is a review of twelfth rib syndrome and its management options. The review provides etiology, pathophysiology, and epidemiology of twelfth rib syndrome. Additionally, diagnosis and current options for treatment and management are presented.

Study Design: This is a narrative review of twelfth rib syndrome.

Setting: A database review.

Methods: A PubMed search was conducted to ascertain seminal literature regarding twelfth rib syndrome.

Results: Conservative treatment is usually the first line, including local heat or ice packs, rest, and oral over-the-counter analgesics. Transcutaneous stimulation and 12th intercostal nerve cryotherapy have also been described with some success. Nerve blocks can additionally be tried and are usually effective in the immediate term; there is a paucity of evidence to suggest long-term efficacy. Surgical removal of all or part of the 12th rib and possibly the 11th rib, as well as the next line of therapy, may provide long-lasting relief of pain.

Limitations: Further large scale clinical studies are needed to assess the most effective management of twelfth rib syndrome.

Conclusions: Twelfth rib syndrome is usually diagnosed late and causes significant morbidity and suffering. The actual epidemiology is unclear given the difficulty of diagnosis. Nerve blocks and surgical rib resection appear to be effective in treating this syndrome, however, further evidence is required to properly evaluate them. Familiarity with this syndrome is crucial in reaching a prompter diagnosis.

Key words: Slipped rib, chronic pain, abdominal pain, chest pain, back pain, neuropathy, injection therapy, nerve block

Pain Physician 2021; 24:E45-E50

The “slipped rib” or “cracking rib” syndromes caused by the slippage of the 8th, 9th, and 10th ribs from their anterior costal cartilage are fairly well reported; however, the pain associated with the 11th and 12th ribs are less understood (1). Since its first description in 1962, twelfth rib syndrome has been an often-overlooked cause of chronic chest, back, abdominal, or flank pain (2,3). The pain can last from hours to weeks and can be described anywhere from a dull ache to sharp and stabbing in intensity. Patients often present following failed treatment for a variety of presumptive diagnoses for their chest, abdomen, or flank pain (2,3). Along with the physical symptoms, patients are often afflicted with concomitant psychiatric problems, that is, anxiety or depression, related to the pain (2).

Pain in twelfth rib syndrome is thought to be caused by irritation of the 12th intercostal nerve related to a hypermobile 12th rib lacking any bony attachments. Similarly, hypermobility of the 11th rib may precipitate comparable pain from irritation of the 11th intercostal nerve. A variety of movements may exacerbate or illicit the pain, including rising from a seated position, lateral flexion of the trunk, and rotation of the trunk. Others may have the pain as a result of pressure on or around the 12th rib and its cartilage. Some patients have sought out manipulations from physiotherapists and osteopaths to try and treat the pain, only to have it made worse (2).

Diagnosis

A delineation between twelfth rib syndrome and slipped rib syndrome is important in the diagnosis of pain related to the false (8th–10th) and floating (11th–12th) ribs. A review of the literature shows unclear definitions of slipped rib syndrome, with most describing it as pain related to ribs 8th through 10th (4), but some describing it as pain related to ribs 8th through 12th, and others stating that the pain is exclusively related to the 11th and 12th ribs (5,6). Definitions of twelfth rib syndrome in the literature have also been inconsistent, with some describing the syndrome as exclusively related to the 12th rib, and others stating that it can be related to the 10th, 11th, or 12th ribs (2,3). This confusing discrepancy in the description of the disease has been recognized since the early 1990s and has caused clinicians to group pain syndromes related to the lower ribs into “painful rib syndrome” (7). Although this description was made in good faith and in an attempt to increase awareness and decrease

confusion, it has unfortunately only added another name to the mix, decreasing clarity and allowing for more fluidity of descriptions in the literature. Slipping rib syndrome and twelfth rib syndrome have different diagnostic criteria and treatment modalities, therefore describing one without clarifying its difference from the other can lead to more confusion and can lead to further delays in diagnosis and appropriate care for these patients.

Diagnosis of this twelfth rib syndrome is clinical and is often referred to as a diagnosis of exclusion (2). After excluding other causes for the patient’s pain, a clinician can confirm the diagnosis by pressing over the 11th or 12th ribs to reproduce the pain exactly (2). The condition is most often unilateral, and disproportionately affects women more often than men (3:1) (2,3). Diagnosis of slipping rib syndrome is also clinical but is confirmed via the “hooking maneuver,” in which the clinician hooks their fingers around the anterior subcostal cartilage and pulls, reproducing the pain and causing a click (8). Slipping rib syndrome also differs from twelfth rib syndrome in that its prevalence is equal in men and women (8). Utilization of this diagnostic “hooking” maneuver would not reproduce the pain in twelfth rib syndrome, as these ribs do not attach anteriorly to the subcostal cartilage.

Anatomic Considerations

Although the 12th ribs do not attach anteriorly, and are therefore “free” at their cartilaginous ends, they do have one bony attachment posteriorly via a single articular facet at the 12th thoracic vertebral body (9). Despite having only a single bony attachment, there is extensive muscular involvement of the 12th rib. It acts as a point of attachment for a plethora of muscles, including quadratus lumborum, the external oblique, the latissimus dorsi, the serratus posterior inferior, the levator costae, external intercostals, the longissimus thoracis, iliocostalis, the lumbocostal ligament, and the costodiaphragmatic recess of the pleura (2). One can imagine an extensive variation in the location of pain produced by irritation of any one of these muscles due to hypermobility of the 12th rib.

The wide variety in presentation and areas affected by this disease may also be explained by the complex anatomy surrounding the 12th intercostal nerve (2). The largest of all intercostal nerves, the 12th intercostal, or subcostal, travels along the subcostal margin of the 12th rib, passing posterior to the kidney before moving anteriorly around the quadratus lumborum and

into the internal and external obliques (2). Early in its course, it sends off collaterals to the first lumbar nerve, and communicates with the iliohypogastric nerve to innervate the pyramidalis (2). Anteriorly, it provides motor innervation to the intercostal muscles, rectus abdominus, and anterior abdominal wall muscles (10). It gives off a lateral femoral cutaneous branch that travels between the internal and external obliques, across the iliac crest, and over the anterior superior iliac spine to send branches to the skin of the gluteal region and the area of the greater trochanter of the femur (2).

Etiology, Differential Diagnosis, Risk Factors

Related to its wide range in presentation, twelfth rib syndrome should be considered in the differential diagnosis of any patient with chronic pain affecting the chest, back, or abdomen that has been refractory to treatment thus far. Patients with twelfth rib syndrome have been reported to present to a wide range of specialists before coming to their final diagnosis. Related to its prominent presentation as abdominal pain, most often lower abdominal pain, one of the more common places to find patients affected by this disease is the gastroenterology clinic. Patients often receive an extensive bowel workup, sometimes taking years before coming to the final diagnosis of twelfth rib syndrome (11).

Other specialists known to see patients with pain related to twelfth rib syndrome include urologists, emergency medicine physicians, radiologists, general surgeons, and psychiatrists (1,6). Specific diseases considered in case reports describing twelfth rib syndrome include irritable bowel syndrome, pleuritis, pneumonia, herpes zoster, aortic aneurysm, sciatica, arachnoiditis, postoperative pain, biliary tract pathology, peptic ulceration, and renal pathology (2,6).

Pathogenesis

The variety of presentations of this disease suggests that its pathogenesis is likely multifactorial, however, it is understood that the pain is related in some way to a hypermobile 12th rib (2). There has been some speculation that this hypermobility could be related to trauma, such as sudden extension, flexion, or twisting of the thoraco-lumbar junction (3). This hypothesis has not been supported by the limited case reports describing this disease, with the only trauma noted being a history of surgery in a single case (1,2,6,11). More likely, hypermobility of the 12th rib irritates the surrounding structures, including the 12th intercostal nerve leading

to pain in the areas that it innervates. Removal of the 12th rib resulting in complete resolution of the pain supports this theory (2,11). Why some people have irritation from a hypermobile 12th rib, and how their 12th rib became hypermobile in the first place, has yet to be fully understood.

Clinical Implications

Twelfth rib syndrome can cause significant discomfort and reduced quality of life in patients. Classically, patients restrict movements such as lateral flexion, trunk rotation, and rising from a sitting position to avoid pain (2). These lifestyle restrictions can lead to depression and anxiety in many of these patients (2).

Case reports have also described their tendency to significantly affect athletes' ability to play. A case report by Udermann et al (12) described a 20-year-old collegiate swimmer who had to modify her athletic activities after the onset of symptoms. She also underwent conservative treatments, attended multiple subspecialty appointments, and underwent multiple imaging tests before she was finally diagnosed with slipping rib syndrome and associated 12th rib involvement 9 months after the onset of symptoms.

This syndrome is a rare disorder often underdiagnosed in the literature. Consequently, lack of recognition frequently leads to extensive diagnostic workup and unnecessary procedures before the diagnosis is made (13). Fortunately, the diagnosis can be made simply in the clinic with careful physical examination and confirmed with the use of an image intensifier (2). As a result, clinicians need to keep this syndrome on the differential when patients present with flank and/or visceral pain to initiate treatment earlier to optimize patients' quality of life (2).

Clinical Presentation

The clinical presentation and course of twelfth rib syndrome can vary widely. It has been reported in the literature to affect patients of all ages, ranging from 6 years old to patients in their mid-80s, tending to affect female patients more than male patients (13). The hallmark of this syndrome is a patient presenting with unilateral flank pain localized to the tip of the 12th or 11th rib, often exacerbated by movement (3). The flank pain can be intermittent or continuous and has been described as sharp pain, dull and achy, or a combination of both (1). The patient's pain can traditionally be reproduced on physical examination by careful point compression over the tip of the involved rib (3). It can

present after a traumatic event, but many cases present without any history of trauma (1).

A case series by Kumar et al (13) published in 2013 described 3 women who presented separately within the same year with twelfth rib syndrome (13). The first case described a 32-year-old woman who presented with a 2-year history of intermittent right thoracic pain with no history of trauma or inciting event. The pain was exacerbated by sitting, leaning forward, and using a sewing machine. On physical examination, the patient endorsed point tenderness over the tip of the 12th rib. She was treated with an intercostal nerve block, which resolved her pain completely. The next case described a 40-year-old woman who presented with a 10-month history of intermittent right flank pain that was initially sharp and turned to dull, aching pain. The pain radiated to her right groin and was exacerbated by trunk rotation. Similarly, the pain was reproducible when pressure was applied to the 12th rib. The pain completely resolved with a 12th intercostal nerve block. The third case described a 22-year-old woman who presented with sharp left flank pain every time she bent over or attempted to lift heavy items. She experienced a period of relief with analgesics, hot packs, and ultrasound therapy, but the pain recurred with increased activity levels. She was also treated successfully with a 12th intercostal nerve block.

In short, the descriptions from case reports in the literature suggest it is common for patients with twelfth rib syndrome to present with prolonged, intermittent dull or sharp flank pain that is exacerbated by various activities.

Treatment and Management

Given the small number of cases in the literature, the treatment for twelfth rib syndrome is based largely on the results from published case reports (1). If symptoms persist despite activity modification of movements that usually provoke the pain, it is appropriate to suggest a trial of conservative treatment, including the use of ice packs, heat packs, and over-the-counter analgesic medication (3).

Other conservative options that may provide a therapeutic benefit include ultrasound therapy, transcutaneous electrical nerve stimulation, or cryotherapy applied to the 12th intercostal nerve (2,3). In one case of a 48-year-old woman described by Cranfield et al (2), transcutaneous electrical nerve stimulation was found to be "moderately successful," although the maximum improvement was demonstrated after a 12th intercos-

tal nerve block. Contrarily, another patient in this case series whose symptoms were refractory to an intercostal nerve block demonstrated considerable relief with a transcutaneous nerve stimulator. In the same case series, a separate female patient received a complete resolution of pain with subsequent nerve blocks and cryotherapy application to the 12th intercostal nerve (2). Unfortunately, no published cases are examining the outcomes of ultrasound therapy for this indication.

Additionally, the case of a collegiate athlete reported minimal, intermittent relief from chiropractic care, consisting of spinal manipulation and electric stimulation (12). However, these improvements did not result in long-term relief.

Minimally Invasive Management

In cases that are refractory to conservative treatment, an intercostal nerve block at the costochondral junction of the 12th rib with local anesthetic and long-acting steroid has shown to be successful with immediate pain relief (13). Specifically, methylprednisolone 40 mg in 5 mL 0.25% to 0.5% bupivacaine to the affected rib tip will often completely resolve the pain (3,14). This treatment option can sometimes break the pain cycle and relieve symptoms permanently. In the case series by Kumar et al (13), all 3 patients were successfully treated with intercostal nerve blocks containing a local anesthetic and long-acting steroid under an image intensifier. Only 1 of the 3 cases required a repeat injection, but all 3 cases eventually experienced permanent pain relief at subsequent visits. This patient series utilized 5 mL of 0.25% bupivacaine with either 40 or 80 mg of methylprednisolone.

On the contrary, other case reports in the literature have reported only temporary relief of symptoms that eventually subsides once the local anesthetic effect wears off (1). In these cases, the immediate pain relief afforded by a nerve block is helpful to confirm the musculoskeletal diagnosis and rule out other sources of pain, but more invasive treatment options may be considered. One of these options includes percutaneous radiofrequency thermocoagulation of the dorsal root ganglion under x-ray guidance; however, there are no studies to our knowledge that have published outcomes of this modality for twelfth rib syndrome (3).

Surgical Management

Surgical management of twelfth rib syndrome offers a permanent solution for those cases refractory to conservative management and whose pain returns despite intercostal nerve block (1,15). As described by

Machin and Shennan (1), surgical excision of the affected 12th rib is a simple procedure that completely cures the severe pain associated with this syndrome. Others suggest surgical management is superior to repeated nerve block injections because pain is often worse when it returns after the local anesthetic effects dissipate (15).

Wynne et al (16) reported successful outcomes in a series of 6 patients who all underwent subperiosteal resection of the outer two-thirds of the 12th rib, one of which also had their 11th rib resected. All of the patients (n = 6) reported immediate postoperative relief of symptoms without recurrence at a range of 5 to 34 months postoperatively. A second case series by Machin and Shennan (1) described 4 female patients with twelfth rib syndrome who underwent surgical rib excision; one underwent 11th rib resection, one underwent 12th rib resection, and 2 underwent both 11th and 12th ribs resection. Every patient experienced immediate cessation of pain postoperatively and remained pain-free at follow-up (range: 6–30 months). Cranfield et al (2) described a separate case of a 66-year-old man who failed a trial of conservative treatment. They did not experience prolonged analgesia from multiple intercostal nerve blocks (2). Surgical excision of the 11th and 12th ribs on the affected side resulted in complete resolution of pain that persisted throughout his 1-year postoperative follow-up visit.

CONCLUSIONS

Twelfth rib syndrome is a subsyndrome of slipped rib syndrome specifically involving the 12th rib. It is a commonly overlooked cause for chronic pain, including abdominal, chest, back, and flank. It is rarely the first diagnosis considered. Irritation of the 12th intercostal nerve can cause a plethora of neuropathic pain mani-

festations. The etiology is not completely understood, but pathogenicity involves hypermobility of the 12th rib, subsequent irritation of the intercostal nerve, and resulting neuropathy.

Diagnosis is clinical and follows the exclusion of other causes of pain. Pressure on the 12th rib can elicit the often unilateral pain; unlike slipping rib syndrome, the “hooking” maneuver is not helpful in diagnosis. Delayed diagnosis usually increases pain and suffering, as well as health care spending to rule out prior diagnoses.

The literature describes a few cases and is nearly void of evidence beyond case reports and small case series, limiting the evidence level supporting different treatment options. Initial treatment is usually conservative and involves local therapy with heat or ice packs, oral analgesics, and rest. Ultrasound therapy, intercostal nerve blocks, and transcutaneous nerve stimulation have been tried as a bridge before injection therapy.

Minimally invasive therapy usually refers to nerve blocks in this context, specifically nerve block at the 12th costochondral junction. There is some evidence to suggest that these may be curative, although other small studies suggest that repeated injections are required to maintain alleviation of pain.

Surgical therapy is thought to be a permanent therapy and is an appropriate consideration for patients failing nerve blocks or requiring repeated blocks. Removal of part or all of the 12th and 11th ribs provided immediate, long-lasting relief in reported cases.

Although evidence is limited to strongly support specific therapy in twelfth rib syndrome, nerve blocks and rib resections are likely the most effective forms of therapy. Further research and larger series are needed to drive proper patient selection and describe the long-term efficacy of these treatments.

REFERENCES

- Machin DG, Shennan JM. Twelfth rib syndrome: A differential diagnosis of loin pain. *Br Med J* 1983; 287:586.
- Cranfield KAW, Buist RJ, Nandi PR, Baranowski AP. The twelfth rib syndrome. *J Pain Symptom Manage* 1997; 13:172-175.
- Keoghane SR, Douglas J, Pounder D. Twelfth rib syndrome: A forgotten cause of flank pain. *BJU Int* 2009; 103:569-570.
- Germanovich A, Ferrante FM. Multimodal treatment approach to painful rib syndrome: Case series and review of the literature. *Pain Physician* 2016; 19:E465-E471.
- Khan NAJ, Waseem S, Ullah S, Mehmood H. Slipping rib syndrome in a female adult with longstanding intractable upper abdominal pain. *Case Rep Med* 2018; 2018:3-6.
- Migliore M, Signorelli M, Caltabiano R, Aguglia E. Flank pain caused by slipping rib syndrome. *Lancet* 2014; 383:844.
- Scott BB, Scott EM. Painful rib syndrome: A review of 76 cases. *Gut* 1993; 34:1006-1008.
- Turcios NL. Slipping rib syndrome: An elusive diagnosis. *Paediatr Respir Rev* 2017; 22:44-46.
- Fam AG, Smythe HA. Musculoskeletal

- chest wall pain. *CMAJ* 1985; 133:379-389.
10. Vadhanan P, Hussain M, Prakash R. The subcostal nerve as the target for nerve stimulator guided transverse abdominis plane blocks: A feasibility study. *Indian J Anaesth* 2019; 63:265-269.
 11. Jalovaara P, Rämö J, Lindholm R. Twelfth-rib syndrome simulating intra-abdominal disease. Case report. *Acta Chir Scand.* 1988;154:407-408.
 12. Udermann BE, Cavanaugh DG, Gibson MH, Doberstein ST, Mayer JM, Murray SR. Slipping rib syndrome in a collegiate swimmer: A case report. *J Athl Train* 2005; 40:120-122.
 13. Kumar R, Ganghi R, Rana V, Bose M. The painful rib syndrome. *Indian J Anaesth* 2013; 57:311-313.
 14. Bonica JJ. The management of pain: The future. In: Stanley TH, Ashburn MA, Fine PG (eds). *Anesthesiology and Pain Management. Developments in Critical Care Medicine and Anesthesiology.* Vol 24. Dordrecht, Springer, 1991: pp. 73-92.
 15. Wells JCD. Twelfth rib syndrome. *Br Med J* 1983; 287:1725.
 16. Wynne A, Nelson M, Nordin B. Costoiliac impingement syndrome. *J Bone Jt Surg Br.* 1985; 67:124-125.