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ORIGINAL ARTICLE

Pain Management of Multiple Rib Fractures based on Early Reduction and Fixation in Patients without Intensive Care Unit

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ABSTRACT

Objective: Blunt thoracic traumas are often complicated with rib fractures. The decision-making process of the treatment approaches not clear for clinicians. So, we aim to investigate the effect of surgical intervention on pain management of patients as treatment indication.

Methods: Cases with 3 or more rib fractures were evaluated in our study. Between 2014-2018, 367 patients with multiple rib fractures were admitted to our hospital. Of the 367 patients, 238 were included in this study. Among them 84 cases with multiple rib fractures that underwent surgery within fist 36 hours, 27 cases were operated after the 7th day 127 patients were managed conservatively. The results of hospitalization time, pneumonia, rates, thoracic deformity rates on 6.month thorax computerized tomography, intercostal blockage requirement, postoperative 6.month quality of life questionnaire for pain and clinical outputs were retrospectively analyzed.

Results: The average hospitalization was found that it was significantly different in favor of the surgical group ($z = 6.674$; $p < 0.001$). Thoracic deformity rates, intercostal blockage requirement was found to be different between the surgery and non-surgery groups ($\chi2=7.149$;$p<0.001$), ($\chi2=22.462$;$p<0.001$). Pain and quality of life scores had also significant difference in favor of the surgical group, respectively ($z = 9.270$; $p <0.001$) and ($z = 8.796$; $p <0.001$). Additionally, there was a statistical difference in pneumonia rates ($p= 0.020$). We did not reach a statistically significant result between the early and late groups in pain 1 and pain 2 results (p1: 0.727, p2: 0.069).

Conclusions: There is no consensus on the treatment of rib fractures. The results of our study suggest that open rib reduction and fixation can be a better treatment option than the surveillance only approach in terms of pneumonia rates, hospitalization time, thoracic deformity rates and pain management.

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INTRODUCTION

Rib fractures occur with a rate of 35-40% following blunt thoracic trauma [1]. These fractures can be single or multiple. The multiple rib fractures can cause intense pain and inadequate inspirium, inadequate clearing of secretions and increase infectious complications such as pneumonia up to 70% [2]. Mortality rates due to pneumonia is between 17-51% [3, 4, 5, 6]. Many studies have been conducted to evaluate the open surgical reduction and conservative follow-up for rib fractures. Surgical approach has been reported better pain management and clinical outcomes [7, 8, 9]. However, most of the literature includes cases with and without intensive care. Therefore, there is no sufficient knowledge for the decision-making process for clinicians during the treatment of multiple rib fracture cases who do not need intensive care. We need more data in this specific case group.

In this study, we aimed to evaluate outcomes of surgical rib fixation for the cases who did not need intensive care management.

The study was approved by the Ethical Committees of the Yıldırım Beyazıt University. The study was conducted according to the principles of the Helsinki Declaration.

MATERIALS and METHODS

aAll patients with more than 3 rib fractures, age between 18 - 65 years were included in the study. Patients were divided into 3 groups according to treatment options; the patients who underwent early surgery within 24-36 hours (Group A), those who underwent surgery after 7 days (Group B) and those who had surveillance only (Group C). The patients in group C were not treated with surgery, only pain treatment was arranged and complications were managed.

The cases evaluated in the groups did not need intensive care management and had no mortality because we especially aim to evaluate the results of this subgroup of patients. The data was scanned by a surgeon from outside the clinic analyzed by our statistics department. Exclusion criteria were strictly applied in three patient groups. The flowchart of patient selection is shown in Figure 1.

Figure-1. Patient Selection Flow-Chart.

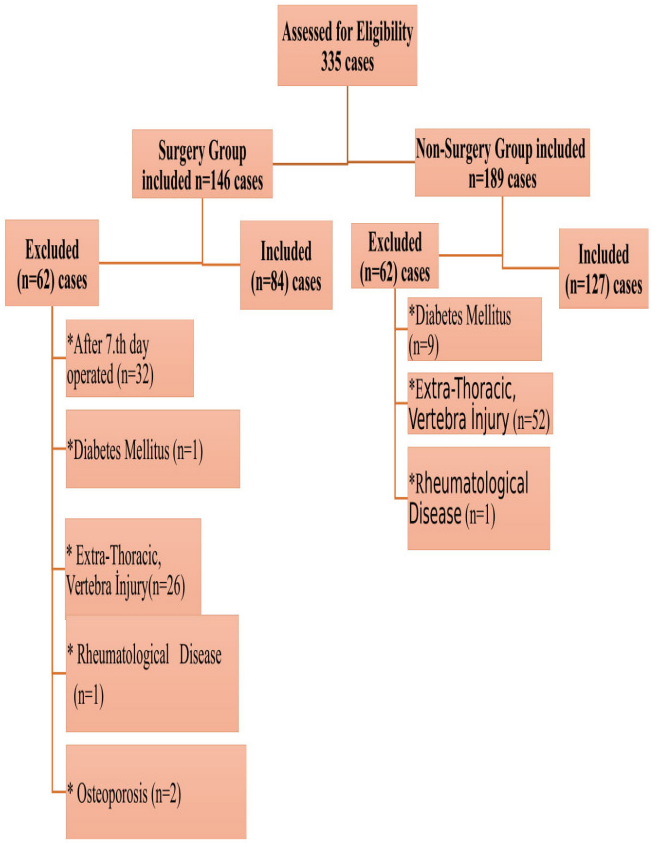

Figure 1. Patient Selection Flow-Chart.

Patients who had extra-thoracic injury and spinal vertebra injury, diabetes mellitus, metabolic bone disease, neurologic or rheumatologic disease were excluded.

The ages, genders, number of fractured ribs and the number of reduced ribs, pulmonary contusion rates; hospitalization time, pneumonia rates, pain scores at 6th-month, thoracic deformity, intercostal blockage requirement in the postoperative fist year were evaluated.

All of the patients initially were assessed with thoracic computed tomography. Thoracostomy tube were placed for patients with hemothorax or pneumothorax.

For intercostal blockage, we used the method defined by Moonre and Bridenbaugh, which the radiologically targeted intercostal interval was determined and local anesthetic was administered to the intercostal targeted area [10]. Multimodal analgesic treatment was started in surveillance only group [8, 11].

Short Form-36 (SF-36) questionnaire was used to assess pain and quality of life [5]. Two questions were asked to assess the pain in the questionnaire. The first question (pain 1) was ''How much bodily pain have you had during the past 4 weeks?'' (none:1 very mild:2 mild:3 moderate:4 severe:5 very severe:6). The second question (pain 2) was asked ''How much did pain and interfere with your normal work?'' (Not at all: 1 A little bit: 2 Moderately:3 Quite a bit:4 Extremely:5). At 6th month, thoracic computed tomography was obtained for all patients to evaluate any thoracic problem and deformity.

Locked plates (Titanium 3D rib clip, 6 segments, MedXpert GmbH, Eschbach, Germany) were preferred during surgery instead of screwed plates that were unsuitable for the thin structure of ribs (Figure-2).

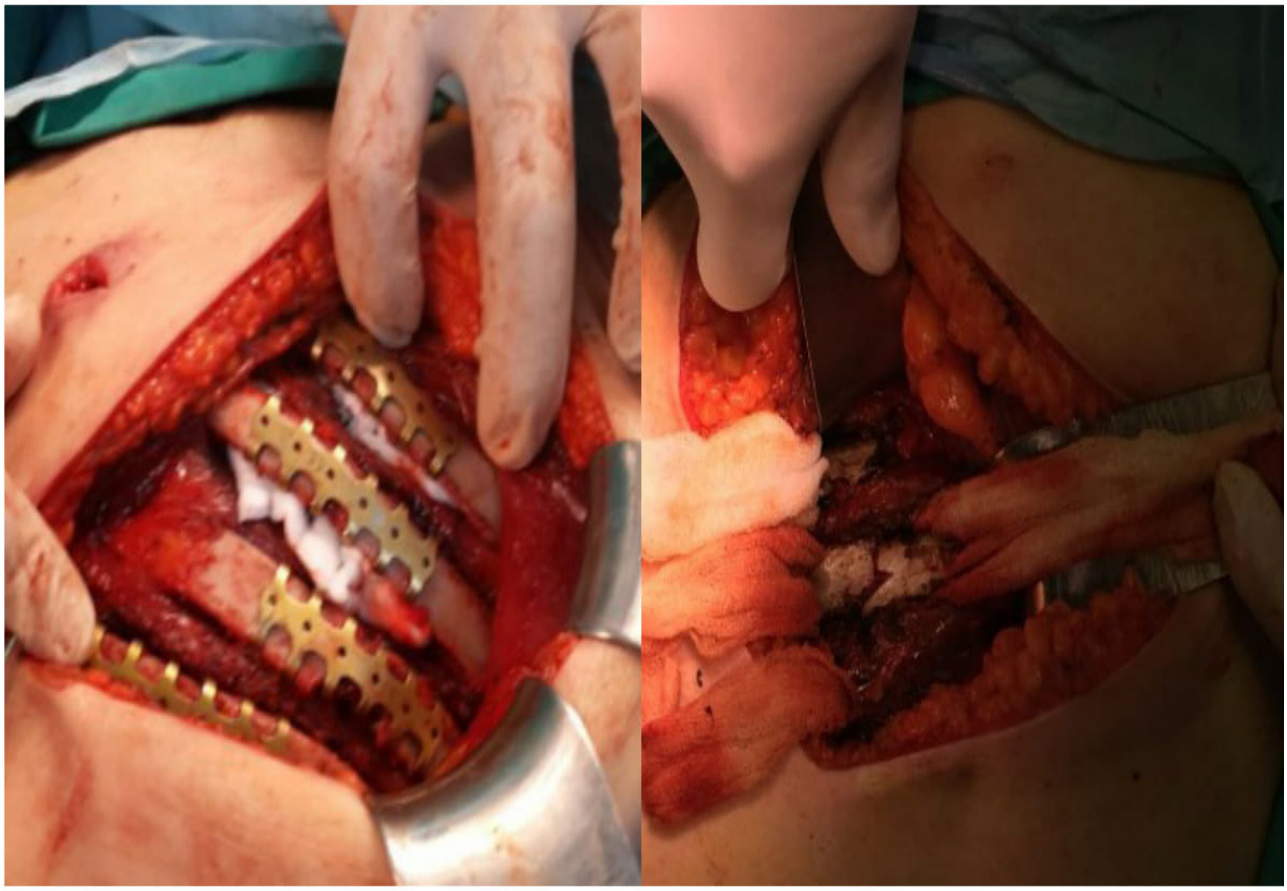

Figure 2. 5th,6th,7th and 8th rib fractures on the left side of the case, Intraoperative view of reconstruction with Titanium 3D rib clip 6 segment clips.

Locked plates (Titanium 3D rib clip, 6 segments, MedXpert GmbH, Eschbach, Germany) were preferred during surgery instead of screwed plates that were unsuitable for the thin structure of ribs (Figure-2). The skin incision was made from the region that corresponded to the rib fractures and the ribs were dissected with preservation of the periosteum [12]. Fixation was not performed for posterior and subscapular fractures. Because in these regions fail chest is not common. The major muscle structures and facia in this region prevent flail chest.

The non-parametric Mann-Whitney U test was used to compare the numerical variables, the Chi-Square test, Fisher exact test, Continuity Correction, and Pearson corrected chi-squared values were used to compare categorical variables. The level of statistical significance was accepted as $p < 0.05$. For statistical analyses IBM SPSS Statistics 21.0 (IBM Corp. Released 2012. IBM SPSS Statistics for Windows, Version 21.0. Armonk, NY: IBM Corp.) was used.

RESULTS

Between 2014-2018, 367 patients with multiple rib fractures were admitted to our hospital. Of the 367 patients, 238 were included in this study (Figure 1). Among them 84 cases with multiple rib fractures that underwent surgery within fist 36 hours, 27 cases were operated after the 7th day 127 patients were managed conservatively.

In the study, the median age of the cases in the early surgery group was 44.0 (24.0-65.0) years, and in the non-surgery group, it was 45.0 (18.0-65.0) years. The mean age distribution in the groups was similar ($z = 0.001$; $p = 0.999$). In the early surgery group, 47.6% ($n = 40$) of the patient were right-sided and 52.4% ($n = 44$) of the patients were left-sided, 46.5% ($n = 59$) of the non-surgery group had right-sided and 53.5% ($n = 68$) of them left-sided patients. The distributions of the patient sides in the groups were similar ($\chi2=0.027;0.868$). There was also no statistical difference between the groups in terms of gender and pulmonary contusion rates ($p= 0.868$, $p= 0.873$). (Table 1).

Table 1. Demographic Information

	Early Surgery Group (n=84)		Non-surgery Group (n=127)			
	Mean±std	Median (min-max)	Mean±std	Median (min-max)		
	n	%	n	%	z, χ2	p
Age (year)	45.0 ± 11.0	44.0 (24.0-65.0)	44.4 ± 11.5	45.0 (18.0-65.0)	z=0.001	0.999
Fracture	4.5 ± 1.1	4.0 (3.0-7.0)	4.2 ± 1.1	4.0 (3.0-7.0)	z=2.023	0.043
Rib Number	3.5 ± 0.6	3.0 (3.0-5.0)	3.4 ± 0.6	3.0 (3.0-5.0)	z=0.931	0.352
Side					χ2=0.027	0.868
Right	40	47.6	59	46.5		
Left	44	52.4	68	53.5		
Gender					χ2=0.025	0.873
Female	30	35.7	44	34.6		
Male	54	64.3	83	65.4		
Pulmoner contusion					χ2=0.381	0.537
+	38	45.2	52	40.9		
-	46	54.8	75	59.1		

χ^2: Pearson Chi-Square Result

When hospitalization time was examined among the groups, it was found that it was significantly lower in favor of the early surgical group (z = 6.674; p <0.001). Similarly, there was a significant difference between the pain 1 and pain 2 values in the groups in favor of the early surgical group, respectively (z = 9.270; p <0.001) and (z = 8.796; p <0.001). While the pneumonia rates values obtained from the patients were not similar in the groups (p= 0.020), intercostal blockage requirement was found to be different between the early surgery and non-surgery groups (χ2=22.462;p<0.001). Thoracic deformities detected in thoracic computed tomography of the patients at the 12th month were significantly lower in the early surgical

Table 2. Surgery ve non-surgery grup karşılaştırması

	Early Surgery Group (n=84)	Non-surgery Group (n=127)		
	Median (min-max)n (%)	Median (min-max)	z, χ2	p
Hospitalization Time	4.0 (2.0-8.0)	5.0 (3.0-14.0)	z=6.674	<0.001
Pain 1	1.0 (1.0-1.4)	3.0 (1.0-6.0)	z=9.270	<0.001
Pain 2	1.0 (1.0-4.0)	3.0 (1.0-5.0)	z=8.796	<0.001
Deformity				
+	7 (8.3)	30 (23.6)	χ2=7.149	0.007[1]
-	77 (91.7)	97 (76.4)		
Pneumonia				
+	6 (7.1)	25 (19.7)	χ2=5.384	0.020[1]
-	78 (92.9)	102 (80.3)		
Septic Complications				
+	2 (2.4)	9 (7.1)	-	0.115[2]
-	82 (97.6)	118 (92.6)		
Intercostal Blokage				
+	12 (14.3)	58 (45.7)	χ2=22.462	<0.001[3]
-	72 (85.7)	69 (54.3)		

[1]Continuity Correction Result, [2] Fisher's Exact Test, [3]Pearson Chi-Square

There were no differences in age, gender, and rib fracture values between the early and late operated groups (Table.3).

Table 3. Early Surgery Group and Late Surgery Group Results

	Early Period [n=84] Median (min; max)	Late Period [n=27] Median (min; max)	Test Z	İstatistiği p
Age	44.0 (24.0; 65.0)	41.0 (24.0; 60.0)	0.829	0.407
Rib number	3.0 (3.0; 5.0)	3.0 (3.0; 5.0)	0.848	0.397
Fracture	4.0 (3.0; 7.0)	4.0 (3.0; 7.0)	0.118	0.906
Pain score 1	1.0 (1.0; 4.0)	1.0 (1.0; 3.0)	0.349	0.727
Pain score 2	1.0 (1.0; 4.0)	1.0 (1.0; 4.0)	1.816	0.069

According to the pain questionnaire results of these two groups of patients, we did not reach a statistically significant result between the two groups in pain 1 and pain 2 results (p1: 0.727, p2: 0.069).
In the first-year evaluation, in terms of the thoracic deformity, significantly better results were obtained in patients who underwent surgery (p = 0.007).

DISCUSSION

Rib fractures due to blunt thoracic trauma occur with a rate of 35-40% and have a 20-25% mortality rate [13]. In addition to mortality, various morbidities are also encountered [2, 3, 6]. The treatment options are pain control and complication management with conservative follow-up or open surgical reduction [1]. Most of the studies in the literature have been done in patients in need of intensive care or some of the cases in the studies had intensive care support [14, 15]. In evaluating the surgical indication, it should be considered that the cases with or without intensive care have different risks. Therefore, more specific data are needed for cases of rib fractures without intensive care support and we planned our study in cases that did not involve the risks of intensive care. Besides, there is not enough data about the timing and results of surgery in previous studies. There is no study predicting this timing in patients other than intensive care. Reducing mortality in multiple rib fractures is one of the most important indications, but other clinical data need to be evaluated for indication [16]. In this regard, we evaluated the rates of pneumonia, hospitalization time, thoracic deformity rates, intercostal blockage requirement, pain and quality of life. One of the most important of these is pain management and whether the pain is a surgical indication. Because pain management is at the center of the clinical course of the cases.

In multiple rib fractures, dyspnea might occur due to intensive pain. This may cause mucus retention and atelectasis, even if there is no paradoxical chest movement. And atelectasis due to insufficient clearing of secretions may predispose to pneumonia and infectious complications that are the main reasons causing morbidity and mortality in blunt trauma cases [17, 18]. So the pneumonia is the most important predictor of the clinical course of the patients. In our study, we found a difference between the early surgery group and conservative follow up group in favor of the surgery (p= 0.020). The rate of pneumonia in these patients who did not require intensive care support was much lower than the patients who did not undergo surgery [8, 19, 20]. However, these studies generally include ICU patients and as we mentioned before, these patients have different risks and intensive care support is a predisposing factor for septic complications. Therefore, our study includes patients without intensive care support.

Hospitalization time was also evaluated in previous studies. The duration of intensive care and after the intensive care period of the patients were evaluated and results were generally in favor of surgical fixation [2, 21]. In terms of hospitalization time, we found more favorable results for the early surgical group (p<0.001). In this respect, this data shows that early fixation has a positive effect not only on pain and complication management but also may decrease treatment costs by shortening hospitalization time.

The presence of deformity in the thorax has many effects on the patient health. There is volume loss in the thorax due to rib fracture. Loss of lung volume manifests as a decrease in lung compliance and a decrease in vital capacity. Forced vital capacity was found to be much better in patients who underwent surgery by Tanaka et al. in the 3rd postoperative month [2]. This

provides much better results on the quality of life and performance of patients in long period, especially in the elderly. In the first-year evaluation of the thoracic deformity, we achieved significantly better results in patients who underwent surgery (p = 0.007)..

Secondly, thoracic deformities after rib fractures also have effects on pain management. It may contribute to the development of chronic pain in such patients. In all studies on rib fracture cases, results in favor of surgery were found [22, 20]. This shows the strong effect of the surgical approach on deformity and pain management.

The need for the intercostal blockade is another important parameter showing indirectly the chronicity of pain and failure in pain management. It is the method that we apply if the desired level of pain does not decrease after intravenous or oral use of conventional analgesics [23, 24]. It provides a reduction in long-term pain, but not throughout the treatment. It is beneficial for a more aggressive treatment approach. The dramatically less intercostal blockage was required in the early surgical group (p <0.001). This is valuable data that ultimately shows that surgical management is much better than conservative pain management.

Inadequate pain treatment can have many harmful consequences in rib fracture cases. This forms the basis of respiration, cardiovascular complication and may lead to mortality and chronic sequelae. Fatal complications such as pulmonary contusion or pneumonia may recur in cases as shown in most studies [25, 26]. The importance of fixation in rib fractures should be evaluated in this respect and short term, conservative management, and complication management may be insufficient and hazardous. These cases usually feel this pain in every respiratory cycle, and it is not difficult to become chronic. In the long term, this reduces the quality of life of the patient considerably and may lead to decreases in daily performance and an increase in labor losses. Considering that clinicians generally treat pain in daily routine, treating long-term pain is a very important indication for rib fixation. In our study, when we evaluated the pain questionnaire results of patients who underwent early surgery and follow-up group patients, we reached a very significant result (p1<0.001, p2<0.001). This shows us that rib fixation is the most important step in pain management in patients without intensive care support. Also, rib fixation for pain management is much more valuable than cases with intensive care unit support in the studies [27, 28]. Other important results we obtained in the data of the pain questionnaire of the patients operated in the early and late periods. This means that early or late period operation of the patients does not affect pain management (p1 = 0.727, p2 = 0.069). Therefore, rib reduction and fixation can be performed for pain management at any stage.

Our study is a retrospective study and includes the results of a limited number of cases. Therefore, it should be supported with randomized prospective studies in larger patient series. Besides, more detailed grouping studies can be arranged to show the exact effect of the timing of surgery on pain.

In conclusion, the thoracic wall should be considered as an organ contributing to the respiratory function. Therefore, correct pain management may be one of the most important step in the treatment of the multiple rib fractures. Open reduction and fixation for rib fractures improves the pain management, chest deformity and quality of life of the patients as well as decrease morbidity and hospital costs.

In our clinic, since March 2013, a group of surgeons has begun to apply open reduction and fixation to costal fracture cases and a group of surgeons continued to follow their cases conservatively. For this reason, to evaluate the timing of the surgical approach, we divided the patients into two groups as those we operated in the early period (24-36 hours) and those operated after the 7th day. We also compared the results of the patients who were operated in the early period with the patients who were followed up without any operation. All the cases that we could reach the records in our clinic were evaluated.

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CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

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