

Surgical strategy for treating multiple symptomatic rib fracture malunions with bridging heterotopic ossifications: A case report[☆]

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SUMMARY

Rib fractures are common and serious injuries, which can negatively impact long-term quality of life. Here we present a woman in her early twenties who was referred to our trauma surgery outpatient clinic five years after a motor vehicle collision in which she sustained upper extremity injury and multiple displaced rib fractures. The rib fractures were initially managed non-operatively. At the time of the outpatient consultation, she endured persistent severe pain located between the left scapula and the thoracic spine. The pain worsened on repetitive motion and deep respiration. A new chest CT revealed left-sided posterior rib fracture malunions of ribs 4 to 8 with heterotopic ossifications (HO) that formed an osseous bridge between these ribs. Surgical excision of the bridging HO and remodeling of the angulated rib malunions resulted in significant alleviation of symptoms, which allowed her to return to work and other activities. Given the dramatic improvement after surgery, we suggest considering surgical remodeling and excision for rib fracture malunions and associated HO that cause local mechanical symptoms.

Introduction

Around one in ten blunt trauma patients sustain rib fractures, and about 50 % of polytrauma patients have rib fractures [1,2]. Rib fractures can negatively impact the quality of life even months after trauma [3,4]. Treatment of acute rib fractures consists of pain management and measures to prevent secondary pulmonary complications. In addition to this, surgical stabilization of rib fractures (SSRF) is performed in increasing numbers and is recommended especially for a flail chest, which is defined as at least three consecutive ribs with two or more fractures [5,6]. However, little scientific literature currently exists concerning the long-term consequences of rib fractures and their treatment. An unknown proportion of patients develop a symptomatic rib fracture nonunion or malunion, with or without heterotopic ossifications (HO). HO is the abnormal growth of lamellar bone in locations where normally only soft tissues reside [7]. Symptomatic rib fracture nonunion (or rib pseudo-arthritis) is commonly defined as a symptomatic rib fracture that remains incompletely healed at 3 months or longer post-injury. A rib fracture malunion is defined as a healed fracture with displacement causing obvious angulation in the rib [8–10]. Rib fracture nonunion, malunion, and HO can lead to symptoms by interfering with the normal mechanics of deep breathing and movement. In addition, chronic irritation or entrapment of the intercostal nerve around the abnormally healed fracture can cause symptoms.

Currently, no guidelines exist about the treatment of rib fracture malunions or HO. Hereby we present a case of surgically

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remodeled rib fracture malunions and resected HO with a good outcome. The patient provided informed consent for the publication of the case.

Case

A 22-year-old woman who endured a motor vehicle collision as a car passenger five years prior, experienced continuing severe chest wall pain. During the initial trauma, she sustained multiple displaced left-sided posterior rib fractures, among other injuries. Her rib fractures were managed non-operatively. However, years later, she complained of pain located between the scapula and the thoracic spine, which worsened during deep inspiration and repetitive motion. In addition, she had a painful clicking sensation when moving her left arm. These complaints severely interfered with her daily activities. The onset of these symptoms was about a year after the injury when she resumed working and the symptoms became gradually worse. On physical exam, the pain worsened by palpating the described area. The mobility of her left arm was not limited, nor was any abnormal movement or snapping of the scapula noted. A chest CT scan demonstrated malunions of ribs 4 to 7 on the left side with distinct posterior angulations protruding in the erector spinae muscle loge (Fig. 1). HO was present, which formed osseous bridges in the posterior intercostal space between ribs 4 to 7 on the left posterior chest wall. These acquired rib abnormalities were deemed a likely explanation for her symptoms.

Although there is ample experience in our institution with treating rib fracture patients both nonoperatively and with SSRF, we had no previous experience with treating this combination of rib fracture malunions and HO. Also, scientific literature about this type of post-traumatic chest wall abnormalities is lacking. To devise the best surgical plan, an online platform for experts in the treatment of chest wall injury was consulted [11]. However, the expert opinions ranged from no intervention to aggressive surgical excision and remodeling, with or without perioperative radiation therapy and/or perioperative bisphosphonates and indomethacin or other nonsteroidal anti-inflammatory drugs (NSAIDs). Finally, while considering the various options, the decision was made for surgery with standard postoperative pain management, which included NSAIDs.

The patient was taken to the operating room and positioned prone. A longitudinal paravertebral incision was placed at the level of the palpable malunions, which allowed for further exposure just below the trapezius muscle. The rhomboid muscle was partially incised and the erector spinae muscle was shifted medially. Next, the protruding rib malunions of ribs 4, 5, and 6 were resected (Fig. 2). Then, the osseous bridge between ribs 4 and 5 was resected, and the large osseous bridge between ribs 5 and 6 was cleaved and partially resected. The remaining HO between ribs 6 and 7 was also resected. During this procedure, new rib fractures occurred in ribs 5 and 6. Both fractures were stable upon testing without signs of a pneumothorax, therefore no rib plating was performed. Last, a wound drain was placed and the incision was closed.

Post-operatively, the patient received naproxen 250 mg three times daily during a week as part of the analgesia regimen. She received physiotherapy for respiratory hygiene and help mobilizing her shoulder. The wound drain was removed on postoperative day two and she was discharged home on postoperative day three without any signs of complications. One month after surgery she contracted COVID-19 which resulted in heavy coughing leading to a relapse of pain and a delay in her recovery. Two months after surgery she was seen in the outpatient clinic where she indicated satisfaction with her recovery and that she continued to improve. However, she still used paracetamol daily and ibuprofen every other day. During the next visit seven months after surgery, she mentioned that she felt completely different because she could work and live her life without debilitating pain. She did not need

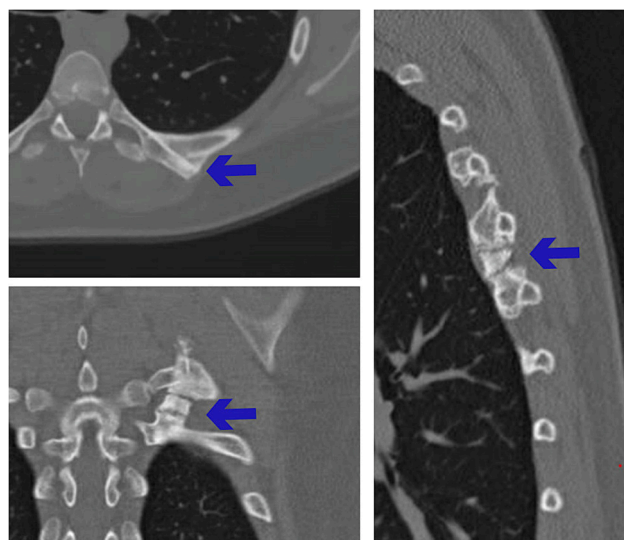


Fig. 1. Pre-operative chest CT-scan with malunions of ribs 4 to 7 with heterotopic ossifications and bridging callus on the left side of the chest wall. Arrows represent an angulated malunion with protrusion into the erector spinae muscle in axial view (top left) and heterotopic ossifications between the ribs in axial and sagittal view (bottom left and right).

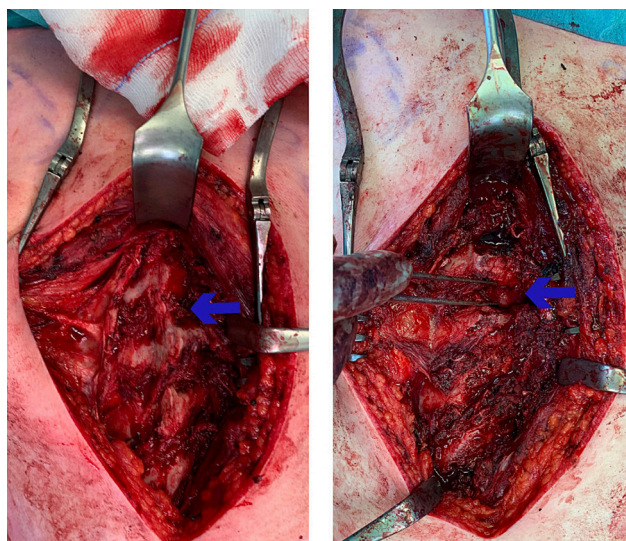


Fig. 2. Per-operative photos of chest wall before and after resection most of the bridging callus and the malunioned osseous angulations of ribs 4 to 7. Arrows represent heterotopic ossifications between the ribs (left) and the intercostal space after resecting the heterotopic ossifications between the ribs (right).

analgesia anymore, and her pain and quality of life parameters improved substantially (Table 1). The follow-up chest CT scan demonstrated anatomical alignment of the previous malunions, consolidation of the iatrogenic fractures, and no HO recurrence (Fig. 3).

Discussion

A case was described of a young trauma patient who underwent successful surgical remodeling of symptomatic rib fracture malunions and intercostal HOs. HO is presumably caused by hydrophobic bone morphogenetic protein leaking from normal bone in a favorable environment in response to venous stasis, inflammation, or damaged attachments of connective tissue to bone [12]. HO prevention strategies have been described mostly in the setting of hip surgery, consisting of perioperative radiation, NSAIDs, and bisphosphonate therapy [13]. The rationale behind radiation therapy to prevent HO is disrupting cell differentiation and thereby preventing bone formation in the radiated soft tissue [7]. The mechanism by which NSAIDs likely prevent HO is by inhibiting prostaglandin synthesis, which is associated with inappropriately activating osteoblastic cells and subsequent HO formation [13]. Bisphosphonates interfere with the process of bone calcification and may thereby prevent HOs [13]. Recurring intercostal HO has previously been prevented successfully in two middle-aged patients in whom symptomatic HO was resected years after SSRF, directly

Table 1
Quality of life measurements before and after the surgery.

	8 months pre-op	1 week pre-op	4 months post-op	7 months post-op
Maximum pain ^a				
NRS	9	9	10	3
SF-36 (%) ^b				
Physical function	30	40	30	95
Physical limitation	0	0	0	100
Energy/fatigue	25	35	25	60
Emotional well-being	48	48	48	80
Social function	25	25	25	75
Pain	22.5	22.5	22.5	77.5
General health	50	20	50	65
EQ-5D ^b				
5 L	0.572	0.261	0.334	0.737
VAS	55	55	40	85
DASH ^a				
Score	60	80	86	34

5 L, five level score for the EQ-5D; DASH, disability of shoulder and hand; EQ-5D, EuroQol five dimensions; NRS, numeric rating scale; post-op, post-operative; pre-op, pre-operative, SF-36, short form 36; VAS, visual analog scale.

^a Higher score indicates more pain or more disability.

^b Higher score indicates higher level of functioning.

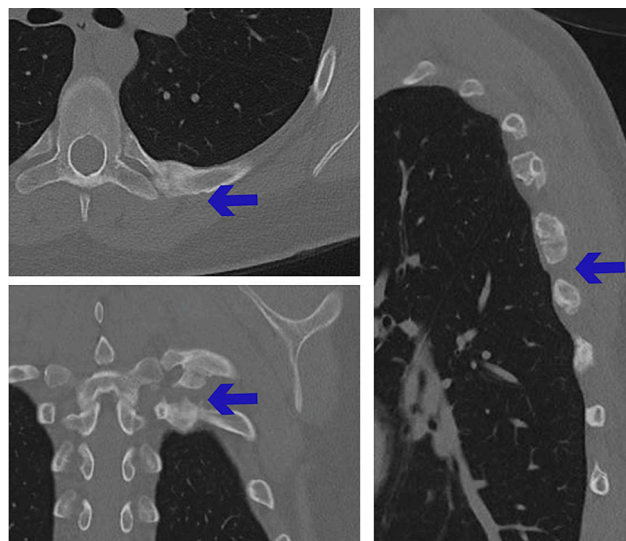


Fig. 3. Seven months post-operative chest CT-scan demonstrating remodeled ribs 4 to 8 and partially resected heterotopic ossifications. Arrows represent the rib after resecting the protrusion of the malunion in axial view (top left) and partially resected heterotopic ossifications between the ribs in axial and sagittal view (bottom left and right).

followed by a single radiation dose of 7 Gray and two months of oral indomethacin [7].

Potential risk factors for developing rib fracture malunions are excessive rib fracture displacement, complex rib fractures with multiple fragments, and damage to the periosteum and vasculature [14]. These risk factors were likely present in our patient. Other case reports have described successful outcomes following surgery on rib malunions [10,14]. These cases featured scapula fractures in combination with posterior rib fracture malunions with local mechanical complaints, referred to as snapping scapula syndrome [10]. In our patient, possibly part of the pain when moving her left arm was due to the scapula scraping over the rib malunions, although no snapping could be observed during physical examination. The HO connecting multiple ribs with osseous bridges could explain her discomfort during deep breathing by limiting the natural chest wall movement. The HO could also cause symptoms by entrapping the intercostal nerves. The protrusions of the angulated malunions into the erector spinae muscle were considered another source of pain, especially on direct pressure; for example when leaning back on a chair.

The shared decision was made for surgery. Perioperative radiation therapy was not selected because of the risk of iatrogenic damage to the lung parenchyma causing long-term respiratory side effects in this young patient. Insufficient data was found to support perioperative bisphosphonate treatment. It was communicated that only limited evidence was available for this specific condition and that the opinions from experts in the field varied widely concerning the optimal treatment strategy. From the patient's perspective, the situation could not become worse than it was, and the possibility that surgery would alleviate the symptoms provided hope, despite the risks associated with surgery.

The dramatic improvement in this case supports surgical treatment of symptomatic posterior rib fracture malunions with HO. Nevertheless, careful patient selection and expectation management are warranted, since more prospective data should be collected to support treatment decisions about symptomatic rib fracture malunion and associated HO. However, early SSRF for severely displaced rib fractures would potentially prevent malunions altogether [5].

In conclusion, symptomatic rib fracture malunions with HO should be suspected in patients with previous thorax trauma and severe ongoing pain. Surgical remodeling of angulated rib malunions and resecting HO alleviated symptoms substantially in the presented case and could therefore be considered a treatment option in this rare condition.

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Declaration of competing interest

The authors declare that they have no competing interests.

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