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Laparoscopic Treatment of Slipping Rib Syndrome in Pediatric Patients

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Abstract

Background: Slipping rib syndrome (SRS) is an often unrecognized cause of lower chest and upper abdominal pain in children and adolescents. Surgical resection of the cartilaginous portions of the slipping rib often provides permanent pain relief, with the standard surgical approach being an open resection. A minimally invasive approach has not been reported previously; we report a novel laparoscopic technique for the treatment of SRS with satisfactory results.

Materials and Methods: A retrospective review of all consecutive pediatric patients who underwent laparoscopic cartilage resection during the year 2019 and open cartilage resection during the year 2018 was included. Following data were recorded: age of patients, length of symptoms, length of procedure, length of cartilage resection, length of stay, resolution of pain, cosmetic acceptability, and postoperative complications.

Results: Four patients underwent laparoscopic slipping rib resection without complication during the year 2019. The mean age of symptom onset was 15 (range 14–16) years old, mean length of symptoms was 1.4 (0.5–2.0) years, and mean age at operation was 16.5 (16–18) years old. The average length of the procedure was 72.8 (55–102) minutes, and mean length of cartilage removed was 2.3 (1.9–3.0) cm. Three patients underwent standard open operation during the year 2018. All patients reported complete resolution of their chronic pain at their 6-month follow-up visit.

Conclusions: Laparoscopic technique can be used to treat SRS. All patients reported high satisfaction from resolution of chronic pain and the cosmetic appearance of their surgical scars.

Keywords: slipping rib syndrome, laparoscopic repair, pediatrics

Background

Slipping rib syndrome (SRS) is an unfamiliar source of lower thoracic and upper abdominal pain in children and adolescents. Often unrecognized, it has been the cause of unnecessary laparotomies and multiple medical consultations, causing patient morbidity and frustration. It tends to occur slightly more often in females.[1,2] The first report of SRS was published in the early 20th century by Cyriax.[3] Unlike ribs 1–7, which are attached directly to the sternum, ribs 8–10 are attached by a cartilaginous connection in children or by a fibrous band in adults.[4] Since these ribs are not articulating with the sternum, they can become ''free-floating'' when cartilaginous connections are loosened and subsequent impingement on the intercostal nerve produces pain.

Historically, treatment options have included pain management/observation, intercostal nerve injections, or surgical excision of the hypermobile rib cartilage. Surgical removal is the definitive treatment for SRS. Although surgery results in highest pain resolution rate, 25% of patients may require reoperation, involving a second excision.[5] Rib plating has also emerged as a possibility to treat pain recurrence.[5,6] In this report, we describe a novel laparoscopic technique to resect the slipping rib cartilage from within the abdomen.

Materials and Methods

A retrospective chart review was conducted of patients at UCSF Benioff Children's Hospitals (IRB no. 2020-022) who were diagnosed with SRS and underwent laparoscopic costal

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cartilage resection during the year 2019 and the standard open operation in 2018. The recorded data were age of symptom onset and diagnosis, operative time, cartilages resected, resolution of pain, length of stay, and postoperative complications. All patients were evaluated postoperatively with an outpatient visit for wound check, pain, complications, recurrence, and cosmetic satisfaction. Data are represented as percentages and mean with range as applicable. Patient data were analyzed using GraphPad Prism 8 (GraphPad Software, San Diego, CA).

Operative technique

Before general anesthesia, the area of maximal tenderness near the patient's costal margin was marked. The patient is positioned supine. A 5 mm umbilical port is placed to gain access into the abdomen. After proper pneumoperitoneum, two more 5 mm ports are placed in the mid-upper epigastric and mid-suprapubic areas. After palpating the slipping rib, a 25-gauge needle is percutaneously inserted through the skin and cartilage of the slipping ribs and penetrating the peritoneal lining, which is seen with the laparoscope. Laparoscopic hook cautery is used to open the peritoneal lining and to follow the needle toward the cartilage (Fig. 1A). The cartilage is exposed, and the muscular fibrous tissues are cleared with cautery. A locking grasper is used during the dissection to pull on the cartilage (Fig. 1B). Pushing down on the skin overlying the cartilage also helps to optimize the amount of cartilage to be excised. After exposing the cartilage to sufficient length, typically $\sim$3 cm, a pituitary rongeur is passed through the umbilical port site after the port is removed, and the laparoscope is positioned into the lower abdominal port. The rongeur is used to cut the cartilage (Fig. 1C) and the cartilage is then removed through the umbilical port site. A solution of 0.25% bupivacaine anesthetic is injected near the resection site. Open peritoneal lining is laparoscopically closed using interrupted absorbable sutures.

Postoperative care

Postoperatively, patients recovered in the postanesthesia care unit and were admitted to a regular ward for pain control. Patients resumed a regular diet and were given intravenous morphine and oral pain medication consisting of hydrocodone–acetaminophen. Patients were discharged when the pain was well controlled. Patients were given a limited course of hydrocodone–acetaminophen on discharge. All patients were followed up in the clinic 1 month later and a phone follow-up 6 months later.

Results

Four consecutive patients with SRS underwent laparoscopic resections. All patients were female and had tried a nonoperative management before resection (e.g., nonsteroidal anti-inflammatory drugs, physical therapy). The mean age for onset of pain was 15 (range 14–16) years old, mean length of symptoms was 1.4 (0.5–2) years, and mean age at operation was 16.5 (16–18) years (Table 1). The average procedure time (from intubation to extubation) was 73 (55–102) minutes, mean number of ribs resected was 1.3 (1–2), 2 of the patients had right rib resection, whereas 1 patient had bilateral rib resection and 1 had left rib resection (Table 1). The average length of rib cartilage resected was 2.3 (1.9–3.0) cm. All patients had the 10th rib cartilage resected. One of the patients had an associated mild asymmetric pectus carinatum, but none of them had other comorbidities. All patients were satisfied with the cosmetic outcome of their surgical scars (Fig. 2), relief of their chronic pain, and none reported any numbness near the costal margin area.

The data for 3 patients who had a standard open operation are given in Table 1. The demographic data were similar between laparoscopic and open cases except that there were more male patients in the open operation. The operation took longer using the laparoscopic method. The length of stay was similar in both methods. Longer cartilage length was removed in the open cases, but the operative outcome, which is pain resolution, was same for both methods.

Discussion

SRS is a commonly missed source of chronic lower chest and abdominal pain, often leading to a delay in diagnosis and

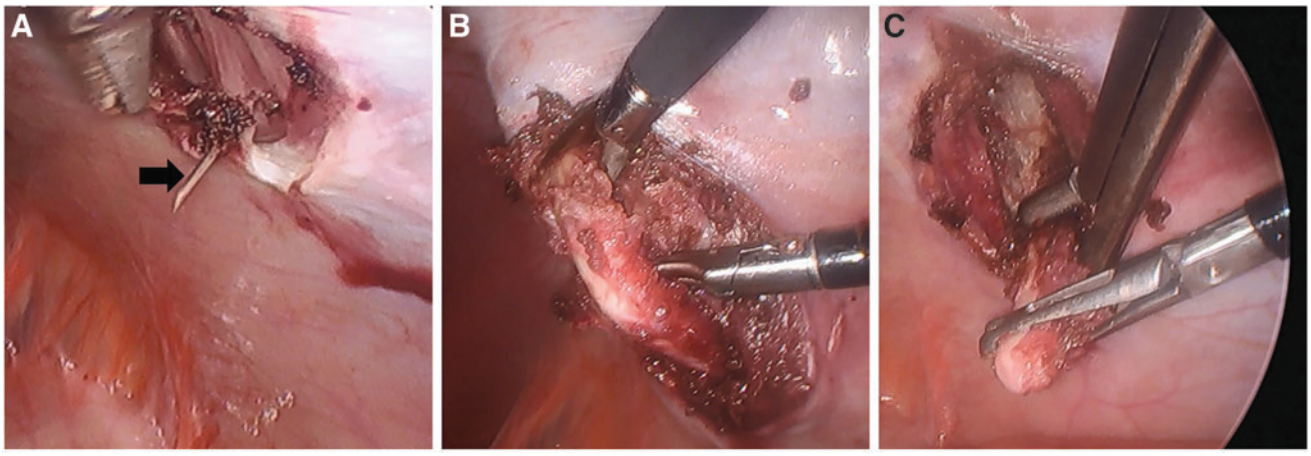

FIG. 1. Laparoscopic slipping rib resection. **(A)** A 25-gauge needle (black arrow) is used to pass the needle through the skin, through the target cartilage then through the peritoneal lining. **(B)** A Maryland or a locking grasper provides traction on the cartilage and facilitates easier sharp dissection of cartilage. **(C)** After exposing the cartilage, pituitary rongeur is used to cut the cartilage proximally and distally.

Table 1. Demographic and Operative Data

	Laparoscopic (n = *4*)	*Open* (n = *3*)
Age (years)	16.5 (16–18)	14 (7–19)
Female %	100	33
Age of onset (years)	15 (14–16)	13 (6–18)
Symptom length (years)	1.4 (0.5–2)	1.2 (0.6–2)
Symptom laterality	Right: 50% Left: 25% Bilateral: 25%	Right: 66% Left: 33% Bilateral: 33%
Procedure time (minutes)	73 (55–100)	57 (40–80)
Number of cartilages resected	1.3 (1–2)	1.3
Length of cartilage resected (cm)	2.3 (1.9–3)	5.5 (4–9)
Length of stay (days)	1.3 (1–2)	1

Data expressed as means with ranges in parentheses.

prolonged suffering in children and adolescents. Often these patients first undergo a myriad of tests to rule out gastrointestinal etiologies for the pain. Symptoms are usually provoked by movement, attributed to the hypermobility of the anterior cartilage of ribs 8–10 resulting in ribs that slip. Typically, it is the 10th cartilage that slips. The classical presentation as described by published reviews and case series is reproducible thoracoabdominal pain, usually unilateral, which is elicited by movement (e.g., sports activity, twisting, palpation). The differential diagnosis of musculoskeletal pain is wide, especially in athletic adolescents, including costochondritis, Tietze's syndrome, and painful xiphoid syndrome.[7,8] A simple physical examination technique known as the ''hooking maneuver''—whereby the clinician places flexed fingers under the costal margin and pulls anteriorly to elicit pain—is known to be a diagnostic test for SRS.[9,10] Modification of the hooking maneuver that we found useful is to have the patients take a deep breath and to hold their breath. This maneuver elevates the chest and better exposes the costal margin. Instead of hooking the rib, the lower costal margin area is palpated with pressure on the mobile cartilage to elicit the patient's pain symptoms. The hooking maneuver is difficult to perform on overweight or obese patients. The length of the cartilage that needs to be removed for treatment is not clear based on literature review. It is likely that the cartilage length will vary with each individual, and we recommend removing sufficient length such that the remaining rib structure will not slide under the costal margin upon palpation. This length is not very long, averaging 2.3 cm, based on our clinical results.

FIG. 2. Postoperative image of surgical scars.

In most of our patients, the diagnosis of SRS was not known to the patient, and they were managed with pain medications before consideration of surgical treatment. One of our patients was an avid athlete with several years of physical therapy and had tried intercostal nerve block, which did not provide long-term control of pain symptoms. Intercostal nerve block can be diagnostic, but pain relief is only transient.[11] Palpation at the area of slipping rib causing pain was diagnostic in all our patients. None of the patients reported a ''popping'' or ''clicking'' as some earlier series have reported.[2,12] Two of our patients had long-standing participation in athletic activities, which is consistent with large retrospective study that reported higher prevalence in athletic females.[1] Increased incidence in females is thought to be due to their higher ligamentous laxity. Imaging studies such as computed tomography, magnetic resonance imaging, and ultrasonography usually do not reveal the underlying pathology. Correct diagnosis of SRS is based on thorough clinical history and precise physical examination paired with SRS awareness.

Other retrospective series have showed success and safety in treating SRS with open surgical resection and that it should be offered as a prompt treatment choice.[5,13,14] Our impetus in changing from an open cartilage resection to laparoscopy was the request from our first laparoscopic patient and parent. Patient and parent were concerned about the cosmetic appearance of the transverse costal margin incision. Improved cosmetic patient satisfaction from laparoscopic method is subjective. The length of the incision, however, is not subjective in that the total length of incisions is much smaller for the laparoscopic method. The locations of the scars are also less prominent in the laparoscopic method compare with the standard transverse costal margin incision. We found that laparoscopic excision of the offending cartilage in SRS is an effective treatment in our 4 consecutive patients. Postoperative pain after the procedure did not appear to be much less compared with an open operation as reflected by similar length of stay for both operations. Previous abdominal surgery is not an absolute contraindication to this laparoscopic procedure, as one of our patients had some adhesions from prior appendectomy, but we were able to access the slipping rib through an intraperitoneal approach. More extensive intra-abdominal adhesions would make laparoscopic technique more prohibitive. Since the cartilage dissection occurs intraperitoneally, there is a potential for intra-abdominal adhesion formation. We tried to prevent bowel adhesion to the peritoneal incision site by closing the peritoneal lining with interrupted dissolving sutures.

The main advantage of this technique is that the cartilage dissection occurs intraperitoneally, thus obviating the need for a larger incision for overweight patients. Bilateral

conditions could be treated without added incisions. One disadvantage is that it can be more difficult to perform compared with an open operation. Our study is limited by short follow-up time, small sample size, retrospective analysis, and subjective outcome status. In the short interim follow-up of 6 months, all patients are still pain free. Other case series report recurrence of pain in 25% that may require reoperation within 2 years.[5,6]

Conclusions

SRS is an under-recognized cause of chronic abdominal pain due to physician unawareness. A laparoscopic approach can be used to treat SRS safely with good clinical outcome and improved cosmesis.

Authors' Contributions

A.I.S. collected, analyzed, and interpreted the data and drafted the article. K.S. collected, analyzed, and interpreted the data and critically reviewed the article for important intellectual content. C.O. interpreted the data and critically reviewed the article for important intellectual content. C.J.C. interpreted the data and critically reviewed the article for important intellectual content. S.K. conceptualized and created the surgical technique, designed the study, analyzed, and interpreted the data, and critically reviewed and revised the article. All authors approved the final article as submitted and agree to be accountable for all aspects of the study.

Disclosure Statement

No competing financial interests exist.

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