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# Minimally Invasive Surgical Management of Chronic Cough-Induced Rib Fracture Non-Union: A Case Report

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Data Interpretation D  
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**Patient:** Male, 54-year-old  
**Final Diagnosis:** Rib fracture  
**Symptoms:** Chest pain  
**Clinical Procedure:** Rib resection  
**Specialty:** Surgery

**Objective:** Rare disease  
**Background:** Nonunion of a rib fracture can cause chronic pain, and pharmacological pain management may lead to medication dependence. This report describes a 54-year-old man with a chronic cough and painful nonunion fracture of the left posterior 8<sup>th</sup> rib, managed with minimally invasive surgery and a rib splint.

**Case Report:** A 54-year-old man presented with chronic cough-induced left chest wall pain. Three-dimensional chest computed tomography (CT) scan showed a nonunion of a fracture of the left posterior 8<sup>th</sup> rib. After medical management failure, we proposed a surgical approach with the aim to remove the tissue comprising the nonunion, release the nerve, and stabilize the bone stumps. To avoid the adverse effects of a large incision, we designed a minimally invasive strategy based on ultrasound fracture localization and the use of an intramedullary splint. The pain disappeared immediately after surgery. The patient was discharged in 24 hours. At 6-week follow-up, he was still asymptomatic, and a new CT scan reconfirmed the correct splint position. From the immediate postoperative evaluation until the last follow-up visit, he consistently reported full satisfaction.

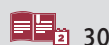
**Conclusions:** This report has highlighted the challenges of management of chronic pain in nonunion of a rib fracture, and has described the use of a minimally invasive surgical approach. In this single case, our tailored surgical strategy achieved definitive success in pain management, minimizing postoperative complications/adverse effects and avoiding the addition of pain medications despite a 24-hour hospital stay. Our goal is to share an alternative solution for colleagues facing similar cases.

**Keywords:** Rib Fractures • Chest Pain • Chronic Pain • Splints • Pain Management • Postoperative Complications

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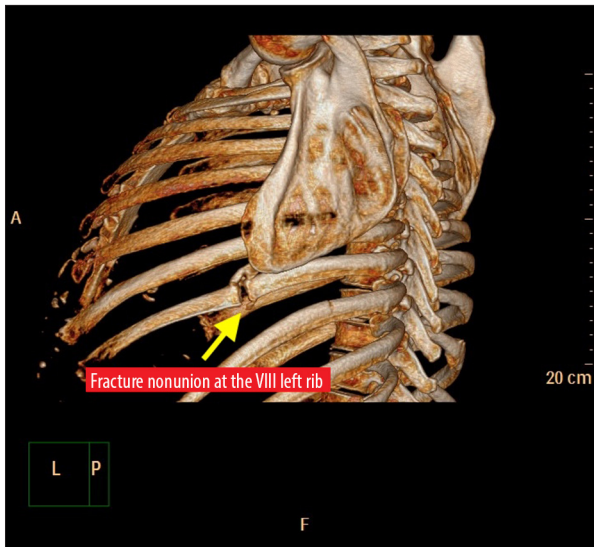
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## Introduction

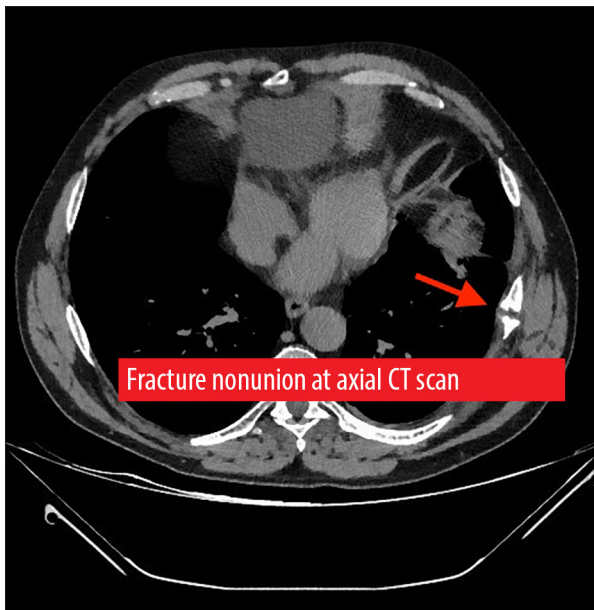
Rib fractures are recorded in at least 10 to 20% of chest traumas [1], representing the most frequent injury described. Their management ranges from conservative treatment to surgical repair according to symptom severity. The conservative strategy is based on pain control and positive pressure ventilation, while surgery involves fracture reduction and rib fixation using prosthetic devices. Surgical repair is commonly accepted by most thoracic and trauma surgeons in cases of flail chest, while in all other cases, the role of surgery is by no means clearly defined despite the publication of more and more evidence regarding indications and timing [2]. Respiratory failure is certainly the highest-impact acute condition related to rib fractures, but chronic pain is a challenge that deserves attention as well [3]. A recent cohort study described some degree of rib pain even after an isolated rib fracture in 40% of patients, and 29% had not returned to preinjury working capacity at 12 months [4]. Further, Prins et al reported long-term lung function recovery to values considered normal, but subjective thoracic complaints, such as pain, often remain present [5]. Depending on the severity of the pain, these patients have usually been managed with standard pain medications, such as acetaminophen, non-steroidal anti-inflammatory drugs, opioids, or regional anesthesia, such as thoracic epidural, paravertebral blocks, and erector blocks; however, the adoption of surgical repair has increased due to recent evidence on functional outcomes. Although most fractured ribs heal spontaneously without discomfort or with mild discomfort, a presumably small percentage of patients (5-10%) [6] develop rib nonunion and an even smaller percentage develop symptomatic rib nonunion with chronic pain. The etiology of nonunion is often multifactorial and includes patient-specific risk factors, such as nicotine use, osteoporosis, diabetes mellitus, fracture severity, fracture location, disease comorbidity, and medication use, including nonsteroidal anti-inflammatory drugs and opioids [7]. The morphologies of rib fractures that increase the likelihood of nonunion include excessive distraction between fractures, excessive displacement, comminution, infection, and soft tissue interposition [8]. In contrast to the emerging evidence on operative treatment of flail chest, until a few years ago there was a paucity of literature on nonunion surgical treatment. In recent years, however, some interesting articles have been published that have changed the perspective, both in terms of the indication for treatment and the different surgical techniques [9-11]. Based on these considerations, this report describes a 54-year-old man with a chronic cough and painful nonunion fracture of the left posterior 8<sup>th</sup> rib, refractory to any medical therapy, managed with minimally invasive surgery and a rib splint. This case is interesting because: 1) the limited amount of data currently available makes it difficult to assess the relative success of current treatments for rib fracture nonunion, and 2) we successfully adopted a strategy to minimize surgical impact.

## Case Report

The patient, a 54-year-old heavy smoker, presented to our office with chronic left chest wall pain exacerbated by movement. His past medical history was perianal cyst, Hepatitis B virus infection, surgically corrected varicocele, 2 episodes of pancreatitis, and a 2018 crush injury with sternal fracture and fracture of some right ribs. He had experienced severe cough-induced pain in May 2023 and had gone to the emergency department of a hospital in northern Italy but was discharged without any evidence of chest injury. Ten days later, he had returned to the emergency department and on that occasion was diagnosed with a massive hemothorax, for which he underwent emergency left biportal thoracoscopy to stop the bleeding and drain the pleural cavity. Postoperative recovery was good, but characterized by the persistence of moderate left chest wall pain. In July 2023, the pain had recurred after a coughing fit. Because the symptoms had worsened in the following weeks, in September 2023, he went to the emergency room of our hospital. Computed tomography (CT) showed an undisplaced lateral left 9<sup>th</sup> rib fracture in an advanced stage of healing and a displaced posterior fracture of the 8<sup>th</sup> rib just below the scapula angle, with the characteristics of a nonunion (Figures 1, 2). Two contralateral, completely healed older fractures were also reported, while no signs of thoracic tumors or any pathologic fracture were detected. After the rheumatological examination, a diagnosis of osteoporosis and vitamin D deficiency was made. The patient was referred to our office. At clinical examination, he presented in good general condition, but very much in pain, describing to us exactly where the pain was. The description was well localized, pointed out precisely, and exacerbated by palpation under the left scapula angle, consistent with the 8<sup>th</sup> rib nonunion. However, no callus was palpable. He had no mechanical complaints such as an unstable feeling or 'clicking' sensation. Based on the symptoms and the investigations performed, we decided on a diagnosis of chronic pain from nonunion of the rib fracture. Therefore, we referred the patient to our pain therapist, who set up pharmacological therapy with pregabalin and oxycodone. The patient refused a nerve block, which was considered temporary relief that might require periodic injections. Unfortunately, the pharmacological therapies failed, so we proposed surgery with the goal of releasing the intercostal nerve and removing the tissue comprising the nonunion. Since our main concern was the adverse effects of a large incision, we designed a minimally invasive strategy to avoid major injury to the chest wall. Although the patient was informed of the possibility of pain control failure after surgery, he was highly motivated by the severe pain. In the operative room, he was positioned in the right lateral decubitus position. The rib cage was then tested with an ultrasound linear probe to correctly detect the nonunion. Under general anesthesia and selective lung ventilation, we performed a 4 cm skin incision above the nonunion

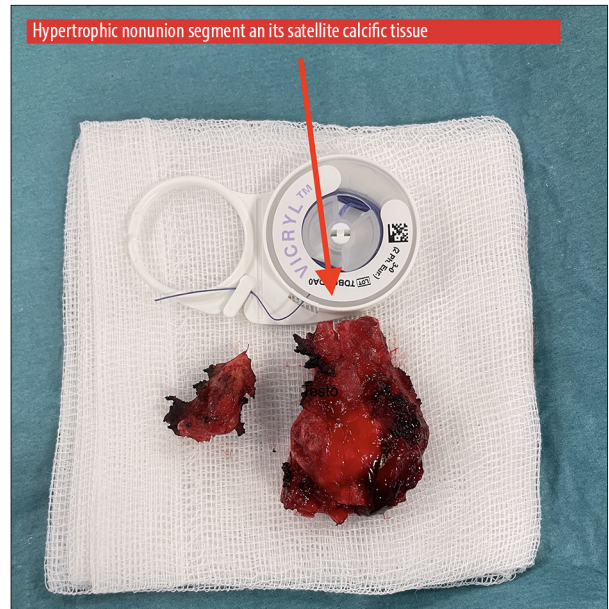


**Figure 1.** Chest 3-dimensional computed tomography reconstruction showing the nonunion of a fracture of the 8<sup>th</sup> left rib. The lack of contact between the margins and the presence of tissue interposition were clearly visible and indicated by the yellow arrow.



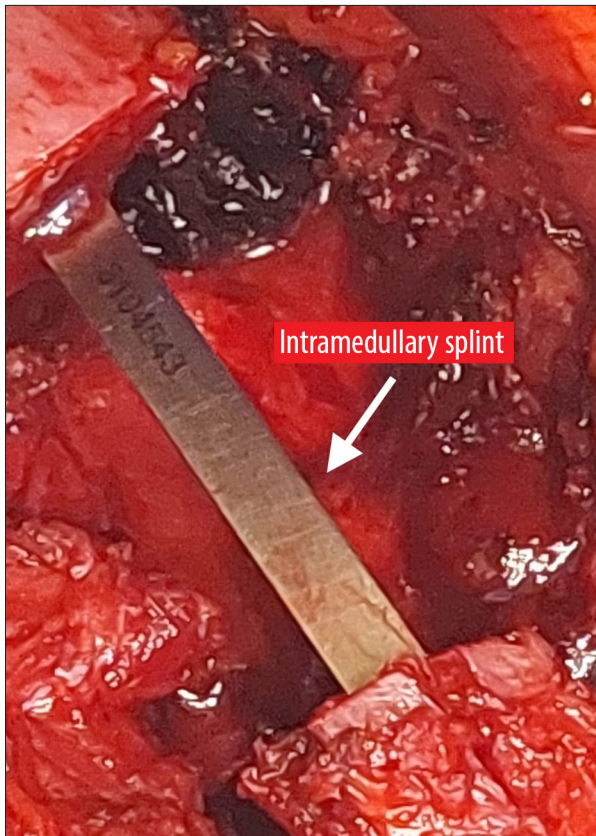
**Figure 2.** Axial computed tomography scan of the nonunion; view of the nonunion in the axial plane.

and parallel to the rib direction. A muscle-sparing approach allowed us to preserve the latissimus dorsi. Once the fibers of the serratus muscle were spread apart, the nonunion area was exposed with the aid of a wound retractor to obtain an adequate and clean surgical field. The fracture edges were stuck in hard overflowing tissue filling the nonunion space, consistent with hypertrophic type. This made it unlikely to be able to perform satisfactory nonunion debridement and reduction.

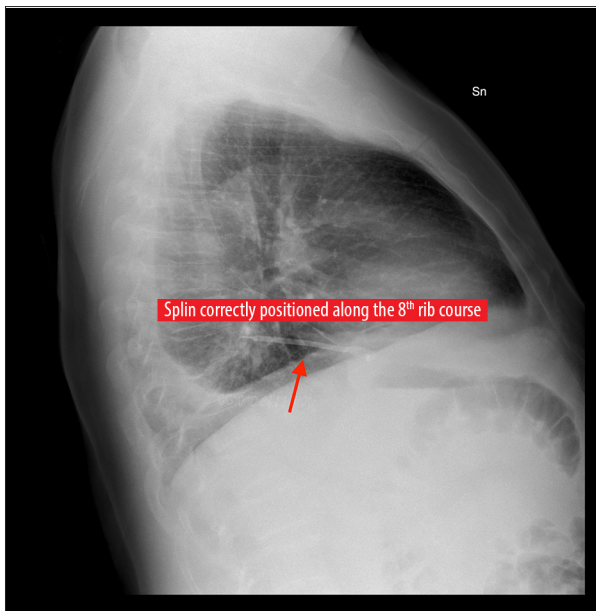


**Figure 3.** The specimen. This picture shows the hypertrophic nonunion segment after removal and its satellite interposition tissue. Both are indicated by the red arrow.

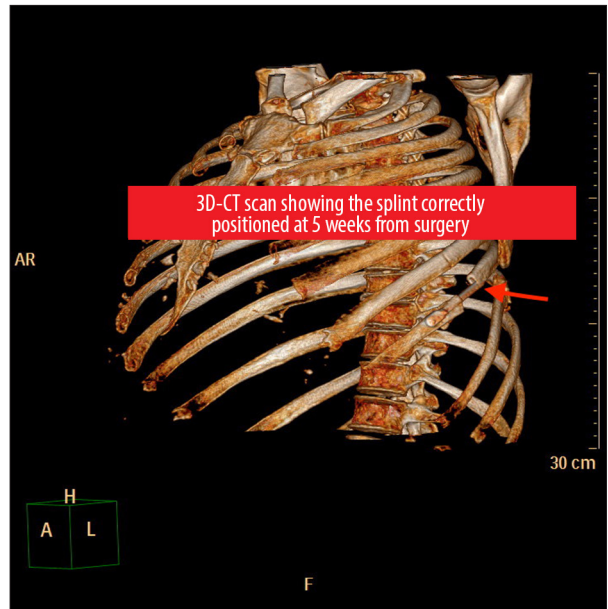
Therefore, we decided to remove the extra bone formation and fibrosis around the fracture that was leading to pain due to the involvement of the intercostal nerve; thereby performing a partial rib resection. The target bone was freed from the intercostal muscles along the upper and lower margin, carefully preserving the nerve, artery, and vein. This maneuver also allowed the release of the nerve itself. The rib was resected immediately downstream and upstream of the fracture and the hypertrophic nonunion tissue was removed (**Figure 3**). Since the space between the bone ends, measuring about 4 cm in length, involved just a single rib, we decide to avoid any bone graft. To ensure the stability of the bone while maintaining the minimally invasive approach, we decided against using a plate, and instead opted for a simpler device. We placed a 5 mm wide and 80 mm long intramedullary splint with a single hole for locking screw fixation to prevent migration (**Figure 4**). At the end of surgery, a pleural tube was placed, as a pleural perforation could not be ruled out. The histological findings showed fibrous tissue and pseudoarthrosis between rib fragments and was negative for malignancy. Just 1 day after surgery, the patient reported the disappearance of his chronic chest pain even during movement, and after removal of the chest tube, he was discharged without the need for opioids. Chest X-ray at 1 and 14 postoperative days (**Figure 5**) showed the correct position of the splint with no evidence of displacement. At 1 month follow-up, the patient was asymptomatic without the use of any pain medication. At 6 weeks, he was still asymptomatic, and a new CT scan reconfirmed the correct splint position (**Figure 6**). From the immediate postoperative



**Figure 4.** Rib fixation. We repaired the rib by introducing a single intramedullary splint as indicated by the white arrow.



**Figure 5.** First postoperative X-ray showing correct splint position along the 8<sup>th</sup> rib projection, as indicated by the arrow.



**Figure 6.** Long-term computed tomography (CT). At 6 weeks following surgery, a CT scan confirmed the correct splint position, as indicated by the arrow.

visit until the last follow-up visit, the patient consistently reported being fully satisfied.

## Discussion

Our experience describes a treatment option based on a minimally invasive surgical approach, for chronic pain caused by nonunion of a rib fracture, that has been resistant to pharmacological therapy. Reports on symptomatic post-traumatic nonunion rib fractures and their surgical management are uncommon; to our knowledge, this condition has been addressed only in a few case series [12-16]. The definition of nonunion is the lack of healing and fusion of the bone edges after at least 9 months following a fracture, without any change in the callus on consecutive chest X-ray [17]. The condition occurs due to excessive movement between the rib edges during respiration, but its etiology is often multifactorial. Starting from the same condition, most cases develop either hypertrophic or atrophic nonunion. Hypertrophic nonunion is a type of nonunion that develops when the body is in good biological condition. Atrophic nonunion occurs in the presence of inadequate biological factors, and is established in the early stages of fracture healing. Hypertrophic nonunion must be distinguished from pseudoarthrotic nonunion. In our case, the fracture and failure to heal (with the features of the hypertrophic type) may have been sustained because of a deficit in calcium metabolism and related osteoporosis in a heavy smoker. Diagnosis is always made by CT scan; the possibility of a 3-dimensional study of the rib cage also helps in planning a possible surgical strategy.

The advantages of rib fixation have been well documented in cases of flail chest when invasive ventilation is required; on the contrary, the indication for rib repair is not so clear in patients with uncomplicated or single-rib fractures. Chronic pain following post-traumatic rib fractures has a large psycho-socio-economic impact on the healthcare system. The FixCon trial in 2019 was the first study to compare clinical, functional, and economic outcomes between operative fixation and nonoperative treatment for multiple simple rib fractures [18]. This was followed by the Chest Wall Injury Society NONFLAIL study in 2020 [19] and studies by Hoepelman et al [20], Marasco et al [21], and Perentes et al [22] in 2022. In this scenario, the surgical treatment of complicated fractures, such as nonunion fractures, deserves attention. The last consensus statement on rib fractures, published by Pieracci et al [23] in 2017, concluded that surgical repair of level 3A, grade B chronic nonunion is advocated for persistent disabling pain that is resistant to medical therapies. Regarding surgical technique, they demonstrated with a level 4, grade C fracture, that the correct approach consists of direct exposure, debridement of the callosity/pseudoarthrosis, correction of the deformity, and fixation with rigid hardware. A comprehensive review in 2022 [9] showed that until recently, it was common practice to partially resect symptomatic rib nonunion, inducing a pseudoarthrosis of the defect without targeting the formation of a bridging callus in the fracture. However, due to the physiology of bone healing, when the mobility of the healing bone exceeds the strain of its tolerance, the fracture will not repair, because a bridging callus cannot form [24]. Therefore, it has been proposed that surgical stabilization of a nonunion rib fracture creates the correct conditions for the bone to heal, as it reduces the bone's mobility [25]. Several variants have been described for surgical stabilization of nonunion rib fractures; plates are the most common. The other key moment in surgical treatment is the management of the intercostal nerve, which needs to be released. However, the data collected suggest that sufficient stability seems to be the main goal for treatment of these nonunions and that treatment of the intercostal nerve does not always seem to improve outcome [9]. In our case, the surgical strategy was set based on this knowledge and consisted of debriding the fibrous tissue and then stabilizing the rib and freeing the nerve. The characteristics of the fibrous tissue made the maneuver unsatisfactory, so we preferred to perform a partial resection that would allow us to realign the rib and still free the nerve. In September 2023, Forrester et al [26] edited the last Chest Wall Injury Society recommendations specific to nonunion surgical repair. This paper was designed using a process of iterative consensus, in which experts voted to accept or reject each recommendation. The researchers concluded that there is lower-quality evidence suggesting that surgery may be beneficial in improving patient-reported outcomes and emphasized that the benefits should be balanced against the risk of symptomatic hardware rupture and infection, focusing again

on good patient selection and surgical strategy. A few case reports or series describing nonunion repair for chronic pain are available, but most of these were cases of pseudoarthrosis. Very few articles described cases of hypertrophy, and most of them were treated with plate fixation [27-29]. As demonstrated by Marasco et al [30], the use of intramedullary fixation is attractive compared with standard plate fixation. Indeed, the use of an intramedullary splint allows minimally invasive access and can avoid the potential complications of a large incision. Splints offer additional theoretical advantages, as they allow for less hardware fixation than cortical plates, which are fixed to the bone with multiple screws. We therefore ruled out plate repair, which would have required enlargement of the operative field. In fact, for proper placement, at least 3 screws must be inserted for each of the properly prepared rib stumps. Also, given the position just below the scapular angle, we wanted to avoid possible complications due to mechanical encumbrance of the plate and its screws during shoulder movements. Another reason we preferred the splint to the plate was that we considered the use of multiple screws on osteoporotic bone to be less suitable and more at risk of displacement. To maximize splint advantages, a correct fracture localization is pivotal. The strength of our case report is precisely in the minimally invasive strategy that was possible thanks to ultrasound-guided fracture localization and intramedullary fixation. Indeed, the use of perioperative ultrasound localization of rib fractures is associated with reduced incision length, operative time, and opioid requirements on patient discharge [27].

## Conclusions

This report has highlighted the challenges of management of chronic pain in nonunion of a rib fracture, and has described the use of a minimally invasive surgical approach. Adopting a tailored strategy ensured ultimate success in pain management, minimized postoperative complications/adverse effects, and avoided the need for pain medication after a 24-hour hospital stay. In the present report, we share our experience, which was built on the foundation of a deep literature review and daily high-volume trauma center activity. Our goal was to describe an effective alternative solution for colleagues facing similar cases.

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## Declaration of Figures' Authenticity

All figures submitted have been created by the authors who confirm that the images are original with no duplication and have not been previously published in whole or in part.

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