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Original Article

Advantages of surgical approach for multiple rib fractures

Serdar Ozkan[1], Ozgur Omer Yildiz[2*]

[1]Department of Thoracic Surgery, Medova Private Hospital, Konya, Turkey
[2]Department of Thoracic Surgery, Yildirim Beyazit University, Faculty of Medicine, Ankara, Turkey

ABSTRACT

Background: In this article, we present our study of surgical treatment of multiple rib fractures, which reduced pulmonary complications and recovery time.

Materials and Methods: From 2014 to 2016, a total 14 cases (8 male, 6 female, average age 59.6 years (range: 29-76)) who underwent plate fixation were included in the study. The cases were evaluated according to their demographic features, symptoms, radiological scans, numbers and locations of rib fractures, surgical approach performed and its results.

Results: The average number of fractures is 7.5 costa (range: 3-16). Multiple rib fractures were in the left hemithorax in nine cases, in the right hemithorax in two cases and were bilateral in three cases. While all cases had additional pulmonary pathology, 12 cases had different system pathologies. Ten out of 14 cases had flail chest. None of the cases underwent mechanic ventilation in the preoperative stage. Following the planning of their medical treatment based on their clinical condition, they underwent tube thoracotomy. Plate fixation surgery was performed for all cases in an average of one day. The average number of plates used is 3.2 plates (range: 2-5). In four cases, postoperative complications were observed. The average length of stay in hospital in the postoperative period was 7.6 days (range: 3-14).

Conclusions: Rib fractures, which often occur following blunt thoracic trauma, usually heal on their own and treatment is based on the symptoms. However, multiple rib fractures can cause morbidity such as increase in pulmonary complications, prolonged healing process, and reduced life quality or mortality due to complications. While there is no consensus on a specific treatment for rib fractures, open reduction and fixation in rib fractures, in particular those caused by blunt thoracic trauma, is a method of treatment with significant benefits including increase the life quality of the patient, and decrease in potential complications, length of stay in the hospital and cost.

Key Words: thoracic trauma, multiple rib fractures, rib fixation

Corresponding Author*: Ozgur Omer Yıldız, MD. Yildirim Beyazit University, Faculty of Medicine, Department of Thoracic Surgery, Ankara, Turkey
E-mail: dr.ooyildiz@gmail.com
Phone: +90 533 814 7314
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Introduction

Rib fractures occur with a rate of 35-40% following blunt thoracic trauma. They usually heal on their own and treatment is based on the symptoms [1]. However, multiple rib fractures can cause morbidity such as increase in pulmonary complications, prolonged healing process, and reduced life quality due to intensive and long lasting pain in rib fractures, inadequate inspirium and inadequate clearing of secretions or mortality due to complications. There is no consensus on a specific treatment for rib fractures.

We aim to contribute to such a consensus on treatment, through a study of surgical treatment of cases with multiple rib fractures caused by blunt thoracic trauma, which resulted in significant improvement in healing period and complication rates, presented along with literature review.

Materials and Methods

Fourteen cases with multiple rib fractures that underwent fracture fixation between 2014 and 2016 were included in the study. All of the cases were assessed with thoracic CT and radiologically. Patients diagnosed with flail chest following the physical examination and who had lung complications such as pneumothorax or hemothorax along with multiple displaced rib fractures, respiratory failure or toilet problems due to intensive pain and those who could not be mobilised due to pain were selected for surgical treatment and they underwent plate fixation of rib fractures. Screws and metal locked plates were used for the fixation according to the location of the facture and size of the rib. Fixation was not performed for posterior and subscapular fractures. Fourteen cases were evaluated according to the number of rib fractures, additional pathologies, number of fixations performed and length of stay in hospital.

Results

Eight of 14 patients were male, while six were female with an average age of 59.6 years (range: 29-76). The cause of injury in three cases was traffic accident with patient outside the car, in nine cases traffic accident with patient inside the car, in one case work accident and in one case falling down from height. Rib fractures were on the left in nine cases, on the right in two cases, and they were bilateral multiple in three cases. The average number of fractures was 7.5 costa (range: 3-16). All of the patients had other pathologies such as pneumothorax and hemothorax along with rib fractures. Ten out of 14 cases had flail chest. While two of the cases did not have additional pathology, they had vertebral and pelvis fractures. None of the cases underwent intubation and mechanic ventilation in the preoperative stage. Following the planning of their medical treatment based on their clinical condition, they underwent tube thoracotomy and rib fixation surgery was performed for all cases in an average of one day. Plate fixation was performed for all cases and the average number of plates used is 3.2 plates (range: 2-5). In a total of four cases, postoperative complications (Acute Respiratory Distress Syndrome (ARDS), pleural effusion, atelectasis, wound infection) were observed. The average length of stay in hospital in the postoperative period was 7.6 days (range: 3-14).

Discussion

Rib fractures due to blunt thoracic trauma occur with rate of 35-40% and 20-25% of the deaths due to trauma are caused by thoracic trauma [2]. Treatment for thoracic trauma is identified based on pain control and complications [1]. In multiple rib fractures dyspnea might occur due to intensive pain and an increase in pulmonary complications and atelectasis due to insufficient inspirium might be observed. This causes an increase in the length of stay in hospital, prolonged intensive care and increase in morbidity and hence increased cost [3]. Respiratory insufficiency, atelectasis due to insufficient clearing of secretions, pneumonia and empyema in flail chest cases are among the main reasons causing morbidity and mortality in blunt trauma cases [4,5].

Flail chest due to multiple rib fractures might cause respiratory distress. In addition to chest wall injuries, lung parenchyma is also common. In such cases of heavy thoracic trauma, the possibility of acute respiratory failure is more likely [6,7]. The first step in treatment of flail chest is ventilator support. Positive pressure ventilation could provide stabilization for the fractured segment of the rib while it could lead to lung complications such as pneumonia, empyema and barotrauma [6,8]. The most important aim of the treatment is to end the mechanical ventilation as soon as possible.

Mechanical ventilation was not used in any of the cases in the preoperative period. Among the reasons are listed below.

a) To prevent complications that could arise due to mechanical ventilation,

b) Even if there is an improvement in respiratory function in an average of 3-4 days ventilation period, ribs cannot be sufficiently stabilized in that period. Due to pain and insufficient mobilization following extubation, there is a risk of lung pathology, clinical improvement cannot be ensured and there might be a need for re-intubation.

c) There is a risk of hospital infections during the mechanical ventilation period as well as complications due to anaesthetics/sedative agents and stopping oral feeding.

d) Only one of the cases that underwent surgery for flail chest was intubated and connected to mechanical ventilator due to ARDS in the post-operative period. The case was followed up during 3 days of intubation. Nine cases with flail chest underwent surgery at an early period and hence were not connected to mechanical ventilator and they did not have complications caused by ventilator and long length of stay in the hospital. Compared to the standard approaches, the need for ventilator in these cases was 10%. The need arose not due to a complication during the pre-operative period but in the post-operative period.

Conservative treatment

Pain control is the first step in treatment of multiple rib fractures. Active pain restricts respiratory movements and cause hypoxia [7,9]. Narcotic analgesics and nonsteroid antiinflammatory agents are often insufficient in such cases and cause gradual decrease in respiratory movements and hence lung volume.

Fixation surgery approach for rib fractures continues to be debated in thoracic surgery literature. There are several reasons for that. Ends of the rib fractures are generally not displaced due to intercostal muscles and because they contact each other, they heal spontaneously. Secondly, ribs are not weight bearing bones. In case of acute respiratory failure due to multiple rib fractures, positive ventilation could be performed to expand the lung sufficiently. Rib fractures in the first three ribs usually do not lead to deformation in the chest wall thanks to muscles around the shoulders, pectoral muscles, clavicle bone and scapula. Therefore, rib fractures in this group do not necessarily require surgical repair. Since the twelfth rib is beneath the diaphragm and does not affect the integrity of the chest wall, it does not need fixation.

The other area where there is no need for surgery is vertebral and posterior rib fractures. Rib fractures in that area, which is surrounded with thick and strong paraspinal muscles, are less likely to have serious deformation. It is also an area with sufficient blood circulation enabling quick healing. Surgical approach in that part is also difficult due to paraspinal muscles. Considering all those factors, it is not possible to plan surgical treatment for all rib fractures.

Although our study is based on surgical approaches in rib fractures, we do not argue for surgical approach for all rib fractures. As it can be seen in more detail in the table 1, plates were not used for all fractures in the cases included in the study. The total number of fractures in 14 cases is 106 and plates were used in only 45 cases. All of the rib fractures that were stabilized through surgery are lateral and anterior rib fractures. A maximum of four ribs in the unilateral hemithorax were surgically treated.

There are some alternatives in conservative treatment including epidural catheter, oral-parenteral non-steroid anti-inflammatory medication, narcotic and sedative agents [10]. As we argued in another study with 513 cases with rib fractures, most of the rib fractures could be treated successfully with medical treatments and conservative approaches by applying treatments such as epidural catheter when necessary [2].

Surgical approach

Even if conservative treatment is the general approach in rib fractures, surgical treatment might be required in addition to medical treatment in cases of prolonged pain, bleeding, damage in parenchyma, poor posture and inadequate inspirium. Patients might continue to suffer from chest pain and have a reduced life quality due to deformed callus structure in displaced fractures left to heal spontaneously and deformed thoracic wall structure.

Studies arguing that medical treatment remain inadequate in treatment of rib fractures and it does not provide pain control and enable return to daily routine [11] demonstrate the need for surgical treatment option particularly for multiple rib fractures.

Table 1. Demographic characteristics of the patients

No	Age	Gender	Etiology	Thoracic pathology	Rib fracture	FC	Number of fractures	Additional trauma	Plated rib fractures	Number of plates	Complications	Hospital stay (days)
1	38	M	In car traffic accident	L hpx	L 6-8	-	3	V	L 6-8	3	-	3
2	72	F	Off-road traffic accident	L hx	L 1-6	-	6	P, Sc	L 4-6	3	-	4
3	72	M	Off-road traffic accident	L hpx	L 1-7	+	7	T, F	L 4,5	2	-	4
4	52	M	In car traffic accident	R hx	R 4-6	-	3	SAB	R 5,6	2	-	4
5	67	M	In car traffic accident	L px	L 2-8	+	7	St	L 3,4	2	-	5
6	46	F	In car traffic accident	R hx	R 2-9	+	8	-	R 6-8	3	Pleural effusion	5
7	65	F	In car traffic accident	L hpx	L 1-9	+	9	-	L 5-8	4	-	6
8	59	M	In car traffic accident	L hpx	L 3-9	+	7	V	L 6,7	2	Atelectasis	7
9	59	F	In car traffic accident	L hx	L 2-10	+	9	P, SAB	L 7-10	4	-	10
10	61	M	In car traffic accident	Bil. hx	L 3-8/R 6,9,10	+	9	V	L 6-8/ R9	4	-	10
11	76	F	Off-road traffic accident	L hpx	L 3-9	+	7	P	L 6-8	3	-	10
12	71	M	Falling	R hx, L hpx	R 3-9/L 5-8	+	11	Fem, P, Sc	R 5-8	4	-	11
13	29	M	Work accident	L px	L 3-7	-	4	Cl, Fem, T, Sc	L 3-6	4	ARDS	14
14	68	F	In car traffic accident	Bil. hx	R 2-10/L 4-10	+	16	V	R 8-10/L 8,9	5	Wound infection	14

Abbrev.: hpx: hemopneumothorax, hx: hemothorax, px: peunomothorax, FC: flail chest, V: vertebra, P: pelvis, Sc: scapula, T: tibia, F: fibula, SAB: subarachnoid bleeding, St: sternum, Fem: femur, Cl: clavicula

Clinical experiences of the majority of thoracic surgeons show that even in simple fractures with no complications, patients' quality of life decreases due to pain, they need medical treatment for a long period, and they suffer from workforce loss for a period of 3-4 weeks. Such conditions are worse especially in cases of multiple rib fractures. We believe that in addition to the cost of treatment, the cost caused by the loss of workforce due to various morbidities in the healing period should also be taken into account.

Rib fixation operations are mostly performed for complications such as prolonged drainage, presence of intrathoracic hematom and prolonged pain. Surgical indication for the flail chest treatment remains controversial. There are scholars who argue for surgical stabilization as well as those who argue for internal fixation by extending intubation period in cases of respiratory failure despite aggressive conservative treatment [12].

The area between 4th and 9th ribs forms the biggest part of the chest cavity and rib fractures in this area lead to significant deformity and hence failure in respiratory function. Flail chest most commonly occur in this area. Fractures in this area are more suitable for surgical stabilization because of the muscle types and as it is easier to manage.

Fractured ribs treated conservatively undergo progressive displacement, which results in volume loss in lungs and atelectasis. Early reduction and fixation of the fractured ribs restores the chest wall integrity, and forestalls the development of permanently damaging sequelae [13].

Stabilized thoracic wall decreases the need for mechanical ventilation thanks to adequate ventilation and tissue oxygenation [12,14]. Surgical stabilization of the chest wall have got advantages including decrease in the mechanical ventilation period, decrease in length of hospital stay, decreased period in intensive care unit and hence decrease in rates of respiratory function and posture deformation [3,15,16].

Additional factors such as the patient's age, cardiopulmonary state following the trauma and injuries in other organs need to be taken into account to select a suitable patient for rib stabilization.

According to a study, patients who were surgically stabilized had a significantly smoother course during the intensive care unit and hospital stays, decreased rate of impairment of pulmonary functions and decreased rate of complications, compared to the conservatively managed patients [13].

Hospital stay of the six cases out of 14 was more than 10 days. Considering the additional pathologies and post-operative complications, this is a reasonable period. The average number of rib fractures in eight cases who had less than 10 days of hospital stay is 6.2 days (range: 3-7). Clinical and radiological findings showed that they could be discharged in a maximum of one-week period and this shows the effect of the surgical approach.

Following the surgical stabilization, simple analgesic treatments enabled improvement in respiratory movements in the early period and mobilization. High average age of the cases and short length of stay in hospital despite their additional pathologies is striking.

In conclusion, we believe that open reduction and fixation in rib fractures is a method of treatment with significant benefits including increase the life quality of the patient, and decrease in potential complications, length of stay in the hospital and cost.

Declaration of conflicting interests

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