



# Slipping Rib Syndrome: A review of evaluation, diagnosis and treatment

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## ABSTRACT

Slipping rib syndrome (SRS) is an under-diagnosed cause of intermittent, yet often debilitating lower rib and abdominal pain. SRS is caused by a hypermobility of the anterior false ribs that allows the 8<sup>th</sup>–10<sup>th</sup> ribs to slip or click as the cartilaginous rib tip abuts or slips under the rib above. Pain occurs from impingement of the intercostal nerve passing along the undersurface of the adjacent rib. Studies consistently find patients reporting months to years of typical pain symptoms, unnecessary tests and procedures prior to diagnosis. SRS is a clinical diagnosis, but dynamic ultrasound can be helpful for confirmation or diagnosis in difficult cases. Resection of the slipping rib cartilages is the mainstay of treatment, with good results for pain relief. Rib stabilization is an emerging option for recurrent symptoms.

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## Introduction

Slipping rib syndrome (SRS) is an under-diagnosed cause of intermittent, yet often debilitating lower rib and abdominal pain. SRS is frequently associated with a popping or slipping sensation, giving it its name. The syndrome is caused by a hypermobility of the anterior false ribs, either from disruption of fibrous articulation, or a congenital deformity that allows for the 8<sup>th</sup>–10<sup>th</sup> ribs to slip or click as the cartilaginous rib tip abuts or slips under the rib above. Pain occurs from impingement of the intercostal nerve passing along the undersurface of the adjacent rib. SRS can affect patients at any age and its true prevalence is unknown due to frequent under-diagnosis. The upper abdominal location of the pain may prompt many unnecessary tests, so knowledge of the syndrome is critical to its timely and appropriate evaluation and treatment.

## Background

Slipping rib syndrome was first described in 1919 by Cyriax, as an anterior rib dislocation causing pain due to impingement of the intercostal nerves. It was hypothesized that the terminal nerves, which run at the inferior border of each cartilage, were irritated due to the abnormally subluxing rib.<sup>1</sup>

The first operation was described in 1922 when Davies–Colley performed resection of a mobile 10<sup>th</sup> rib cartilage, which was incidentally found on laparotomy for pain. There was subsequent relief

of symptoms in a 42 year-old female domestic servant. His second case was of a 17 year-old girl whose 10<sup>th</sup> rib moved abnormally, protruded and was painful with flexion. Removal of this cartilage also resulted in relief.<sup>2</sup>

Although this publication was well received, little broad notice was taken and its presence in surgical textbooks is lacking. Since 1922, almost *four hundred* cases have been reported in the literature, yet this diagnosis still remains elusive to most physicians and some surgeons (Fig. 1).

The pain in SRS is caused when the lower costal cartilages (ribs 8 through 10, i.e. ribs which are not directly connected to the sternum), lose their fibrous or cartilaginous attachments to each other. The pain and clicking sensation is also sometimes reported in the floating ribs, 11 and 12 (Fig. 2). This lack of attachment allows the cartilages to sublux, anteriorly or posteriorly with movements such as twisting, bending, deep breathing, sitting, sneezing, or coughing. The resulting irritation to the intercostal nerves may cause intermittent sharp, stabbing pain, followed by dull aching pain or a burning sensation. The initial pain is usually described as lasting a few minutes, and the dull pain is described as lasting hours. Some patients describe attaining temporary relief by stretching the affected side or placing pressure on the area. Prolonged periods of rest are often required to alleviate the pain. This pain may also be associated with nausea and vomiting when severe.

The symptoms of SRS may also be vague and misinterpreted as abdominal pain due to interconnections between intercostal nerves and somatic visceral nerves. Innervation of the intercostal nerves and visceral sympathetics converge at the same spinal cord levels

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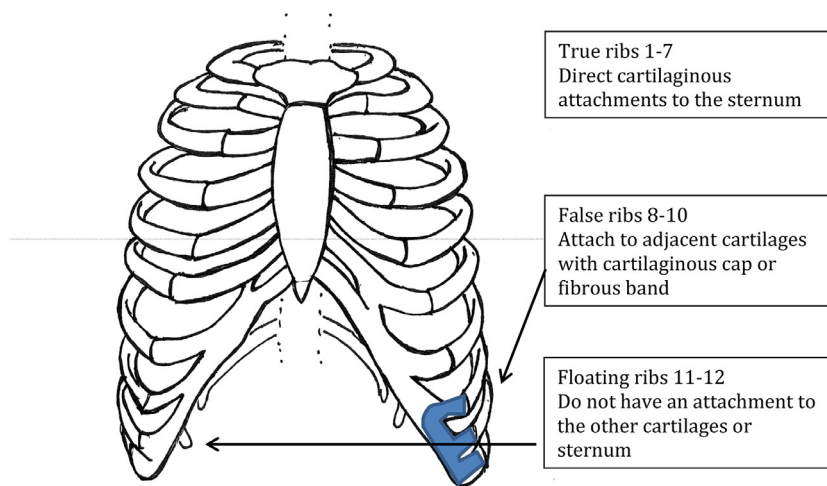


Fig. 1. Normal chest wall anatomy.

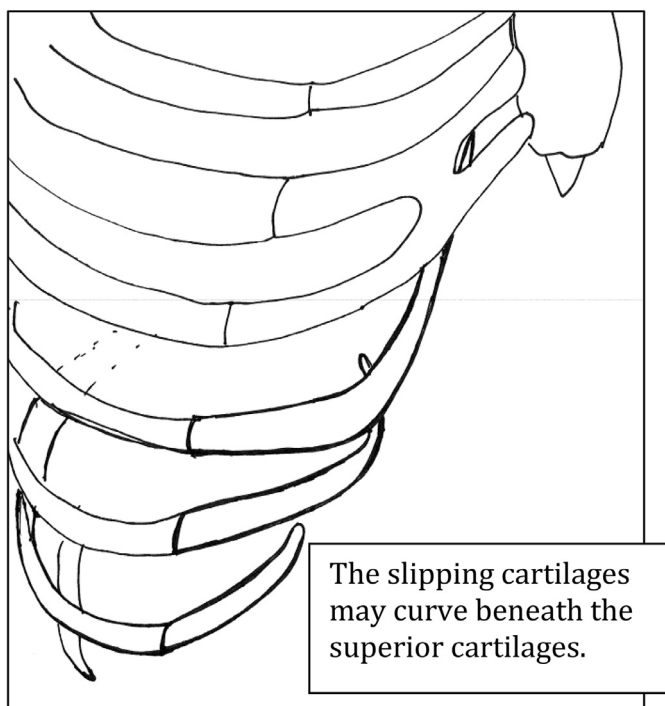


Fig. 2. Lateral view of lower chest wall demonstrating detached, deformed slipping costal cartilages 8, 9 and 10. The lack of cartilaginous attachment allows the cartilages to move and slide beneath each other, irritating the intercostal nerves and causing pain.

ease, hepato-splenic issues, peptic ulcer, renal colic, esophagitis, and pancreatitis may also be implicated.

Historically, SRS has had many different names:

- Clicking rib syndrome
- Rib-tip syndrome
- Painful rib syndrome
- Slipping-rib-cartilage syndrome
- Painful rib syndrome
- Nerve nipping
- Gliding ribs
- Displaced ribs
- Interchondral subluxation
- Traumatic intercostal neuritis
- Twelfth rib syndrome
- Cyriax syndrome

Although early authors claimed that the condition was always unilateral,<sup>3</sup> multiple reports of bilateral SRS have been reported.<sup>5,11,14,15</sup> Usually there is one dominant symptomatic side, but either side may be affected equally. Initially the sparse reports determined that the right side predominated, and it was hypothesized that this was due to the predominance of right-handedness, but as more reports came forth, left and right sides were found to be equal.<sup>11,16–19</sup>

Slipping rib syndrome can occur in any age group; the oldest patient reported is 86 years of age<sup>20</sup> and the youngest 7 years.<sup>14</sup> Females and female athletes in particular are more frequently affected than males,<sup>14, 21,22</sup> and this may possibly be related to hormonal shifts and joint laxity.<sup>23</sup> Multiple reports of SRS in athletes especially in swimmers, indicate that this group is at risk for SRS and SRS is likely due to the higher demands placed on their bodies.<sup>24,25</sup>

Foley et al were the first to mention hypermobility as a predictor of slipping rib syndrome. Their group found that among the athletes studied, 1/5th were hypermobile.<sup>22</sup> Diagnosing hypermobility is difficult, but in normal practice, asking a patient about hyperflexible joints may be enough. Some patients may have laxity and subluxation of the contralateral cartilages without symptoms. Additionally, they may even feel a clicking sensation without pain.

An association with SRS and psychological diagnoses exists. The difficulty with this association is that there is often a long delay from seeking care to obtaining a correct diagnosis. This may be months to years.<sup>9,11,19</sup> Patients may seek care from multiple medical practitioners without relief from their symptoms and when no organic cause can be found, they become frustrated and of-

as the slipping ribs, namely the 8th and 9th.<sup>3–6</sup> This can cause pain that may seem intraabdominal in nature.<sup>7–10</sup>

The pain can be confusing for medical practitioners, and many patients undergo unnecessary testing and procedures to try to identify the source of the pain. Radiographs, computed tomography (CT) scan, Magnetic Resonance (MR) imaging, Positive Emission Tomography (PET) scans, diagnostic procedures such as laparotomy and laparoscopy have all been performed with negative result in patients prior to their correct diagnosis of slipping rib syndrome.<sup>10–13</sup> The lack of radiographic findings for the cause for the pain is frustrating for physicians and patients alike.

The differential diagnosis of SRS is long and includes chest wall issues such as rib fracture, Tietze syndrome, costochondritis, and pleuritic pain. Abdominal pathology such as biliary dis-

Epidemiology
<ul style="list-style-type: none"> <li>• Any age</li> <li>• Females &gt; Males</li> <li>• Often associated with rib flare</li> <li>• May be associated with pectus excavatum</li> <li>• May have a psychiatric diagnosis</li> <li>• May be hypermobile</li> </ul>
Differential diagnosis
<p>Includes almost any causes of abdominal or chest wall pain</p> <ul style="list-style-type: none"> <li>• Biliary disease</li> <li>• Hepato-splenic disease</li> <li>• Peptic ulcer</li> <li>• Pancreatitis</li> <li>• Esophagitis</li> <li>• Abdominal wall strain</li> <li>• Neuritis</li> <li>• Renal colic</li> <li>• Rib fracture</li> <li>• Tietze syndrome</li> <li>• Costochondritis</li> <li>• Pleuritic pain</li> </ul>

Fig. 3. Epidemiology and differential diagnosis of SRS.

ten doubt the organic nature of their pain. Frustrated physicians unable to elucidate the etiology of pain have diagnosed these patients as having psychogenic pain. Dealing with intermittent and sometimes debilitating pain without an organic cause or hope for relief can be stressful and lead to depression. Being told that the problem is somatic when it is mechanical can be psychologically damaging. These patients have been labeled by physicians as hystericals, neurotics, and depressives.<sup>5,10,11,19,21</sup> Spense found that 5 patients with SRS who had previously had a diagnosis of neurosis were found to be psychologically normal following their operations and resolution of pain.<sup>5</sup>

SRS may be seen in conjunction with a lower costal flare, and this physiology may predispose a patient to slipping rib. It has also been diagnosed and treated in patients with pectus excavatum (Fig. 3).

### Risk factors

Although an exact etiology is not apparent, it seems that SRS is likely related to overuse or direct trauma that causes the pain. More often, a direct traumatic incident is not remembered by the patient, but an insidious insult may have occurred that was overlooked. Sudden extension or flexion, repeated one-sided weight bearing or exercise such as throwing a ball, vigorous swimming, or swinging a bat may be implicated.

In 1975, McBeath and Keene endeavored to elucidate the etiology of slipping rib. They studied 20 cadavers, aged 3–72 and attempted to move the lower cartilages which were loosely attached with fibrous attachments. Only when they divided the fibrous or cartilaginous attachments between the ribs were they able to make the cartilages come into contact with each other. They concluded



Fig. 4. The hook maneuver is performed by grasping the costal margin and retracting anteriorly and superiorly. The slipping cartilages are easily palpated and often visible.

that the cartilaginous tips or fibrous attachments must be disrupted in order to move and cause the symptoms.<sup>26</sup>

### Diagnosis

A careful clinical history should be performed. A traumatic event may or may not be recalled. The pain is intermittent and is usually localized in the lower ribcage and can be extremely painful. For some patients, there may be a trigger point of tenderness. Patients may or may not notice a popping or grinding sensation with certain movements, and it is not uncommon for the patients to be able to demonstrate the popping for the physician. Nausea or vomiting may accompany the pain, confusing the diagnosis.

The hook maneuver, as described by Heinz and Zavala in 1977, reproduces movement of the lower cartilages against each other. In this painful maneuver, the examiner slides their fingers under the costal margin and lifts anteriorly and superiorly, reproducing movement, sometimes a click, and pain, diagnosing the condition. SRS was initially believed to be a unilateral phenomenon and Heinz and Zavala initially felt the contralateral side could be used as a control.<sup>4</sup> Bilateral SRS does exist, as do bilateral slipping cartilages without pain, so the contralateral side is not necessarily a “control” (Fig. 4).

Palpating carefully along the lower cartilages, one can feel the disconnected cartilages, sometimes with associated movement. By following the contour of the costal margin, the examiner can even feel the cartilage curling beneath the overlying ribcage. Point tenderness may also be elicited. This is generally less painful than the hook maneuver and an adequately demonstrates the slipping ribs.<sup>21,27</sup>

Local anesthetic rib blocks can help to define the levels of nerve irritation and help guide preoperative planning. The blocks may also provide temporary relief and in some cases may provide complete symptom relief.<sup>11,28</sup> In other cases, the rebound pain is severe. It is recommended to block the entire nerve of the painful rib, as well as the one above and below it. The most common block is with Bupivacaine with or without corticosteroid.<sup>8</sup>

Most radiographic imaging is not effective in diagnosing SRS. The affected cartilages are not easily visualized by plain radiographs, CT or MRI, or even standard ultrasound. Dynamic ultrasound, also called high-definition ultrasound, is done while the patient moves. The examiner visualizes the cartilages while the patient performs prescribed movements, such as valsalva, cough-



ing, twisting, crunching and pushing on the lower costal cartilages. This may demonstrate the ribs moving under, or abutting each other during the movements, diagnosing the syndrome. Moreover, the exact levels of rib abnormalities can be reported, assisting in pre-surgical planning.<sup>29,30</sup> At our institution, a new protocol in which the lower cartilages are visualized at rest, during a crunch maneuver, and by pushing along the cartilages has shown a sensitivity of 92% and a specificity of 100%.<sup>30</sup>

## Treatment

Often having the diagnosis of a benign condition is enough to reassure the patient that there is nothing gravely wrong with them. Some patients thus diagnosed are then able to cope with their symptoms. Rest from the inciting activity, along with ice, NSAIDS, and topical analgesics may be enough to alleviate the symptoms completely.<sup>11,31,32</sup> Avoiding the movements, however, may not be feasible, especially those patients involved in sports.

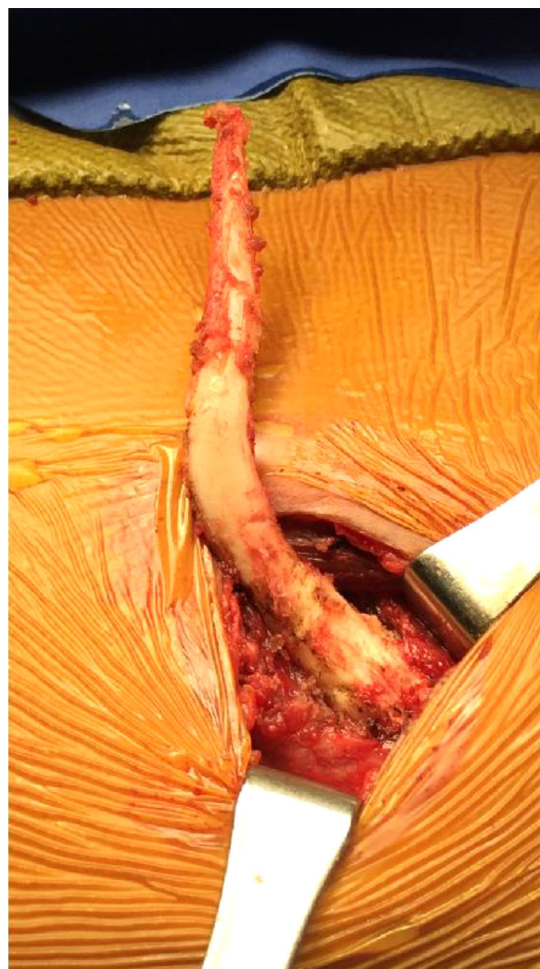
Repeated anesthetic and steroid rib blocks, manipulative techniques, acupuncture and topical analgesics have also given some positive, long-lasting results.<sup>11,33</sup> Foley reported that their athletes with SRS benefitted from osteopathic treatment.<sup>22</sup>

There has been one case report from Italy describing temporary relief of a 50 year-old female nurse who had symptoms for 9 years by using botox. Injections into the transversus abdominalis, external oblique, rectus abdominalis, and quadratus lumborum muscles were performed. The first injection gave relief for 1 month. It was then repeated 4 times, every 3 months. After the third injection, the pain reduced from a 9 to a 1. The pain recurred after 6 months and was injected again after which she had 10 months of pain relief.<sup>34</sup> There have been no long-term outcomes on adults nor studies published on using botox for slipping rib syndrome on children to date. One wonders if the paralyzed muscles would create excessive weakness of the abdominal wall, and how this would affect daily activities.

Removing the slipping, disconnected cartilages may seem invasive, yet is the treatment should conservative therapies fail. This can be accomplished through a small incision at the lower the costal margin, dissecting down to the chest wall, where the detached and hypermobile cartilages are easily palpated (Fig. 5). An intraoperative hooking maneuver may be performed, further demonstrating the pathology. The most likely cartilages involved are the 8–10th, and care must be taken to palpate the distal tip of the 8th, which is often found to be subluxed and is quite diminutive. It may have a strong fibrous connection with the 7th cartilage at its midpoint, so a partial chondrectomy may be sufficient. If not, it is usual to take the hypermobile cartilages to the costo-chondral junction, taking care to attain hemostasis. The detached cartilages are often curled and immediately abutting the inside of the rib above where it comes into close contact with the intercostal nerve (Fig. 6).

The initial descriptions of the procedure involved resecting the cartilages while leaving the perichondrium intact. This was done, much like in an open pectus repair (Ravitch procedure), to preserve the intercostal neurovascular bundle.<sup>9,14</sup> Like the Ravitch procedure for pectus deformities, leaving the perichondrium intact allows the cartilages to regrow. In the case of slipping rib syndrome, regrowth of cartilage is not desired, and it is possible to excise the entire cartilage with the perichondrium, leaving the neurovascular bundle intact (Fig. 7).

Each of the hypermobile anterior rib cartilages is removed, leaving the boney rib intact. Some surgeons perform partial resection of the boney rib, due to the hypermobility of the rib itself. Copeland took 5–7 cm of rib along with the cartilage in subperiosteal resection.<sup>19</sup> We have preferred to take the cartilage portion of the rib, leaving the mobile ribs intact, and bridge them with



**Fig. 5.** Left-sided slipping rib excision. A small incision can be made and tissues mobilized to remove the slipping cartilage and rib.

an absorbable plate to stabilize them. Early outcomes of this technique have been satisfactory and will be published soon.

Sternocostal slipping rib syndrome is a variant of lower costal slipping rib syndrome.<sup>13</sup> It occurs when pain and popping are present lateral to the sternum at the upper seven rib cartilages. Bonasso describes the diagnosis is based on history and clinical exam and concludes that imaging is not useful, based on CT scan. (bonasso<sup>16</sup>) Our center has had success in diagnosing sternocostal slipping rib with ultrasound, and we were able to use the ultrasound intraoperatively to detect the offending cartilage (Fig. 8). All 4 cases of sternocostal SRS resolved after excision. Care should be taken to carefully assess patients with sternal pain and movement, and ultrasound should be considered (Fig. 9).

## Outcomes

In the almost 400 cases reported in the literature since 1919, the majority of patients are reported to have pain relief after treatment. Scott described 76 patients with painful rib syndrome. This was defined as pain in the lower chest or upper abdomen, a tender spot on the lower costal margin and reproduction of the pain with palpation. Their treatment protocol was reassurance and paracetamol. Five patients went to a pain clinic for treatment without relief. No patients went to surgery. Of the 56 patients surveyed at a mean of 4 years post-treatment, 30% had resolution of pain and 70% had continued pain. They concluded that if the pain did not resolve with conservative measures within three months that it



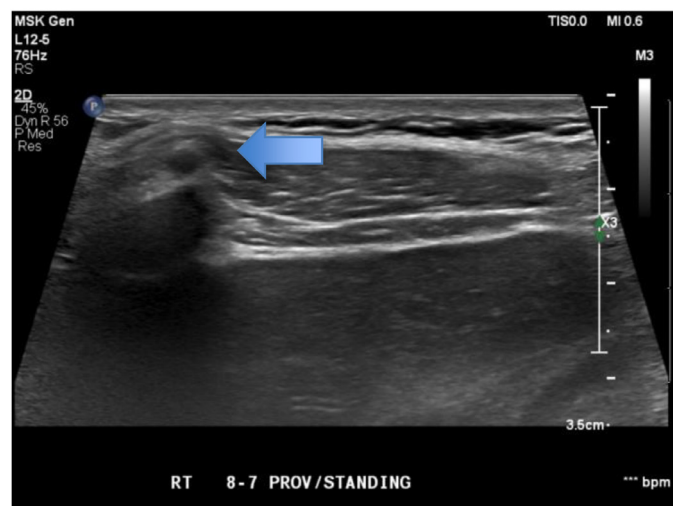
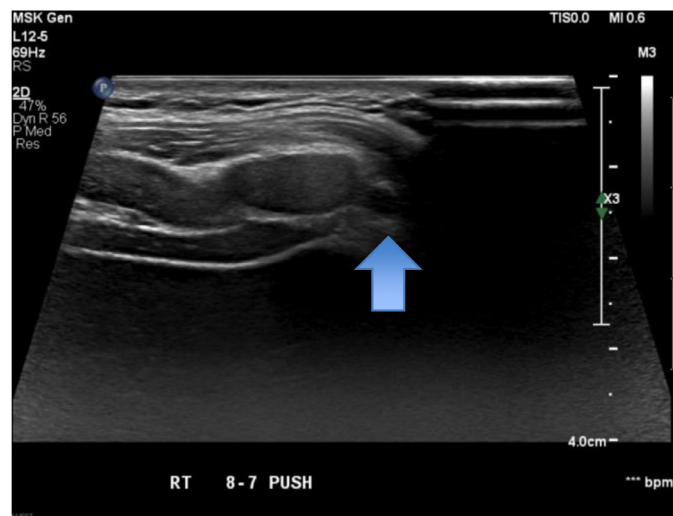
**Fig. 6.** Resected 10th, 9th and tip of 8th left costal cartilages.



**Fig. 7.** The neurovascular bundle is left intact after excision of the slipping cartilage.

became chronic in 87% of patients. Additionally, their patient population had a 23% incidence of depression.<sup>21</sup> Wright surveyed 46 middle aged patients with SRS, most of whose symptoms were “relieved by reassurance” or local anesthetic injections.<sup>11</sup> Almost every publication in which surgery was performed concluded that patients have complete resolution of pain following excision of the slipping ribs.<sup>2,14,17,18,19</sup>

Very few publications about SRS mention recurrence. In Gould’s series of 30 patients, 8 (26%) underwent reoperation. In a survey of the patients, 18 were contacted, and all reported significant improvement. 72% felt they were cured. Of the 8 recurrences, 1 patient required 2 reoperations on the same side, 2 required re-



**Fig. 8.** Slipping rib 8 at rest, with a push on the lower costal cartilage and with a provocative maneuver, demonstrating abnormal movement of the cartilage.

excision on the ipsilateral side at a different level, 2 on the contralateral side, and 1 underwent bilateral re-excision, 1 underwent excision of xyphoid process for symptom recurrence.<sup>15</sup>

Spense reported one of 6 patients with recurrent pain 3 months after surgery, who was treated for depression and his pain resolved.<sup>5</sup>



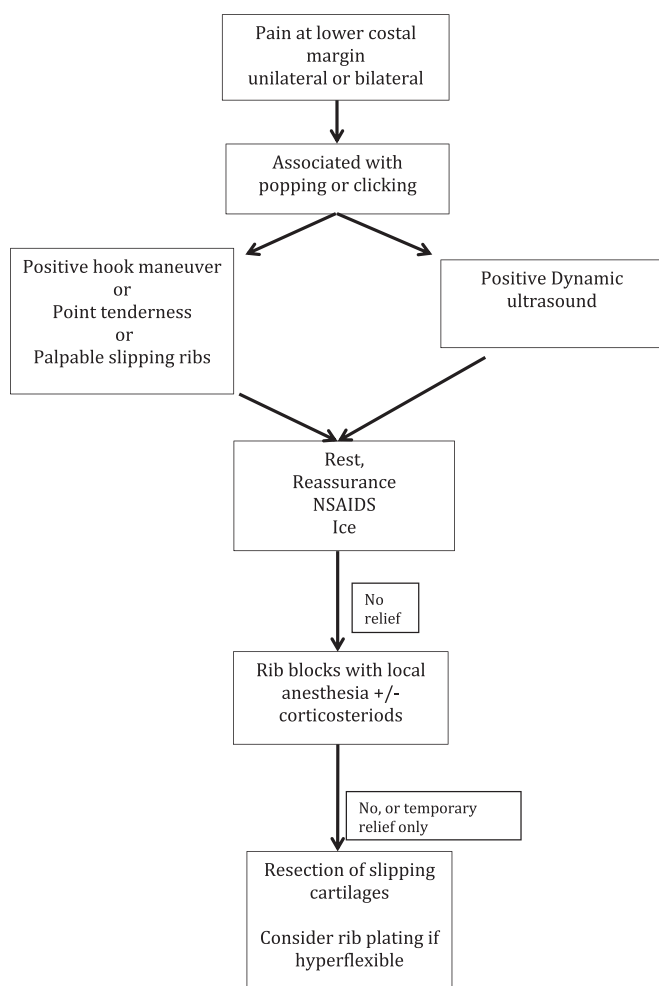


Fig. 9. Algorithm for the evaluation, diagnosis and treatment of SRS.

Recurrent pain after surgery, both at the same site and at remote sites is likely underreported. Recurrent symptoms may be due to missed slipping cartilages at the primary operation, re-growth of cartilage, or new symptoms on the contralateral side. Although most reports claim that the symptoms resolve immediately after surgery, no mention is made of the logical postoperative pain felt during recovery. For patients with longstanding pain, it stands to reason that it may take longer for the irritated nerves to heal once the irritant has been removed. More prospective studies are needed to determine the true outcome of the procedure. At this writing, one can assume that the majority of patients who undergo surgical resection of their slipping ribs are satisfied to very satisfied with their outcome. In our cohort of SRS patients, some have had recurrent pain requiring reoperation prompting the use of resorbable plating to stabilize hyperflexible subluxing bony ribs to eventually create enough fibrous tissue to maintain separation between the ribs.

## Conclusion

Slipping rib syndrome has been part of the medical and surgical literature for almost a century. The diagnosis and treatments for this syndrome are well outlined, yet patients often go months

to years without proper diagnosis while being submitted to extensive unrevealing and unnecessary testing. Dynamic ultrasound is a useful diagnostic tool when performed properly, especially in cases with recurrent pain after surgery. When conservative therapy fails, surgery is a well-tolerated treatment with good outcomes. Knowledge of the condition is important. By recognition and appropriate evaluation, patients avoid months to years of chronic physiologic and psychological pain.

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