



Outcomes of Thoracic Wall Resections and Reconstructions

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ABSTRACT

Objectives: Pain is a pathological condition that affects the individual both in terms of health and socioeconomic aspects. Non-cardiac chest pain is a frequent symptom in patients admitted to the hospital. The aim of this study was to evaluate the surgical treatments and pathological results of chronic chest pain of unknown cause.

Methods: In this study, patients admitted to the Gaziantep City Hospital Department of Thoracic Surgery with complaints of chest pain between October 2023 and December 2024 were retrospectively examined. Patients older than 18 years of age, with normal radiological examinations, rib pain lasting at least 1 year, unresponsive to drug therapy and intercostal neurolytic treatments, and treated surgically were included. The visual analog scale (VAS) was used to quantify pain.

Results: A total of 69 patients were analyzed retrospectively. Of the patients, 50.7% were male and 49.3% were female. The mean age was 30.6 (19–55) years. According to the VAS score, the mean pain severity was 6.28. No pathological findings were detected radiologically or scintigraphically in 89%–90% of the patients. Pathology results included benign lesions, chronic inflammation, enchondroma, chondroma, chondrosarcoma, osteoma, osteomyelitis, and malignant mesenchymal tumor. In the first postoperative month, 81.1% of the patients had no complaints of pain, while 15.9% reported mild pain.

Conclusion: Even if radiological and scintigraphic examinations are normal, pain may be caused by an underlying disease. In chronic rib pain, pain control can be achieved with surgical treatment despite unsuccessful analgesic therapies.

Keywords: Pain, reconstruction, resection, thorax, VAS

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Introduction

Pain is a pathological finding that disturbs the individual both in terms of health and socioeconomic aspects. Chronic pain is defined as pain lasting longer than three months and affects approximately 20% of adults; it is a significant and devastating public health problem.^[1,2] Traditionally, chronic pain is categorized as nociceptive and neuropathic.^[3] Nociceptive pain occurs as a result of trauma to peripheral tissue, and neuropathic pain occurs as a result of pathology of the somatosensory nerve. Pathophysiologically, pain may have both nociceptive and neuropathic components.^[4,5] Chest pain is a frequent symptom in patients admitted to the hospital. Causes of pain include bone, cartilage, muscle, pleura, and other chest structures, known as non-cardiac

pathologies. Single or multiple rib fractures are detected in 60-80% of blunt chest trauma patients.^[6] However, chest pain caused by the ribs can also be non-traumatic. Even when chest pain is atypical, coronary vascular evaluations (CT or angiography, etc.) can be performed to rule out possible cardiac pathology. It has been reported that medications such as paracetamol, nonsteroidal anti-inflammatory drugs, gabapentinoids, and lidocaine can be used to control pain in non-cardiac rib pain.^[7] Additionally, invasive interventions such as intercostal nerve block, serratus anterior plane block, erector spinae plane block, paravertebral block, intrapleural block, and epidural analgesia have also been reported for pain control.^[8-13] Chronic chest pain negatively affects a person's life,

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including social life and sleep. All treatments are performed in an attempt to relieve this pain. It has been reported that rib resections are recommended for chest pain presenting with costochondral swelling without an underlying cause.^[14] The aim of this study is to evaluate the results of surgical treatment of chronic chest pain of unknown cause that persists despite all medications and other treatments.

Methods

In this study, patients admitted to the Gaziantep City Hospital Department of Thoracic Surgery with complaints of chest pain between October 2023 and December 2024 were retrospectively examined. Patients older than 18 years of age, with normal radiological examinations, rib pain lasting at least 1 year, unresponsive to drug therapy and intercostal neurolytic treatments, and treated surgically were included. Patients with a radiologically detected mass or cyst in the thoracic wall, those who responded to drug treatments, and those younger than 18 years of age were excluded from the study. The visual analog scale (VAS) was used to quantify pain in the preoperative period (Fig. 1). The postoperative 1st-month evaluation was based on the patient’s verbal statement by the same physician. This retrospective, single-center analytical study was conducted from October 7, 2023, to June 25, 2024, in the Department of Thoracic Surgery at Gaziantep City Hospital. This study was conducted in accordance with the Declaration of Helsinki. The Institutional Research Ethics Committee approved the study protocol (number 44/2024).

Statistical Analysis

The homogeneity of the population distribution was assessed with the Kolmogorov-Smirnov test. The parameters were examined by both univariate and multivariate analyses. Comparisons between groups were made with the Mann-Whitney U test or the chi-squared test. The Kruskal-Wallis test was used for multiple dependent variables. Results were reported as mean±SD, median, number (n), and percentage (%), with p<0.05 considered significant. Analyses were performed using SPSS for Windows Version 22.0 (IBM Corp., Armonk, NY, USA).

Results

A total of 69 patients were analyzed retrospectively in this study. 50.7% of the patients were male and 49.3% were female. The mean age was 30.6 (19-55) years. The comorbidity rate was 11.5% (8.6% hypertension and 2.9% diabetes mellitus). 8.6% of the patients complained of persistent pain after trauma, whereas 91.4% had no history of trauma (Table 1). Pain localization was on the right in 21.7% and on the left in 78.3%. According to the VAS score, the mean severity of pain was 6.28. Despite medical treatments, pain complaints continued for 1 year in 49.2% of the patients. The rate of pain persisting for 2 years was 15.9%, for 3 years it was 14.4%, and 20.5% had pain that had persisted for longer periods. Pathological findings were detected in only 11.5% of patients on computed tomography (CT) and 10.1% on bone scintigraphy (BS). No pathological findings were detected radiologically or scintigraphically in 89%-90% of the patients. The anatomical structures affected in surgical exploration were, in order of frequency, the 4th rib (34.7%), arcus costarum (26.1%), 3rd and 5th ribs (14.4%), 2nd rib (8.7%), processus xiphoideus (5.8%), and 6th rib (4.3%) (Fig. 2). All patients received analgesic medications and algological treatments, but their pain continued. All patients underwent surgery under general anesthesia, and only 14.4% required postoperative intercostal nerve block. The surgical method was thoracic wall resection and/or reconstruction with an incision appropriate to the pain localization. Reconstruction materials were, in order of frequency, cartilage or bone graft (42%), titanium (33.4%), muscle flap (14.4%), and dual mesh (10.2%) (Fig. 3). Pathology results were benign (32.9%), chronic inflammation (28.6%), enchondroma (12.6%), chondroma (10.1%), chondrosarcoma (8.7%), osteoma (2.8%), osteomyelitis (2.8%), and malignant mesenchymal tumor (1.5%). In the first postoperative month, 81.1% of the patients had no complaints of pain. 15.9% of the patients had mild pain (VAS severity 2) and 3% had moderate pain (VAS severity 4) in the first postoperative month.

According to the statistical analysis of the study, patients between the ages of 20 and 40 had no complaints of pain in the first postoperative month (p=0.0403). In patients younger than 20 and older than 40, the VAS values of

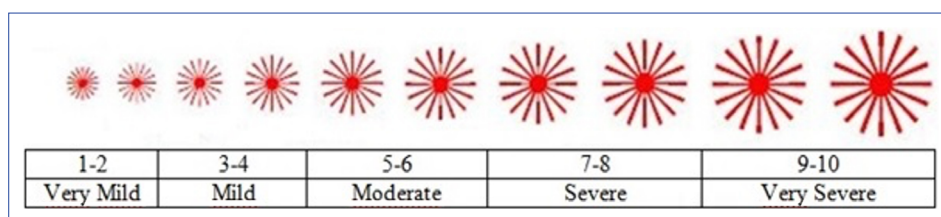


Figure 1. Pain intensity values on the Visual Analog Scale.

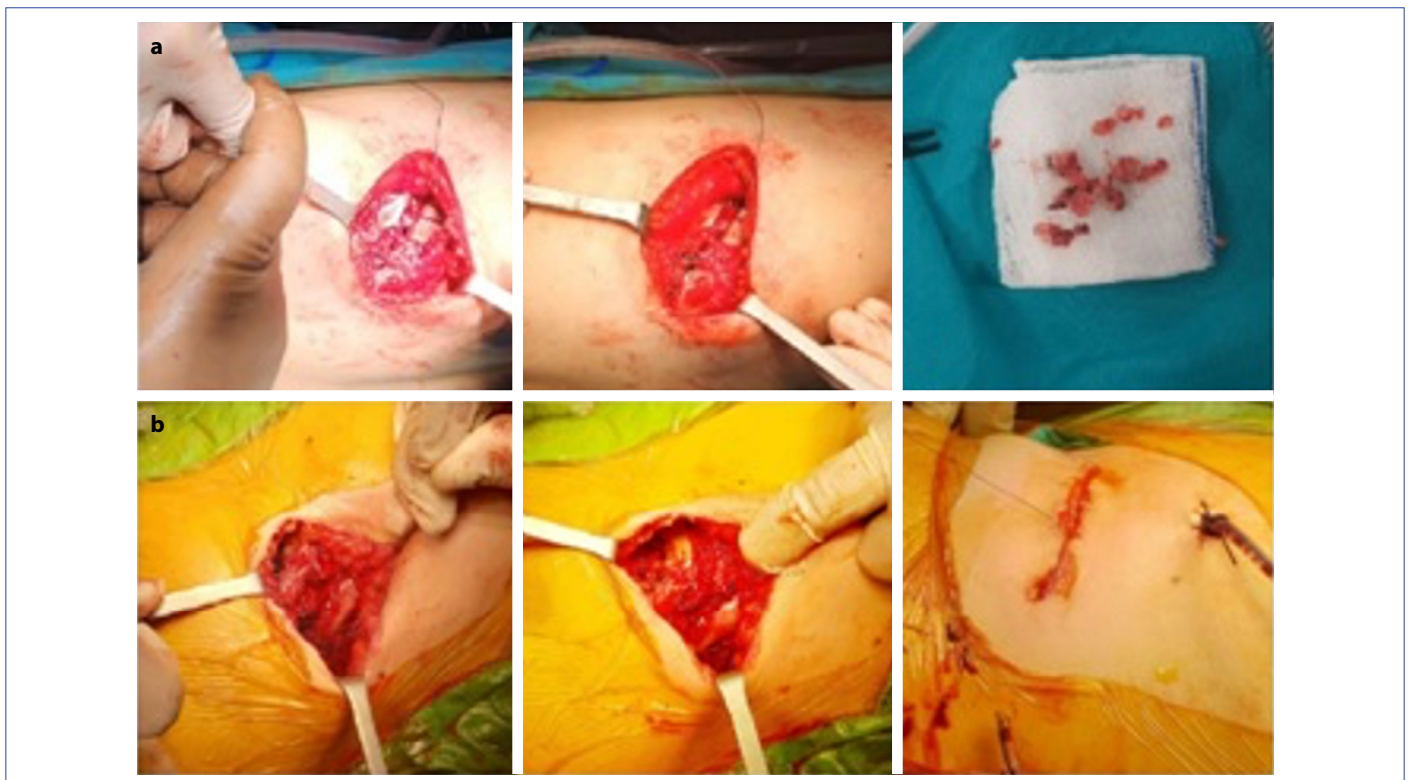
Table 1. The demographic data of the study

Parameters	n	%	Mean	SD
Ages	69		30.6 (19–55)	8.95
Gender	69			
Male	3	50.7		
Female	34	49.3		
Comorbidity				
Yes	8	11.5		
Hypertension	5	7.2		
Diabetes mellitus	2	2.9		
Others	1	1.4		
No	61	88.5		
Trauma				
Yes	6	8.7		
No	63	91.3		

SD: Standard deviation.

postoperative pain were not statistically significant. Gender had no statistically significant relationship with pain. Among comorbidities, diabetes mellitus was significantly associated with high postoperative pain ($p=0.0001$). The patient's history of thoracic trauma was associated with mild postoperative pain ($p=0.0087$). It was determined that 81.2% of the patients had no pain complaints after surgery. If the patient's pain duration was 2 years or less (1 year $p=0.0203$, 2 years $p=0.0463$), it was associated

with complete recovery after surgery. However, if the patient had complaints of pain for more than 5 years, it was associated with the continuation of pain, even if mild, in the postoperative period ($p=0.0402$). As preoperative pain intensity increased according to the VAS value, it was related to an increase in the degree of postoperative pain (if the VAS value is 10, postoperative high pain $p=0.0023$). There was no relationship between postoperative pain and whether the pain was localized on the right or left. Rib resections and reconstructions were related to complete postoperative recovery ($p=0.0234$). Resection and reconstruction of the costal arch was statistically significant with continued postoperative pain, albeit mild ($p=0.0391$). Among the reconstruction techniques, the use of muscle flaps was associated with complete postoperative recovery ($p=0.0206$). The use of titanium plaques was statistically significant with continued, albeit mild, postoperative pain ($p=0.0032$). The use of synthetic mesh or cartilage graft was not associated with postoperative pain. Pathologically, chondrosarcoma ($p=0.0314$) and osteomyelitis ($p=0.0368$) were statistically associated with higher postoperative pain. Mesenchymal tumor was related to mild postoperative pain ($p=0.0489$). Other pathological results (mature cartilage tissue, chronic inflammation, enchondroma, chondroma, osteoma) were related to complete recovery of postoperative pain, but there was no statistically significant relationship with the persistence of pain (Table 2).

**Figure 2.** (a) Image of left thorax wall resection (6) (b) Image of right 6nd costovertebral reconstruction.

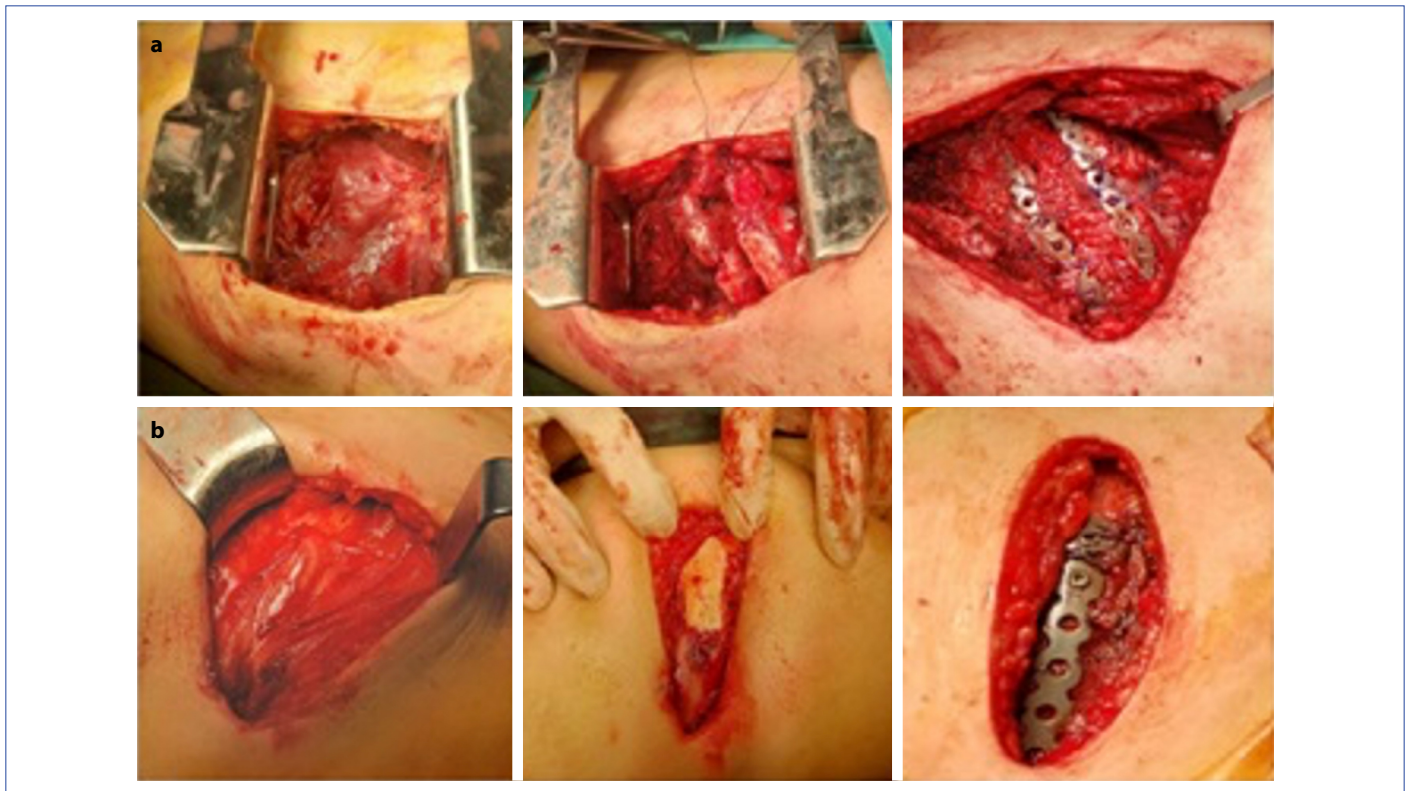


Figure 3. (a) Image of right 6 and 7nd thorax wall resection (b) Image of right 6nd thorax wall resection.

Discussion

Chondromas are benign cartilage tumors mostly found in the hands and feet. This tumor is lobulated, hyaline, and calcified. These are rare lesions that cause palpable pain. The lesion should be considered malignant due to its histological and radiological similarity to chondrosarcoma. Therefore, it should be completely removed with negative surgical margins.^[15,16] Our patients, whose pathology results revealed chondroma, complained of severe pain and non-palpable tenderness on physical examination. Radiological and scintigraphic examinations were normal. Surgical exploration revealed no findings other than irregularity on the outer surface of the rib. This lesion was completely removed with negative surgical margins. Reconstruction with cartilage and muscle tissue was often preferred. Postoperatively, the vast majority received both diagnosis and curative treatment.

Chondrosarcomas are painful, aggressive tumors that usually occur in the pelvis, ribs, and long bones. They are often sporadic but can transform from osteochondroma or enchondroma.^[17,18] It may not be possible to distinguish between enchondroma and low-grade chondrosarcoma radiologically and histologically.^[19] Therefore, it is difficult to determine effective treatment. Chondrosarcoma usually requires radical surgery. While benign tumors can be monitored, malignant tumors cannot be risked. Since it is known that low-stage chondrosarcoma cannot be clearly differentiated from

enchondroma, these tumors are completely removed in our clinic with negative surgical margins. We perform the same surgical procedure for both low-grade chondrosarcoma and enchondroma. Due to negative surgical margins, there was no need for additional oncological treatment. In our patients diagnosed with chondrosarcoma who presented only with persistent pain, radiological and scintigraphic results were normal. These were lesions consistent with subcentimetric irregularities discovered incidentally during surgical diagnosis and treatment. The surgical technique was planned due to the lack of response to anamnesis, physical examination, and pain relief treatments. Both diagnosis and curative treatment of a malignant tumor at an early stage were achieved. The follow-up of these patients continues in our clinic.

Primary chest wall tumors are very rare, accounting for 0.04% of all tumors and 5% of thoracic tumors. Fibrous dysplasia and enchondroma are the most frequently detected benign rib lesions.^[20,21] Biopsy is controversial in benign rib tumors. Traditionally, if a biopsy is planned before surgery, caution should be exercised. It may cause possible tumor transplantation, complications, and failure to reach a pathological diagnosis. In our cases, no preoperative biopsy was preferred. Surgical resection is the treatment of choice for benign rib tumors for both diagnostic and curative purposes.^[20] Curative surgery was performed in every case with intraoperative pathological findings in the

Table 2. Results of the statistical analysis of the study

Parameters	Postoperative pain severity			OR	p	Parameters	Postoperative pain severity			OR	p
	0 (n)	2 (n)	4 (n)				0 (n)	2 (n)	4 (n)		
Ages						Pain localization					
<20 years	2 (100%)	0	0	0.121	0.0785	Right	13	2	0	1.204	0.0674
20-40 years	38 (84.5%)	6 (13.3%)	1 (2.2%)	0.635	0.0403	Left	45	9	2	2.143	0.0516
>40 years	16	5	1	0.345	0.0583	Resection					
Gender						Ribs (2,3,4,5)	41	6	0	2.016	0.0234
Male	28	5	2	0.923	0.0921	Arcus costarum	12	4	2	4.069	0.0391
Female	28	5	1	0.892	0.0865	Processus Xiphoideus	3	1	0	1.347	0.5130
Comorbidity						Reconstruction					
Hypertension	1	4	0	2.167	0.0056	Muscle flap	10	0	0	8.340	0.0206
Diabetes Mellitus	0	0	2	5.386	0.0001	Cartilage graft	25	4	0	1.984	0.0510
Trauma	0	5	1	3.056	0.0087	Synthetic mesh	5	1	0	1.210	0.0602
Duration of pain (years)						Titanium plaque	16	6	2	3.514	0.0032
1	33	1	0	4.183	0.0203	Pathology					
2	10	1	0	1.142	0.0463	Mature cartilage tissue	21	1	0	0.541	0.8413
3	8	2	0	1.084	0.9033	Chronic inflammation	16	3	0	0.861	0.5120
4	2	2	0	0.931	0.0893	Osteomyelitis	0	1	1	2.301	0.0368
5	3	3	0	1.364	0.0741	Enchondroma	5	3	0	1.874	0.4931
>5	0	2	2	2.987	0.0402	Chondroma	5	2	0	1.284	0.0741
Preoperative pain severity						Osteoma	2	0	0	0.435	0.0674
4	9	0	0	7.302	0.0034	Mesenchymal tumor	1	1	0	2.142	0.0489
6	38	3	0	1.812	0.0403	Chondrosarcoma	6	0	1	5.236	0.0314
8	9	8	0	0.983	0.0631						
10	0	0	2	5.230	0.0023						

OR: Odds ratio.

study. Surgical treatment of rib tumors involves extensive resection with possible reconstruction of the thoracic wall in malignant rib lesions. In this study, mesh-supported titanium reconstruction of the chest wall was rarely used in cases undergoing extensive resection. Cartilage grafts and muscle flaps were frequently preferred. No significant postoperative pain was observed in our patients.

Benign rib lesions are treated by resection of only the affected rib.^[22] In small lesions, only the affected rib was resected while leaving negative surgical margins. For surgery to be considered adequate, it must consist of wide resection of the involved ribs with 2-3cm free margins.^[23] More than 2-3cm of negative surgical area was left in the resections of all cases in this study. In this study, the average hospital stay of the patients was 2-3 days. No complications were observed in any patient. In our patients whose pathology results revealed osteomyelitis, empirical antibiotic therapy was administered. No signs of infection were detected during outpatient clinic visits. Subtotal regression of pain was observed.

In general, the common feature of all our patients in the study was persistent pain complaints despite treatments lasting at least 1 year. Traditionally, analgesic treatment is used in patients who do not have any pathological findings

in radiological, laboratory, and, if necessary, scintigraphic examinations. However, although no significant radiological or scintigraphic findings were detected in any of our patients, the pain complaint continued. Surgery was the only option left for complaints of persistent pain despite nonsteroidal anti-inflammatory drugs, analgesic drugs, intercostal blockade in those with severe pain, and algological treatments. A detailed anamnesis and physical examination revealed that the pain was of organic origin. Both diagnosis and treatment were performed using surgical techniques. Numerous tumoral lesions, especially malignant tumors, were detected in the pathology results. If the patient's anamnesis, physical examination findings, and complaints persist, it was observed that there may be an undetected tumoral lesion even if all tests were normal.

Conclusion

Anamnesis and physical examination are very important for reaching diagnosis and treatment. Even if radiological and scintigraphic examinations are normal, the cause of the pain may be an underlying disease. Despite all analgesic treatments, pain control can be achieved with surgical treatment in chronic rib pain.

Disclosures

Ethics Committee Approval: The study was approved by the Gaziantep City Hospital Ethics Committee (no: 44/2024, date: 17/07/2024).

Informed Consent: Informed consent was obtained from all participants.

Conflict of Interest Statement: The authors declare that there is no conflict of interest.

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