

Chapter 10

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Slipping rib syndrome

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Definition

Slipping Rib Syndrome (SRS), also known as rib tip syndrome or lower rib subluxation, is a musculoskeletal condition characterized by hypermobility of the false ribs (ribs 8–12) where they attach to the spine or the cartilage of the upper ribs (the costal cartilage slipping out of its normal anatomical position). This hypermobility can lead to symptoms, primarily localized pain and discomfort in the upper abdomen or lower chest. The condition is often marked by tenderness and can be exacerbated by certain movements or activities, such as twisting or bending. Individuals with SRS may also experience a clicking or popping sensation in the affected area (Gress et al., 2020).

SRS may be confused with Tietze Syndrome, but they are not the same, although they can share similar symptoms. Tietze Syndrome is characterized mainly by inflammation of the cartilage where the upper ribs attach to the sternum (de Carvalho, 2022).

The literature is rich in various definitions for SRS, including (McMahon, 2018; Patel et al., 2021):

- Clicking rib
- Displaced ribs
- Rib tip syndrome
- Costal margin syndrome
- Floating rib syndrome
- Nerve nipping
- Painful rib syndrome
- Slipping-rib-cartilage syndrome
- Gliding ribs
- Traumatic intercostal neuritis
- Twelfth rib syndrome

- Cyriax syndrome
- Interchondral subluxation, among others

History

The condition was first detailed in 1919 by Edgar Ferdinand Cyriax, an English-Swedish orthopedic physician and physiotherapist. He stated that disrupted ribs were responsible for aggravating downstream branches of the nerve. Cyriax also assigned the lesser-known name “Cyriax syndrome” to this condition ([Cyriax, 1919](#)). The initial recorded treatment of the condition is attributed to Eleanor Davies-Colley, the inaugural female fellow in the history of the Royal College of Surgeons. In 1922, she documented the cases of two female patients whom she treated by surgically removing the mobile cartilage of the tenth rib, resulting in immediate symptomatic relief ([Davies-Colley, 1922](#)).

Types

There are two different types of SRS:

- Primary SRS: Occurs due to inherent ligament laxity or congenital factors, contributing to the hypermobility of the false ribs.
- Secondary SRS: Results from external factors such as trauma, repetitive strain, or sports-related injuries leading to the displacement of the cartilage.

Forms

The disease can be categorized as follows:

- Acute: Characterized by sudden onset of symptoms, often following a specific triggering event like a trauma or strenuous activity.
- Chronic: Involves persistent or recurrent symptoms over an extended period, potentially indicating long-term ligamentous or structural issues.
- Intermittent: Symptoms may come and go, with periods of relief followed by exacerbation, making diagnosis challenging.
- Unilateral: Hypermobility and pain are localized to one side of the ribcage, affecting a specific set of false ribs.
- Bilateral: Involves hypermobility and symptoms on both sides of the ribcage, impacting a broader area.

Understanding the various types and forms helps clinicians tailor treatment approaches to the specific characteristics and underlying causes of SRS in individual cases.

Demographics

SRS can affect individuals of any age, but it is often seen in adolescents and adults. The condition may be more prevalent in certain demographics due to factors such as physical activity levels and underlying health conditions (Gress et al., 2020).

Incidence

It is regarded as an uncommon syndrome, constituting approximately five percent of all musculoskeletal chest pain cases in primary care. Exact incidence rates may vary, and the syndrome may be underdiagnosed due to its diverse and sometimes subtle symptomatology. Incidence can be influenced by factors such as age, lifestyle, and participation in activities that put strain on the ribcage (Gress et al., 2020).

Etiology

The etiology of SRS involves several factors (Gress et al., 2020):

- **Ligamentous Laxity:** Weakened or lax ligaments in the costovertebral or costotransverse joints contribute to hypermobility of the false ribs.
- **Trauma:** Direct impact or trauma to the ribcage can disrupt the normal alignment of the ribs and contribute to the syndrome.
- **Repetitive Movements:** Activities involving repeated twisting or bending of the torso can strain the ribcage, leading to subluxation.
- **Congenital Factors:** Inherent ligament laxity or structural abnormalities from birth may predispose individuals to SRS.

Pathogenesis

Understanding both the etiology and pathogenesis of SRS is crucial for developing targeted interventions and treatments that address the underlying cause and mechanisms contributing to the condition. Irrespective of the mechanism, the inadequate interchondral attachments become loose and may even rupture, permitting the tips of the cartilage to curl up and override the superior rib. The ensuing pain is a consequence of the impingement of branches of the intercostal nerve due to the described subluxation (Ayloo et al., 2013).

The basic conditions of pathogenesis are analyzed below:

- **Rib Displacement:** The primary characteristic is the abnormal movement or displacement of the false ribs, particularly ribs 8–12. The anterior false ribs slide out of orientation and become pinned underneath their adjacent superior ribs

- Costovertebral and Costotransverse Joint Involvement: Instability in the joints where the ribs articulate with the spine (costovertebral) or the transverse processes (costotransverse) is a key aspect of pathogenesis.
- Cartilage and Soft Tissue Involvement: The cartilage connecting the ribs to the sternum can also be affected, causing inflammation and contributing to symptoms.
- Pain Sensation: Displacement and irritation of surrounding structures lead to pain, manifesting as localized discomfort, tenderness, or referred pain.
- Inflammatory Response: Inflammation in the affected joints and surrounding soft tissues may exacerbate symptoms, contributing to the overall pathogenesis.

Main symptom

The primary and most prominent symptom of SRS is localized pain. The pain typically occurs in the upper abdomen or lower chest, often on one side of the ribcage. It can be sharp, aching, or both, and individuals may describe it as a stabbing sensation. Pain intensity may vary but is often exacerbated by specific movements, such as twisting, bending, or deep breathing. The pain may be reproducible during a physical examination, confirming the involvement of the ribs. Recognition and understanding of this main symptom guide the diagnostic process, helping healthcare providers differentiate SRS from other conditions presenting with chest or abdominal pain. A comprehensive history of the present disease is crucial for healthcare professionals to establish the timeline, characteristics, and impact of SRS. This information aids in accurate diagnosis and the development of an effective treatment plan ([Lum-Hee & Abdulla, 1997](#)).

Diagnostic approach flow chart

Clinical assessment ([Madeka et al., 2023](#))

- Onset and Duration: Inquire about when the pain started and its duration. Determine if the onset was sudden or gradual.
- Nature of Pain: Understand the character of pain (sharp, aching, stabbing) and its specific location. Ask about factors that worsen or alleviate the pain.
- Activities and Triggers: Explore activities or movements that seem to trigger or exacerbate the pain. Inquire about any recent trauma or repetitive actions involving the torso.
- Previous Episodes: Ask if the individual has experienced similar symptoms in the past. Explore any patterns of recurrence or specific triggers.

- **Associated Symptoms:** Inquire about any associated symptoms such as swelling, tenderness, or clicking sensations. Explore the presence of referred pain in other areas like the back or shoulder.
- **Impact on Daily Life:** Assess how the pain affects daily activities, work, and sleep. Explore any modifications in posture or behavior to alleviate symptoms.
- **Medical History:** Gather information on any previous rib injuries, surgeries, or relevant medical conditions. Inquire about underlying factors like hypermobility syndromes or congenital conditions.
- **Treatments Tried:** Ask about any self-management strategies or treatments attempted for pain relief. Inquire about the effectiveness of these interventions.
- **Psychosocial Factors:** Explore the impact of pain on the individual's mood, stress levels, and overall well-being. Inquire about any psychosocial factors that may contribute to the symptomatology.

Physical examination

A thorough clinical examination helps confirm the diagnosis of SRS, ruling out other potential causes of chest or abdominal pain. It also provides valuable information for tailoring an effective treatment plan (Mazzella et al., 2020).

- **Inspection:** Observe for any asymmetry, swelling, or deformities in the ribcage. Note any visible signs of discomfort or guarding.
- **Palpation:** Palpate the ribcage, specifically focusing on the costovertebral and costotransverse joints.
- **Identify tenderness or localized pain during palpation.**
- **Rib Maneuvers:** Perform specific maneuvers to reproduce or exacerbate symptoms, such as the Hooking Maneuver or Rib Mobilization Test.
- **The Hooking Maneuver** was initially described by Heinz and Zaval in 1977. In this technique, the examiner palpates under the costal margin and pulls the entire ribcage superiorly and anteriorly. During the maneuver, both the examiner and the patient may sometimes perceive a click, disconnected cartilage, or hypermobility, all of which can result in significant pain (Fam & Smythe, 1985; Turcios, 2017) (Fig. 10.1).
- **The Rib Mobilization Test** is a diagnostic examination used to assess the mobility and potential abnormalities in the ribs. During this test, a healthcare professional typically evaluates the movement, flexibility, and integrity of the ribs to identify any issues such as subluxations, dislocations, or restrictions in the ribcage. One common technique involves applying gentle pressure or manipulation to the ribs to assess their response and detect any abnormalities in movement. This test is often employed in the evaluation of conditions related to the thoracic spine, costovertebral



FIGURE 10.1 This picture shows the position of the patient and the “hook maneuver” to examine for possible slipping rib syndrome. The operator stands on the side of the patient and cephalad.

joints, and intercostal muscles, helping clinicians diagnose and address issues affecting the ribcage. It can be part of a broader physical examination for individuals experiencing chest or ribcage pain, discomfort, or related symptoms ([Heiderscheit & Boissonnault, 2008](#)).

- Cough Test: Instruct the individual to cough and observe for increased pain, which may indicate rib involvement.
- Respiratory Assessment: Assess respiratory patterns and note any discomfort during deep breathing. Evaluate for potential diaphragmatic involvement.
- Range of Motion: Assess the range of motion of the thoracic spine and observe for pain or restriction during movements such as twisting and bending.
- Neurological Examination: Rule out neurological involvement by conducting a basic neurological assessment, focusing on sensory and motor functions.
- Muscle Strength: Evaluate the strength of the surrounding muscles, especially those supporting the ribcage.
- Reflexes: Check reflexes to rule out neurological issues contributing to pain.
- Provocative Tests: Perform tests like the Rib Springing Test or Rib Compression Test to elicit pain or reproduce symptoms.
- Breastbone Examination: Assess for tenderness or inflammation at the junction of the ribs and the sternum in case of Tietze Syndrome.
- Functional Assessment: Evaluate how the symptoms impact daily activities and function.

Differential diagnosis

Thorough evaluation, including history, physical examination, and appropriate diagnostic tests, is crucial for differentiating SRS from other potential causes of chest or abdominal pain. Collaboration with healthcare professionals helps ensure an accurate diagnosis and tailored treatment plan (Fu et al., 2012). The following list of differential diagnoses might not be exhaustive but offers an opportunity to understand why SRS is often misdiagnosed.

- Costochondritis: Inflammation of the cartilage where the upper ribs attach to the sternum, presenting with localized chest pain.
- Musculoskeletal Strain or Injury: Trauma or overuse injuries affecting muscles, ligaments, or joints in the chest or abdominal region.
- Rib Fractures: Fractures of the ribs may result in localized pain, often exacerbated by movement.
- Intercostal Neuralgia: Irritation or inflammation of the intercostal nerves, leading to sharp or burning chest pain.
- Tietze Syndrome: Inflammation of the costal cartilage, causing localized chest pain and swelling.
- Scoliosis: Abnormal curvature of the spine may contribute to chest or back pain.
- Herniated Disks: Disc issues in the spine may cause radiating pain into the chest or abdomen.
- Pleuritis or Pleurisy: Inflammation of the parietal pleura, leading to sharp chest pain exacerbated by breathing.
- Pneumonia: lower respiratory infections can lead to chest pain, cough, and respiratory symptoms.
- Referred Pain from Abdominal Organs: Conditions affecting abdominal organs, such as kidney stones or liver disease, may cause referred pain to the chest.
- Gastrointestinal Issues: Conditions such as gastritis, peptic ulcers, or gallbladder disease may cause abdominal pain.
- Psychogenic Factors: Anxiety, stress, or psychosomatic factors can manifest as chest or abdominal pain.

Diagnostic examinations

Diagnostic examinations are selected based on clinical judgment and may be performed sequentially to rule out other potential causes and confirm the diagnosis of SRS (Hussain, 2020).

- Plain chest films: To visualize the ribcage and assess the alignment of the ribs. Helpful in ruling out fractures or identifying any bony abnormalities.

- **Magnetic Resonance Imaging (MRI):** Provides detailed images of soft tissues, including cartilage and ligaments. Helps evaluate the condition of the costovertebral and costotransverse joints.
- **Dynamic Ultrasound:** This can be used to assess the movement and alignment of the ribs in real time. Useful for visualizing soft tissues and detecting inflammation ([Scholbach, Ribinjuryclinic.com](#)).
- **CT Scan:** Offers detailed cross-sectional images of the chest and ribcage. May be used to identify structural abnormalities or assess fractures.
- **Nerve Block or Local Anesthetic Injection:** Diagnostic injections near the affected ribs can help confirm if the pain is originating from the ribs.
- **Laboratory Tests:** Blood tests to rule out inflammatory or autoimmune conditions contributing to symptoms.
- **Electromyography and Nerve Conduction Studies:** Assess nerve function and rule out neurological involvement.
- **Pulmonary Function Tests:** Evaluate lung function and assess for any impact on respiratory mechanics.
- **Cardiac Evaluation:** Electrocardiogram (ECG) and other cardiac assessments to rule out heart-related issues contributing to chest pain.
- **Gastrointestinal Studies:** If abdominal symptoms are prominent, consider endoscopy or imaging to evaluate the gastrointestinal tract.
- **Psychological Assessment:** Consideration of psychological factors through interviews or assessments, especially if stress or anxiety may contribute to symptomatology.
- **Provocative Maneuvers and Clinical Tests:** Specific clinical tests, such as the Hooking Maneuver or Rib Mobilization Test, reproduce or exacerbate symptoms.

Treatment options flow chart

The choice of treatment depends on the severity of symptoms, individual factors, and response to initial interventions. A multidisciplinary approach involving healthcare professionals, physical therapists, and, if necessary, surgeons can provide comprehensive care for individuals with SRS ([McMahon, 2018](#)).

- **Rest and Activity Modification:** Avoidance of activities that exacerbate symptoms, allowing the ribcage to heal. Modification of daily activities to minimize strain on the affected area.
- **Pain Medications:** Nonsteroidal anti-inflammatory drugs for pain and inflammation relief. Analgesics for pain management.
- **Physical Therapy:** Targeted exercises to strengthen the muscles supporting the ribcage. Stretching exercises to improve flexibility and mobility.
- **Manual therapy,** involving the manipulation of the costovertebral joint and electric stimulation, may assist in pain management, though long-term relief is uncertain ([Udermann et al., 2005](#)).

- Taping of the ribs may offer temporary relief. To determine the optimal location and direction for taping, administer a manual superior compression force through the postero-lateral aspect of the rib cage. Instruct the patient to take a deep breath or rotate. If the patient experiences a notable improvement in symptoms, apply the tape at that level (Bahram, 2015).
- Rib mobilization with movement (MWM), as introduced by Brian Mulligan, involves evaluating the range of motion and pain level. A cranial glide is applied over the lateral aspect of the rib above the painful region. While sustaining this rib elevation (unloading), the patient is instructed to rotate, and both range of motion and pain are reevaluated. If there is no change, the technique is repeated on a rib above or below. If MWM on a rib at a specific level is found to reduce or eliminate the pain, the process is repeated 10 times (Bahram, 2015).
- A home program of MWM may be recommended. Instructions include using the web space of one hand to lift the rib up and actively rotating towards the painful direction; repeat as often as necessary. The objective is to move the irritated costovertebral joint without pain as frequently as possible, aiming to diminish both protective muscle spasms and local inflammation (Bahram, 2015; Hansen et al., 2020).
- Rib Maneuvers and Manipulation: Manual manipulation by a qualified healthcare professional to reposition displaced ribs. Specific maneuvers, such as the Hooking Maneuver, to alleviate symptoms.
- Breathing Exercises: Diaphragmatic breathing techniques to improve respiratory mechanics and reduce strain on the ribs.
- Supportive Measures: Application of heat or cold packs to alleviate pain and reduce inflammation. Use of supportive braces or wraps for added stability.
- Injections: Local anesthetic or corticosteroid injections around the affected ribs for pain relief and inflammation reduction.
- Surgical Intervention: Reserved for severe cases where conservative measures have failed. Surgical stabilization of the ribcage may be considered to prevent recurrent subluxations.
- Psychological Support: Counseling or psychological support if stress or anxiety contributes to symptoms. Mindfulness or relaxation techniques.
- Education and Lifestyle Modification: Patient education on proper body mechanics and posture to prevent recurrence. Lifestyle modifications to address contributing factors.

Surgical treatment

Surgical treatment is usually considered for SRS if all other measures have failed and decisions are made on a case-by-case basis. It is essential for individuals to discuss the potential benefits, risks, and alternatives with their

healthcare team to make informed decisions about surgical intervention (Hansen et al., 2020).

Indications for surgical intervention

- Persistent Symptoms: Severe and persistent pain despite conservative measures.
- Recurrent Subluxations: Frequent recurrence of rib subluxations despite attempts at manual reduction.
- Functional Impairment: Impaired daily activities and reduced quality of life.

Surgical options

Several techniques have been described, either as an isolated procedure or hybrid combinations.

Resection of affected cartilage (Madeka et al., 2023; Mazzella et al., 2020): Often surgeons, considering that the hypermobile cartilage impinges on the intercostal nerve, opt to resect the cartilage of the involved false rib. Such cases have been successfully reported either in the adult or pediatric population.

We would exercise caution when employing such a technique for the following reasons:

- Complete resection of the affected cartilage with the perichondrial bed could produce a defect on the chest wall with potential chest wall weakness and herniation;
- Using significant energy in the lower intercostal nerves could damage the nerves, induce pain, and also an upper abdominal quadrant weakness presenting as a pseudo hernia of the abdominal wall.
- Often the cartilage resection in itself can produce a true floating rib and such could be responsible for symptom recurrence.

We would therefore recommend removal of the cartilage by filing it off from the cartilaginous “bed” (similar resection performed for pectus deformities) and reconstructing the defect with reefing sutures of the perichondrium and re-attachment to adjacent cartilage. In this manner impingement of the cartilage to the nerve is alleviated, the neurovascular bundle is protected and preserved, the cartilage is allowed to re-grow as a good fibrous start, and the stability of the false ribs is secured with the re-establishment of a stable costal arch.

Stabilization of costal arch and cartilages with absorbable or non-absorbable implants (Madeka et al., 2023): There are now reports in the literature of stabilization of the cartilages with vertical rib plating. Most authors have utilized bio-absorbable plates which dissolve after months leaving a strong fibrous band supporting the cartilage. Most cases seem to experience good overall pain relief, although long-term results are not yet available. Additionally, plating has been employed in combination with cartilage

excision and therefore these two techniques might complement each other but not necessarily have equal benefits when employed on their own.

Additionally, one should remain cautious in employing a complex and at times lengthy procedure with unnecessary tissue dissection when treating a pathology with pain being the cardinal symptom.

Rib Stabilization Surgery: Involves stabilizing the affected cartilages using simple suturing. This technique seems to be by far the simplest and has been described well by [Hansen et al. \(2020\)](#).

The most important points are identification of the lax cartilage/s, a small incision on the top of the pathology, careful dissection of overlying muscle fibers, and stabilization of cartilages with the simple figure of eight sutures avoiding a breach of the pleural cavity.

The technique can be employed with simple sedation and local anesthetic as a day case. Nonabsorbable heavy orthopedic sutures or ethibond sutures can be applied to stabilize the cartilage as shown in the following pictures [Figs. 10.2 and 10.3](#).

Picture showing the floating cartilage of the 10th rib with a sizeable gap between the ribs at the anterior aspect of the costal arch.

Two figures of eight stitches have been applied and the cartilages are now approximated and ribs stabilized.

We would recommend to try and place the suture around the upper rib or cartilage and protect the intercostal bundle of the upper rib from injury.

1. Local ablative treatments:

- a. Intercostal Nerve Blocks:** these could alleviate pain, if successfully applied, in patients with mild symptoms and those who do not wish to

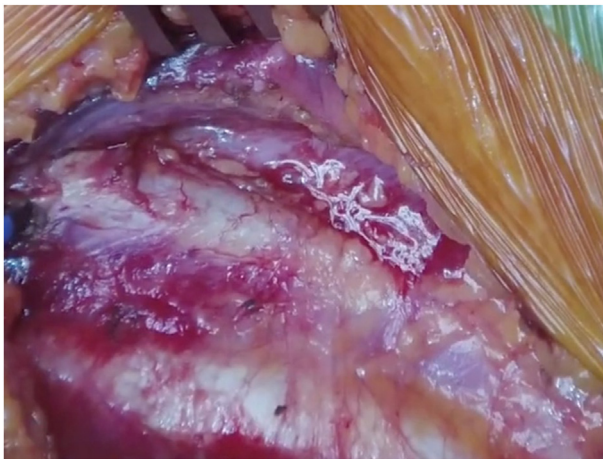


FIGURE 10.2 The floating cartilage of the 10th rib with a sizeable gap between the ribs at the anterior aspect of the costal arch.

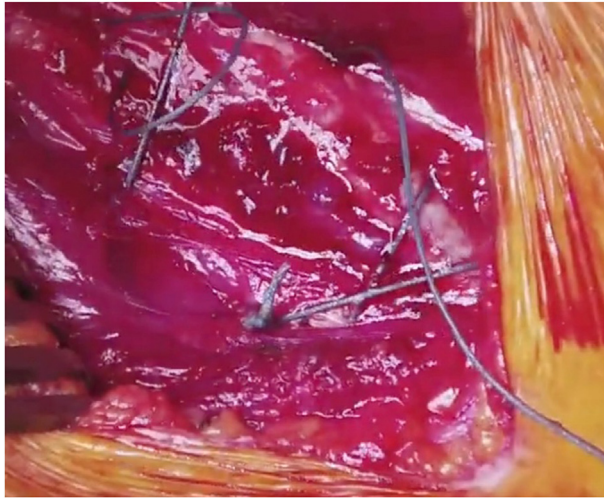


FIGURE 10.3 Eight stitches have been applied and the cartilages are now approximated and ribs stabilized.

consider any form of surgery. There are reports of pain relief with the combination of local anesthetic agents and steroids. The long-term effect of these agents is limited considering the pathophysiology of the SRS and the constant impingement of the intercostal nerve with activity.

- b.** Cryoablation ([Migliore et al., 2014](#)): Cryoprobes have been employed recently in the management of SRS. It should be noted that such were not used as a single therapeutic agent but as part of multimodality treatment including stabilization of the cartilages. It has been noted that cryoablation can reduce postoperative pain and length of hospital stay. There is no real evidence that long-term results should be expected with isolated use of cryoprobes for SRS. The reasons are obvious as such have to breach the pleural cavity if they were to be employed underneath the rib and those used outside the chest cavity would require a large incision and multiple tunnels to reach the neurovascular bundle.

Additionally, the manufacturers of the cryoprobes advise against their use below the 9th rib as the lower intercostal nerves, innervate the upper abdominal wall muscles with the risk of denervation and gradual redundancy with weakness of the upper abdominal wall.

- 2.** Use of botox injections ([Pirali et al., 2013](#)). Such experience is limited to case reports. It is only referenced in this chapter for completion purposes and it is not recommended with the current evidence.

Patient monitoring

Patient monitoring is essential for optimizing the management of SRS. Regular follow-up and open communication between the patient and health-care team contribute to effective treatment and improved quality of life.

- **Regular Follow-up Appointments:** Schedule periodic follow-up appointments with healthcare professionals to assess progress and adjust the treatment plan as needed.
- **Pain Assessment:** Continuously monitor pain levels and inquire about any changes or fluctuations in symptoms during follow-up visits.
- **Functional Evaluation:** Assess the impact of SRS on daily activities and overall functional status.
- **Imaging Studies:** Consider repeat imaging studies (X-rays, MRI) if necessary to evaluate the alignment of the ribs and assess the success of interventions.
- **Physical Examination:** Conduct regular physical examinations, including palpation and specific maneuvers, to check for tenderness, swelling, or signs of recurrence.
- **Response to Treatment:** Evaluate the response to ongoing treatments, including physical therapy, medications, or injections.
- **Psychological Support:** Monitor psychological well-being and provide additional support if stress, anxiety, or mood changes are noted.
- **Educational Reinforcement:** Reinforce proper body mechanics, posture, and lifestyle modifications to prevent recurrence.
- **Rehabilitation Progress:** Track progress in rehabilitation exercises and adjust the exercise regimen as needed.
- **Patient Education:** Provide ongoing education about SRS, its management, and potential triggers for symptoms.
- **Long-Term Management Strategies:** Develop and implement long-term strategies to prevent recurrence, including lifestyle modifications and ongoing exercises.

Prevention strategies

Prevention of SRS involves a combination of individual awareness, lifestyle modifications, and population-level strategies to minimize risk factors and promote musculoskeletal health ([Gress et al., 2020](#)).

- **Proper Body Mechanics:** Educate individuals on maintaining good posture and body mechanics to reduce strain on the ribcage during daily activities.
- **Core Strengthening Exercises:** Promote exercises that strengthen the core muscles, which play a role in supporting the ribcage.

- Avoidance of Trauma: Encourage caution and safety measures to prevent direct trauma to the chest or ribcage.
- Posture Awareness: Raise awareness about the importance of maintaining proper posture, especially during activities involving repetitive or prolonged torso movements.
- Condition-Specific Education: Provide education to individuals with hypermobility syndromes or congenital factors that may predispose them to SRS.
- Periodic Health Check-ups: Include routine health check-ups where healthcare professionals assess musculoskeletal health and address any predisposing factors.
- Physical Activity Guidance: Offer guidance on appropriate physical activities and exercises to ensure a balanced and supportive musculoskeletal system.
- Early Intervention for Trauma: Encourage seeking medical attention promptly for any chest or ribcage trauma to address potential issues early.
- Psychological Support: Address stress management and provide psychological support, as stress can contribute to musculoskeletal issues.

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