REVIEW ARTICLE

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A Comprehensive Review of Slipping Rib Syndrome: Treatment and Management

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ABSTRACT ~ Purpose of Review: *This is a comprehensive review and update on advances in the understanding and treatment of slipping rib syndrome. It covers the physiology and pathophysiology at the basis of the syndrome, epidemiology and clinical presentation as well as diagnosis. It goes on to review the available literature to provide description and comparison of the available methods for alleviation.* ***Recent Findings:*** *Slipping rib syndrome stems from irritation of intercostal nerves. It is caused by slipping of the costal cartilage and the resulting displacement of a false rib and pinning underneath the adjacent superior rib and nerve irritation. It is rare and spans genders and ages; most evidence about epidemiology is conflicting and mostly anecdotal. Risk factors include trauma and high intensity athletic activity. Presentation is of a sudden onset of pain with jerking motion; the pain can be localized, radiating or diffuse visceral. It is often alleviated by positions that offload the impinged nerve. Diagnosis is clinical, and can be aided by Hooking maneuver and dynamic ultrasound. Definitive diagnosis is with pain relief on nerve block, visualization of altered anatomy during surgery and relief after surgical correction. Initial treatment includes rest, ice and NSAIDs, as well as screening for co-morbid conditions, as well as local symptomatic relief. Injection therapy with local anesthetics and steroids can provide a diagnosis as well as symptomatic relief. Surgical correction remains the definitive treatment.* ***Summary:*** *Slipping rib syndrome is a rare cause of chest pain that could be perceived as local or diffuse pain. Diagnosis is initially clinical and can be*

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confirmed with nerve blocks and surgical visualization. Initial treatment is symptomatic and anti-inflammatory, and definitive treatment remains surgical. More recently, advanced surgical options have paved way for cure for previously hard to treat patients. Psychopharmacology Bulletin. *2020;50(4, suppl. 1):189–196.*

Introduction

Slipping rib syndrome (SRS) is a constellation of symptoms that originates from irritation of the intercostal nerve traveling along the undersurface of the ribcage.[1] The condition was originally described in 1919 by Edgar Ferdinand Cyriax, a British orthopedic surgeon who proposed that downstream branches of the nerve were aggravated by disrupted ribs.[2] He gave SRS its lesser-known name, Cyriax syndrome.[2] The first documented treatment of the condition is credited to Eleanor Davies-Colley, the first female fellow in the history of the Royal College of Surgeons; in 1922, she published cases of two female patients whom she treated by removing the mobile cartilage of the tenth rib, providing immediate symptomatic relief.[3] In 1980, following Davies-Colley's publication by over half a century, J.T. Wright, a renowned gastroenterologist at London Hospital, was still working to call attention to the diagnosis.[4] He proceeded to fault the medical community, as many were still ignorant of the fact that the condition originates from a musculoskeletal rather than a gastrointestinal origin.[4] While still relatively unfamiliar to most providers, recent publications estimate that SRS accounts for approximately five percent of all musculoskeletal chest pain in primary care.[5] Recognition of the syndrome is made more difficult by its many names, including rib-tip syndrome, twelfth rib, clicking rib, interchondral subluxation, and nerve nipping.[6]

Pathophysiology

The pathophysiology of SRS hinges on the basic mechanism of the costal cartilage slipping out of its normal anatomical position; the anterior false ribs (eight through ten) slide out of orientation and become pinned underneath their adjacent superior ribs.[7] This displacement can be caused by a congenital anomaly, damage to the fibrous articulation, or hypermobility of unknown origin.[1] Regardless of the mechanism, the insufficient interchondral attachments loosen and may even rupture, allowing the tips of the cartilage to curl up and override the superior rib; the pain then results from the impingement of branches of the intercostal nerve secondary to the described subluxation.[8] In a study of 20 cadavers performed in 1975, McBeath and Keene attempted to recreate the subluxation seen in SRS and determined that it was only possible in

the presence of altered costal cartilage.[8] Therefore, any patient who had experienced trauma with resulting disruption of fibrous attachments would be expected to develop symptoms over time. Of note, similar pain can rarely be seen in the floating ribs (eleven and twelve).[1] It should also be noted that a similar mechanism acting up ribs one through seven carries its own specific diagnosis, sternocostal slipping rib syndrome, a condition that is more rare but can also be treated using similar treatments.[1]

Risk Factors

Based on current literature, SRS has been reported in both sexes and in all ages from 7 to 86.[9,10] Risk factors are not fully understood as SRS is rare, and some literature suggests that the syndrome has no predilection for age or sex.[11] When examining approximately 400 case studies, SRS has been seen more often in females.[6,12–18] A potential risk factor for females is thought to be joint laxity secondary to hormonal changes.[19] The literature also lacks consensus regarding age as a risk factor with the existence of two competing hypotheses. Per one school of thought, children's hypermobility puts their cartilage at a greater risk of catching, explaining the numerous described cases of pediatric SRS.[10,14,20–22] According to the opposing hypothesis, children have immature bone structure that is protective against the catching of cartilage.[7,23] Indirect trauma secondary to any rapid movements including lifting, twisting, or sneezing is usually underreported due to commonalities among the different motions; direct trauma, for example secondary to sports, can also predispose an individual to SRS.[23] Given the unique movements associated with athletics, these known risk factors begin to compound.[10] Athletes are at augmented risk secondary to increased contraction of chest and abdominal wall musculature given their increased muscle density.[24]

As stated above, any history of trauma has been shown, through the cadaver study as well as case studies, to be correlated with SRS; the cases in which this has been demonstrate include football players, wrestlers, cyclists, and hockey players all with a similar mechanism of blunt rib cage injury.[12,21,25,26] It should be noted that a history of trauma, while a risk factor, is not required given the ability of SRS to arise from congenital and unknown origins.[22]

Patient Presentation: Childhood, Adolescence, Adulthood

Patients usually present with sudden-onset pain that transitions to a dull, aching pain secondary to fast, jerking movements that include

sneezing, coughing, or even simple lumbar flexion, extension, or rotation.[1] The pain can range anywhere from the midline to the lateral flank and from the xyphoid process to as inferior as the umbilical line.[23] Further, subjects can also feel a slipping, clicking, or popping sensation in the lower chest with specific spontaneous movements or with the hooking maneuver.[11,23] The pain can be felt as a somatic localized pain or a diffuse visceral irritation.[7] It is possible for the pain to radiate to the anterior ribs or the back as a result of specific movements.[24] The pain can be alleviated by lying down or other motions that offload the impinged nerve.[24]

The spread and vague nature of the location of SRS pain is what can make it so difficult to diagnose, especially in setting of the broad differential for chest and abdominal pain.[1] Although SRS pain is usually unilateral, cases of bilateral pain have been reported.[27] The pain can wax and wane with on conservative management but can go on years without a correct diagnosis or definitive treatment.[11]

Clinical Diagnosis

The diagnosis of SRS is difficult to confirm as there are minimal radiologic findings, and while there have been hundreds of cases reported in the literature the diagnosis and treatment remains underrepresented in medical and surgical textbooks.[1] Radiologic imaging of the chest and abdomen including chest x-rays and CT scans are often negative. While x-ray does not adequately describe soft tissue, the ability of CT to visualize soft tissue will sometimes uncover a protuberant rib.[24] However, given that the supine position can be an alleviating factor, CT scans still often show no abnormal findings. Unfortunately given the vagueness of symptoms and lack of radiologic evidence, patients can sometimes see physicians for months to years before obtaining a correct diagnosis.[22] Since other abdominal pain diagnoses must be ruled out, a lot of SRS pain is often unfortunately misdiagnosed as psychogenic pain.[27]

Diagnoses can be made using physical exam by elucidating the pain via the hooking maneuver first described by Heinz and Zaval in 1977.[28] In this maneuver, the examiner palpates under the costal margin and pulls the entire ribcage superiorly and anteriorly. During the maneuver the examiner and patient can sometimes feel a click, disconnected cartilage, or hypermobility, all of which can cause immense pain.[7] Further, testing using dynamic ultrasound involves constant real-time ultrasound monitoring as the patient attempts to recreate the pain through sudden movements like coughing or abdominal crunches.[17] When dynamic ultrasound testing is positive, the ribs can be seen subluxing, providing support for a diagnosis of SRS and guiding intervention.[17,29] In 2002,

Meuwly published two case reports describing a combination Valsalva and palpation under ultrasound to visualize the anatomical variation of SRS.[29] In a scanning study of 46 patients, dynamic ultrasound correctly identified SRS in 89% (32 or 36) of patients with confirmation by hooking maneuver and direct visual assessment during surgery.[17] Further, dynamic ultrasound found no evidence of SRS in the remaining 10 cases, consistent with a negative hooking maneuver.[17] On dynamic ultrasound the rib push maneuver was most effective with an 87% sensitivity, while crunch and Valsalva were much less sensitive at 54% and 13%, respectively.[17] Even with the use of dynamic ultrasound, at present definitive diagnose of SRS can only be made with intercostal nerve block that results in relief of pain due to blocked nerve transmission, direct visualization of altered anatomy during surgery, and relief following surgery.[27]

Treatment: Conservative, Medical, Minimally Invasive, Surgical

After a positive diagnosis of slipping rib syndrome the initial treatment is decreased activity, oral NSAIDs, and ice.[24] Further, patients should be reassured that this is a benign condition that is treatable.[24] It should be noted that in a study of fifty-four athletes, 22.2% also had an underlying psychiatric or psychological diagnosis, most likely due to their inability to continue to compete; thus, potential mental health issues should also be taken into account.[24] Other conservative treatments include heat, physical therapy, massage, topical NSAIDs, chiropractic manipulation and electronic stimulation, all of which focus on symptom control.[16] Even in cases of misdiagnosis, such as SRS diagnosed as a rib contusion or vice versa, the hallmark of treatment remains control of inflammation and pain.

When conservative treatment is unsuccessful, minimally invasive treatment should be considered starting with a combination of steroids and local anesthetics.[15] These local nerve blocks confirm the diagnosis, rule out other causes such as fracture and contusion, and provide symptomatic relief. In some cases, symptoms are largely ablated and do not recur, but given the anatomical etiology of the pain, the only long-term solution is correcting anatomy. Of note, there has been a single case report that described the use of botulinum toxin to provide similar, yet shorter-term pain relief compared to local nerve block.[30]

In order to change the anatomy and definitively cure SRS, surgical intervention is recommended. As previously stated, the first described surgery occurred in 1922.[3] Surgical intervention involves resection of the subperiosteum and costal cartilage.[24] This operation requires utmost

precision; if insufficiently resected, the subperiosteum can regrow cartilage whereas if too much is resected, injury to the neurovascular bundle may occur.[24] Injuring the neurovascular bundle puts the patient at risk of blood loss in the acute phase as well as neuropathic pain in the long run.[14] Spence, Porter, Mooney, Copeland and Saltzman have all published case reports of surgical excision with favorable results dating back to the early 1980s.[10,20,27,31,32]

More recently, Gould published a cohort of thirty patients undergoing thirty-eight operations from 2006 to 2015, including eight re-operations with an overall satisfaction rate of 7.84/10; all patients reported significant improvement and 44% had no pain.[18] Fu had similar results with a cohort of seven patients from 2000 to 2011 where five experienced symptom resolution, one had recurrence of pain in the same location, and one had recurrence of pain in a different location.[33] It should be noted that all patients in Fu's cohort were noted to have grossly abnormal cartilage visible to the naked eye.[33] Van Tassel published a study describing a cohort of twenty-four patients who underwent rib excision surgery between 2017 to 2018; the majority of the twenty-four patients showed no further symptoms and reported complete pain resolution.[17] Unfortunately, 17% had recurrent symptoms after surgery, with approximately equal numbers reporting pain in the same versus a new location.[17]

Most recently in 2019, McMahon implemented a novel technique in patients for whom rib excision was not curative. In three separate cases, bioabsorbable rib plating techniques traditionally used for fracture repair were utilized to vertically plate ribs 8–10 and mechanically separate the hypermobile ribs. Symptom reduction was achieved in all three patients, but given the singularity of this case report, further research into this technique is required.[34]

Van Delft et al developed a flow chart to help guide treatment and choose from among the described options. Per the flow chart, it is necessary to first recognize the syndrome and then to implement conservative treatments such as NSAIDs. If analgesics do not help, secondary testing by hooking maneuver and dynamic ultrasound should be performed. If positive, a single intercostal nerve block should be used to attempt to relieve pain and essentially confirm a diagnosis of SRS. If intercostal nerve block does not relieve symptoms, it is necessary to consider a missed fracture, a muscle tear, or another source of pain. If the pain returns after the nerve block, the next step is to consider surgical resection as the pain is likely to continue to recur.[26] Chhipa and Cheesman expanded upon this algorithm adding in corticosteroids to augment the

initial nerve block based on anecdotal evidence that decreasing swelling could decrease contusion; further, they recommended considering rib plating if the patient was hyperflexible.[21]

Conclusion

Slipping rib syndrome has been described in literature over the span of more than one hundred years. Unfortunately, due to its relative rarity is still misdiagnosed and patients remain in pain and untreated despite the availability of curative measures that carry relative low risk. An initial diagnosis can be made with simple physical exam maneuvers that can then be corroborated with dynamic ultrasound in the hands of a skilled sonographer. Confirmatory diagnosis can be made with a nerve block. If more conservative measures fail, the same implementation of ultrasound can guide the surgeon through the excision of a precise amount of cartilage that significantly improves patient outcomes. With further investigation, there may be one day be an opportunity for rib plating to be used to treat patients with symptoms secondary to hypermobility. While the treatment of SRS is relatively simple using the delineated algorithm, the biggest hurdle towards maximizing positive patient outcomes is boosting knowledge of the condition among members of the medical community. ✤

References

Paper of particular interest, published recently have been highlighted as:

• Of importance: 5, 23, 28

5. A review of musculoskeletal causes of chest pain, including slipping ribs, and available literature to support diagnosis and treatment.
23. A case report of a rare presentation of slipping rib, with accompanying review of available literature.
28. A case report of slipping rib causing recurrent abdominal pain, and description of the hooking maneuver as a diagnosis aide.

• Of major importance: 1, 18, 24

1. A review of the pathophysiology of slipping rib syndrome, clinical diagnosis and the use of dynamic ultrasound. It also presents surgical treatment options, including resection of cartilage as well as novel stabilization techniques.
18. A retrospective review of 30 pediatric cases of slipping ribs treated with surgical excision, citing improvement in all and about a 72% cure rate following surgery.
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