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Effectiveness of Simple Stretch Exercises in Relieving Restrictive Chest Wall Tightness Post-surgery for Empyema Thoracis

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Abstract

Introduction: Inflammatory changes in the pleural cavity often result in restrictive chest wall deformity. Despite successful infection control, a significant number of patients may still experience restrictive chest wall tightness. Effective approaches to alleviate these symptoms are seldom studied in the literature. Therefore, we aim to evaluate whether simple stretch exercises can serve as an effective strategy for relieving chest wall tightness.

Materials and methods: From January 1st, 2014, to December 31st, 2018, we conducted a retrospective review of empyema thoracis cases treated in our department. The inclusion criteria consisted of patients with fibrinopurulent stage empyema thoracis who were successfully treated with surgery. All included patients were instructed to perform simple stretch exercises starting one month after surgery. We evaluated their symptoms at 1, 3 and 12 months post-surgery and compared the effectiveness of stretch exercises in relieving restrictive chest wall tightness.

Results: A total of 103 patients were included in the study. Among them, 30% of patients performed stretch exercises more than 3 times a week, 26% performed stretch exercises between 1-2 times a week and 43% of patients never engaged in stretch exercises. The occurrence of chest wall pain was similar between patients who did and did not perform stretch exercises. However, at 12 months after surgery, patients who engaged in stretch exercises had a significantly lower incidence of restrictive chest wall tightness (p=0.03).

Conclusion: Simple stretch exercise can be an effective approach in alleviating restrictive chest wall tightness.

Keywords: Empyema thoracis • Stretch exercise • Post-surgery • Care

Introduction

Thoracic surgery entails making incisions in the chest wall. Following wound healing and recovery from the underlying condition, a subset of patients may experience symptoms related to the chest wall. These symptoms commonly include intercostal neuralgia, reduced lung function, and, in severe cases, chest wall deformities. Intercostal neuralgia manifests as neuropathic pain within the chest wall, often triggered by surgical procedures involving the chest wall. According to certain studies, the prevalence of persistent chest wall pain exceeds 50% following general thoracic surgery [1,2]. Typically, the pain arises as a consequence of prior thoracic surgery or chest trauma. The primary cause often involves nerve injury during thoracotomy or prolonged compression from tube thoracostomy. During open thoracostomy procedures, rib retractors are employed, which can compress the ribs for extended periods, leading to discomfort. This pain is commonly referred to as post-thoracostomy pain syndrome. Furthermore, chest trauma resulting in displaced rib fractures is another frequent etiology. Tube thoracostomy, by compressing the intercostal nerves, can induce similar pain. Additionally, regional inflammation may provoke nerve irritation through cytokine release, thereby dysregulating ion channels [3,4]. In addition to chest wall incisions, pleural infection or inflammation may also contribute to chest wall symptoms. This inflammatory process can lead to pleural thickening and fibrosis. In cases of severe fibrosis, restrictive chest wall deformities may develop, resulting in tightness of the chest wall, particularly during chest expansion or lateral trunk bending [5]. The condition is common in empyema thoracis. The pain characteristics may include sharp, pin-pricking sensations, as well as a burning sensation. Occasionally, it may be associated with numbness. Symptoms are typically transient and self-limiting. However, in some patients, pain or tightness symptoms may persist long after initial treatment. In our studies, we assessed chest wall symptoms in patients who underwent thoracoscopic debridement or decortication. We also evaluated whether providing standard instructions for simple stretching exercises could be an effective approach to alleviating these symptoms.

Materials and Methods

From January 1st, 2014, to December 31st, 2018, we conducted a retrospective search for cases of empyema thoracis treated in our department. The study protocol was reviewed and approved by the institutional review board committee in Mackay Memorial Hospital. This study complies with the Declaration of Helsinki and was performed according to ethics committee approval. Utilizing the diagnosis of empyema thoracis, we identified 756 patients in the thoracic surgery database. After excluding patients treated with non-surgical methods, simple tube thoracostomy, those with uncomplicated effusions, individuals with empyema in the organizing phase, patients with multiple co-morbidities, bilateral empyema cases, those with mortality, individuals discharged with poor performance status, those lost to follow-up and cases of malignancy-related empyema, we identified 103 patients who met the criteria. All patients were followed in the outpatient department weekly for one month, monthly for three months and subsequently returned to the hospital for follow-up or had telephone consultations 6 to 12 months later. One month after discharge, patients were provided with basic instructions for stretching exercises. The goal of these exercises is to stretch the chest wall

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through two actions: lateral bending of the trunk and rotation of the trunk, which can be performed in a standing position, sitting, or in a supine position on a bed or the floor (Figure 1).

The exercise regimen consisted of initially bending or twisting the trunk, followed by holding the position statically for 10 to 15 seconds while the chest wall was tightly stretched and then returning to the initial position. This stretch exercise was repeated consecutively for 3 to 5 times. All patients were instructed to perform the stretch exercise at least 3 times a week for the following one-month period. During subsequent follow-up visits, patients were queried regarding the frequency of performing the stretch exercise and their subjective responses regarding chest wall discomfort. Patients were categorized as having Good Compliance (GC) if they performed the exercise with a frequency of 3 times a week or more for at least one month and Poor Compliance (PC) if they did the exercise less than 3 times a week. The endpoints of the study included evaluating the acceptability of the stretch exercise and assessing subjective improvement in chest wall pain or discomfort one year after the exercise intervention.

Statistical analysis was conducted using SPSS 13.0 software. Student's t-test and chi-square tests were employed to compare results between groups. A p-value less than 0.05 was deemed significant.

Results

There were 24 women and 79 men, with an average age of 61.1 years. Left-sided empyema was identified in 42 patients, while right-sided empyema was observed in 61 patients. The mean duration from the induction of anesthesia to the completion of the surgical procedure was 176 minutes. The average hospital stay was 13.8 days, with a mean duration of 1.2 days in the intensive care unit. Further details regarding the patients' demographics are presented in Table 1.

All enrolled patients received instruction on performing stretch exercises through demonstration. However, only 30% of the patients (31 out of 103) confirmed that they adhered to the prescribed regimen, performing the stretch exercises at least 3 times a week for one month following the instruction. The remaining 70% of patients (72 out of 103) reported performing the stretch exercises less than 3 times a week. Among those who infrequently performed the stretch exercises, 43% (45 out of 103) did not engage in any stretch exercises during the postoperative period. Overall, the compliance rate with the recommended stretch exercises was low, at 30%.

One month after surgery, 77 out of 103 patients (77.1%) reported experiencing chest wall tightness and discomfort. By the third month, this number decreased to 41 patients out of 103 (39.8%) and by the twelfth month, 14 out of 103 patients (13.6%) described chest tightness. Concerning chest pain after surgery, 72 out of 103 patients (69.9%) reported chest wall pain. By the third month, the incidence of chest wall pain decreased to 24.3% and by the twelfth month, only 3 patients (2.9%) reported experiencing chest wall pain. These results are displayed in Table 1. Following the provision of stretch exercise demonstrations, 31 patients demonstrated Good Compliance (GC) with the exercise prescription, while 72 patients exhibited Poor Compliance (PC). There were no significant differences in age, sex, or affected side between the GC and PC groups. Similarly, the length of hospital stay and ICU stay did not differ significantly between the two groups. During the recovery process, some patients may experience chest tightness and chest wall pain. One month after surgery, 21 out of 31 patients (67.7%) in the GC group reported chest tightness, compared to 56 patients (77.7%) in the PC group. There was no statistical difference between the two groups (p-value: 0.28). At the third month after surgery, chest tightness was reported by 41.9% of patients in the GC group and 38.8% of patients in the PC group, with no statistical difference observed (p-value: 0.77). However, by the twelfth month after surgery, only 1 patient (3.2%) in the GC group experienced chest tightness, while 14 patients (19.4%) in the PC group still reported chest tightness. Aggressively adhering to stretch exercises at home appeared to be effective in reducing chest tightness long after the post-operative recovery period. Regarding chest wall pain, similar differences were observed between the two groups (Table 2).

Figure 1. In the outpatient department, clinicians will demonstrate how to perform lateral bending. **A)** The initial action is in a standing position. **B)** Then, the patient slowly bends toward one side, allowing for an appropriate stretch of the affected side (indicated by the blue arrow in B), and holds the position for around 10-15 seconds. Afterward, the patient returns to the standing position (A). **C)** The second stretch exercise involves rotating the trunk from the standing position **D)** to rotation towards the healthy side, ensuring a full stretch of the affected side (blue arrow in D).

Table 1. Patient's demographics included in the study.

	Patient NO	103
Sex	M	69
	F	24
Side	L	42
	R	61
Operative Time(min)		
Stretch Exercise	>=3 times/week	31
	< 3 times/week	72
	0	45
Tightness	1 month	77(77.1%)
	3 months	41(39.8%)
	12 months	15(14.6%)
Pain	1 month	72(69.9%)
	3 months	25(24.3%)
	12 months	3(2.9%)

NO: Number; M: Male; F: Female; L: Left side; R: Right side

Table 2. Subjective symptoms, chest wall tightness and chest wall pain at 1, 3 and 12 months after surgery.

		GC(=31)	PC(=72)	
Age		62.6	60.4	
Sex	M	26	53	p=0.26
	F	5	19	
Side	L	12	30	p=0.78
	R	19	42	
Operative Time(min)		169	179	p=0.89
HS		13.6	13.8	p=0.76
ICU stay		1.1	1.1	p=0.91
Chest Tightness	1 month	21	56	p=0.28
	3 month	13	28	p=0.77
	12 month	1	14	p=0.03*
Chest Pain	1 month	19	54	p=0.16
	3 month	7	18	p=0.79
	12 month	1	2	p=0.91

GC: Good Compliance to stretch exercise; PC: Poor Compliance to stretch exercise; HS: Hospital Stay; ICU: Intensive Care Unit; *: Indicates statistical significance

Discussion

Empyema thoracis is a prevalent condition, with approximately 70% of cases originating from bacterial pneumonia [6]. When the infection is not effectively managed, it can lead to the development of parapneumonic effusion, which may subsequently progress to empyema thoracis [7]. Historically, empyema thoracis has been categorized into three stages: the exudative stage, fibrino-purulent stage and chronic organizing stage [8]. The standard treatment comprises antimicrobial agents, thoracentesis, tube thoracostomy, thoracoscopic surgery and open thoracotomy. There exists a wide spectrum of disease severity and prognosis. In the early stages of empyema thoracis, tube thoracostomy and fibrinolytics may be the optimal approach for treatment. With prompt tube thoracostomy, over 90% of patients can be successfully treated without surgical intervention [9]. However, as the disease advances into the fibrinopurulent stage, early surgical intervention may yield better outcomes in terms of hospital stay, complications and mortality rates [10]. The majority of studies concentrating on the treatment of empyema thoracis prioritize outcomes including hospital stay, duration of ICU admission, complications and mortality rates. Anatomical and functional outcomes are seldom discussed.

Anatomical outcome

A common issue following recovery is restrictive chest wall deformity, characterized by pleural fibrosis, scarring and the subsequent reduction in lung compliance, along with chest wall pain and tightness. Occasionally, such restrictive chest wall deformities may result in respiratory insufficiency. In a 2009 study conducted by Mertol G, et al. preoperative and postoperative chest wall deformities were assessed, revealing that surgical intervention improved restrictive chest wall deformity by 5% to 10%, as observed in the transverse and antero-posterior diameter on computed tomographic scans [11]. In one of our cases, a typical chest wall deformity was observed following an episode of empyema. Despite a satisfactory recovery, a significant restrictive chest wall deformity persisted during the follow-up period (Figure 2A and 2B). While the infectious process was effectively treated, the issue of restrictive chest wall deformity could lead to symptoms long after the initial treatment, considering both anatomical and functional status. Common complaints include chest wall tightness, difficulty with deep inspiration and intermittent or unexpected pain with body movement. These symptoms are often overlooked, particularly in patients with a high prevalence of co-morbidities among those discharged in a bedridden state, wheelchair-bound, or with severely limited daily activity. Consequently, the aforementioned long-term symptoms may easily go unnoticed. Early surgical intervention in the fibrinopurulent stage of empyema thoracis is effective in achieving the goal of preserving lung function. However, patients may still experience limitations in lung function [5,11].

Functional outcome

In 2009, Abraham, et al. conducted a study on lung functional outcomes following empyema surgery. The study revealed that FEV1 increased from a preoperative value of 70.5% to 83.4% and FVC increased from 69.7% to 85.4% after surgery. Similarly, a study conducted in 2016 by Potzger T, et al. reported comparable results, suggesting that decortication can enhance lung function in patients with empyema thoracis [12].

Although appropriate surgical intervention significantly improves both functional and anatomical outcomes, subjective symptoms have rarely been studied in the literature. Based on clinical experiences, some patients continue to experience symptoms of chest tightness despite near-total recovery evident in radiographic images. Even when postoperative chest wall pain resolved in 97.1% of cases one year after the operation, a significant proportion of patients (14.6%) reported persistent chest tightness. These symptoms are often described as feeling "tight and restricted when moving the trunk." This is the primary reason why we provide instructions on simple stretching exercises to all eligible patients when their condition stabilizes. Since 2010, stretching exercises have been regularly incorporated into postoperative patient care in the outpatient department. However, these exercises are to be performed at home without supervision and there is no reinforcement strategy in place. Consequently, the percentage of patients appropriately adhering to the exercise intervention at home is only 30%. More than 43% of patients did not actually engage in the prescribed stretch exercises at home. When we compared the efficacy of the simple stretch exercise, it was found to be effective in relieving chest wall tightness during the one-year follow-up period. However, it did not contribute to the relief of chest wall pain, as most of the pain naturally resolved during the one-year recovery period. Among those who adequately performed the stretch exercises, only 1 patient complained of chest wall tightness (0.97%), which was significantly less than those who did not engage in the stretch exercises (13.6%). An interesting finding was that when stretch exercises were performed infrequently, the outcomes were similar to those of patients who never performed the exercises. This finding suggests that there may be a minimal threshold frequency required to effectively stretch the chest wall. However, the exact threshold could not be determined based on the current results. A more detailed analysis involving a larger number of patients is warranted in future studies. To the best of our knowledge, this is the first study to investigate the feasibility and efficacy of regular chest wall stretch exercises in the treatment of chest wall tightness related to restrictive chest wall deformity.

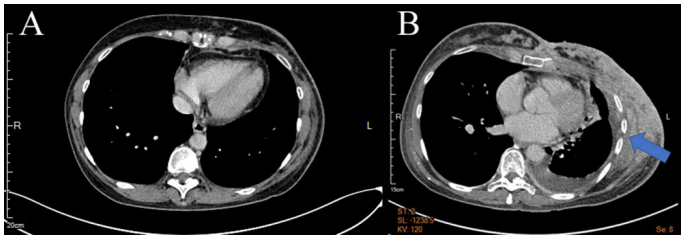

Figure 2. A common issue that may be encountered is thickening and fibrotic changes involving the entire chest wall on the affected side, resulting in a significant decrease in intercostal space as seen on CT scan (indicated by the arrow in 2B).

Limitations

Although preliminary results suggest that simple stretch exercises might be effective in relieving postoperative restrictive chest wall tightness, it's important to note that the study was retrospective and conducted in a single institution. Additionally, the execution rate of the exercises was quite low. Therefore, increasing the execution rate is necessary to investigate the effectiveness of stretch exercises on anatomical, functional outcomes and subjective symptoms.

Conclusion

The implementation of stretch exercise intervention during the postoperative period in patients with empyema thoracis proves beneficial in alleviating subjective chest wall tightness but not chest wall pain.

Acknowledgements

None.

Conflict of Interest

None.

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