



*Original Contribution*

## **RIB FRACTURES IN BLUNT CHEST TRAUMA – MORBIDITY AND MORTALITY: SELF-EXPERIENCE STUDY**

**Iv. Novakov<sup>1\*</sup>, P. Timonov<sup>2</sup>, Ch. Stefanov<sup>3</sup>, G. Petkov<sup>4</sup>**

<sup>1</sup>Department of Thoracic Surgery, Medical University, Plovdiv, Bulgaria

<sup>2</sup>Department of Pathology, Medical University, Plovdiv, Bulgaria

<sup>3</sup>Department of Anesthesiology and Intensive Care, Medical University, Plovdiv, Bulgaria

<sup>4</sup>Department of Radiology, Medical University, Plovdiv, Bulgaria

### **ABSTRACT**

The aim of this study is to analyze the morbidity and mortality in patients with rib fractures in blunt chest trauma. The group of 212 patients with rib fractures was examined. Fractured ribs and associated thoracic injuries were established by imagine methods (plain chest radiographs and computed tomography) and pathological examination. Fractures of one or two ribs were established in 72 (33, 96 %) patients. Multiple rib fractures ( $\geq 3$  ribs) were established in 140 patients. Lung contusion was the most common associated thoracic injury. Mortality, as an outcome of thoracic trauma, was established in 36 (16, 98 %) of patients. The level of mortality was higher in the group of patients, age  $> 65$  years. Lung contusion was main cause of death in patients with fractured ribs.

**Conclusion.** This study has proven that the age over 65 years, bilateral rib fractures and lung contusion are three risk factors for mortality in patients with blunt thoracic trauma.

**Key words:** thoracic trauma, rib fractures, lung contusion.

### **INTRODUCTION**

Rib fractures are one of the most common injuries in blunt chest trauma – more than 40 % of patients with thoracic trauma have fractured ribs (1-7). The real problem in patients with blunt chest trauma is the associated thoracic injuries, which determine the outcome of the trauma (8-13). It is established that associated thoracic injuries have direct correlation with the number of fractured ribs. (1,2,4,6). At this point, even though rib fractures are not serious injury, they are considered as a marker of the severity of blunt chest trauma (14-17).

The aim of this self-experience study is to analyze the morbidity and mortality in patients with rib fractures in blunt chest trauma.

### **MATERIAL AND METHODS**

In this retrospective study 212 patients with rib fractures in isolated blunt chest trauma were

included. Cases associated with other trauma injuries, such as abdominal trauma, head injuries and limbs fractures were not included in our study.

Several methods were used to establish the morbidity and mortality of the patients who were included in the study: clinical examination; imagine methods - thoracic chest radiography, thoracic computed tomography; data from pathological findings. Thoracic chest radiography was performed in every patient admitted at emergency unit and on the 24<sup>th</sup> hour after hospitalization. Thoracic computed tomography was performed in every patient with more than three fractured ribs, established of chest X-ray.

Variable, alternative and correlation analyses were used for the purpose of this study.

### **RESULTS**

Mean age of the patients, included in this study was 53,  $92 \pm 18$ , 9 years (interval: 15 – 91 years). It was established significantly higher

*\*Correspondence to: Ivan Novakov, Department of Special Surgery, Medical University, Plovdiv, "Peshtersko shosse" – 66, phone: +359 887 75487, inovakov2003@yahoo.com*

number of the patients at age  $\leq 65$  - 147 (69, 33%) (**Table 1**).

The number of the male patients was significantly higher ( $p < 0, 05$ ), either for the

whole group [161 male (75, 94 %) vs. 51 female (24,06 %)], or for both subgroups ( $\leq 65$  and  $> 65$  years)/ (**Table 1**).

**Table 1.** Age-gender distribution of the patients with rib fractures ( $n$  - number of cases,  $S_p$  - standard error).

gender	overall			$\leq 65$ years			$> 65$ years		
	n	%	$S_p$	n	%	$S_p$	n	%	$S_p$
male	161	75,94	2,98	113	76,87	3,48	48	73,84	5,49
female	51	24,06	2,94	34	23,13	3,48	17	26,16	5,49
overall	212	100		147	69,34	3,17	65	30,66	3,17

Fractures of one or two ribs were established in 72 (33,96 %) patients (table 2). The number of the patents with multiple rib fractures ( $\geq 3$  ribs) was significantly higher - 140 (66,04 %) / ( $p <$

0,05) (**Table 2**). For 26 (18,57 %) of the patients. bilateral rib fractures were established. Flail chest was diagnosed in 8 patients, all of them in aged group  $\leq 65$  years (**Table 2**).

**Table 2.** Type of rib fractures, associated with aged distribution ( $n$  - number of cases;  $S_p$  - standard error)

type of rib fractures	Overall			$\leq 65$ years			$> 65$ years		
	n	%	$S_p$	n	%	$S_p$	n	%	$S_p$
1-2 ribs	72	33,96	3,26	46	21,69	2,84	26	13,26	2,33
$\geq 3$ ribs	140	66,04	3,26	101	47,64	3,43	39	18,39	2,66
bilateral rib fractures	26	12,26	2,25	19	8,96	1,96	7	3,30	1,22
flail chest	8	3,77	1,31	8	3,77	1,31	-	-	-

Lung contusion was the most common thoracic injury, associated with rib fractures - it was established in 139 (65,56 %) of cases, 124 of them were with multiple rib fractures (**Table 3**). Hemothorax was established in 45 (21,21 %) of patients with rib fractures, 40 of whom with multiple rib fractures (**Table 3**). Pneumothorax was established in 40 (18,86 %) patients, 30 of whom with multiple rib fractures. Hemo-pneumothorax was established in 25 (11,79 %) of patients. Clavicular fractures were established in 11 (5,18 %) patients; sternal fractures - in 6 (2,83 %) patients with multiple rib fractures; scapular fractures - in 5 (2,35 %) of patients with multiple rib fractures (**Table 3**).

Mean time of hospitalization was 8,7 days ( $\pm 6,8$  days) / [interval: 0 - 94 days]. 62 of patients were attended in Intensive Care Unit (ICU), with

mean duration of stay - 13,3 days ( $\pm 13,04$ ) / [interval: 0 - 91 days] (**Table 4**).

The admission in ICU was done if one of these three criteria was met: six and more fractured ribs;  $PaO_2 > 60$  mm Hg; respiratory rate  $> 35 \cdot \text{min}^{-1}$ . Respiratory therapy was conducted in 57 of patients: Continuous Positive Airway Pressure with mask - in 12 patients and mechanical ventilation (Positive Endexpiratory Pressure - PEEP) for the rest of 45 cases.

Mortality, as the outcome of thoracic trauma, was established in 36 (16,98 %) of patients - significantly higher in the group of patients, aged  $> 65$  (**Table 4**). It was established that the age higher than 65 years is a risk factor for mortality in patients with blunt thoracic trauma and rib fractures - odds ratio (OR) = 2,38.

**Table 3.** The distribution of associated thoracic injuries, on the base of 1-2 or multiple rib fractures – number of cases.

Associated thoracic injuries	overall	1-2 fractured ribs	Multiple rib fractures ( $\geq 3$ ribs)	p
Lung Contusion	139	15	124	< 0,001
Lung lacerations	3	0	3	-
Pneumothorax	40	10	30	< 0,05
Hemothorax	45	5	40	< 0,05
Hemopneumothorax	25	3	22	< 0,05
Clavicular fractures	11	1	10	< 0,001
Sternal fractures	6	2	4	< 0,05
Scapular fractures	5	0	5	-

**Table 4.** Patients with rib fractures - outcome. (\*Intensive Care Unit; n – number of patients; data are expressed as mean (Standard Deviation);  $S_p$  – standard error).

Outcome	overall			$\leq 65$ год.			$> 65$ год.		
hospitalization (in days - mean/ (SD))	8,7 (6,8)			9,1 (7,6)			7,8 (5,4)		
Stay in ICU* / in days/mean (SD)	13,3 (13,04)			12,5 (8,4)			10,6 (6,3)		
	n	%	$S_p$	n	%	$S_p$	n	%	$S_p$
Patients in ICU	62	29,25	3,13	50	34,01	3,90	12	18,46	4,84
Mortality	36	16,98	2,58	19	12,93	2,76	17	26,15	5,49

A correlation between the level of mortality and the number of fractured ribs was established-coefficient of correlation (R) = 0,86 (Table 5).

**Table 5.** Mortality in patients with rib fractures (n – number of patients;  $S_p$  – standard error).

	overall			$\leq 65$ years			$> 65$ years		
mortality	n	%	$S_p$	n	%	$S_p$	n	%	$S_p$
I. $\leq 72^{\text{th}}$ hour	13	36,11	8,73	6	31,57	10,95	7	41,18	12,30
II. $> 72^{\text{th}}$ hour	23	73,89	8,73	13	68,43	10,95	10	58,82	12,30
III. number of fractured ribs:									
1-2	1			0			1		
3-4	7			2			5		
5-6	10			5			5		
$>6$	18			12			6		
overall	36			19			17		
IV. unilateral rib fractures	22	61,11	8,13	9	47,36	11,76	13	76,47	10,61
V. bilateral rib fractures	14	38,89	8,13	10	52,64	11,76	4	23,53	10,61

The mortality in patients with multiple rib fractures was significantly higher than in those with one or two fractured ribs ( $p < 0,01$ ) – either for the whole group or for the two age subgroups of patients (**Table 5**). Significantly higher level of mortality was established in cases with six and more fractured ribs, than those with less fractured ribs. It was also established significantly higher mortality in patients with bilateral rib fractures, than the patients with unilateral rib fractures -  $p < 0,05$ ). Bilateral rib fractures were determined as a risk factor for the mortality in patients with blunt thoracic trauma – OR = 8,69. The death cases were divided in two subgroups, on the base of the time of the death after patient's hospitalization – before and after the 72 hour. It was established significantly higher mortality after the 72 hour of patients' hospitalization – for the whole group and for the two age subgroups -  $p < 0,05$  (**Table 5**).

Associated thoracic injuries were the causes of death in patients with rib fractures. The causes of death were as followed: lung contusion - in 33 cases: 10 of whom before the 72 hour, hemorrhagic shock with massive hemothorax - in 3 cases all of them before 72 hour of hospitalization. The massive hemothorax was caused by lung laceration. Emergency thoracotomy was performed in these three patients and the death was set in up to 24<sup>th</sup> hour after operation.

## DISCUSSION

Rib fractures are the most common injury in patients with blunt chest trauma. According to many authors, more than 40 % of patients with blunt thoracic trauma have rib fractures (1-7).

Many authors have used the age of 65 years as a point of differentiation in studying different aspects in patients with rib fractures (5-12). That's why we also have accepted to differentiate the patients in this study in two aged subgroups: at  $\leq 65$  years and  $> 65$  years. We have confirmed that the number of patients younger than 65 year of age dominates. As we have expected, the male patients were significantly higher than females. Aged and gender differences in frequency of rib fractures in blunt thoracic trauma are explained with the aged and gender differences in physical activity. This retrospective study was performed in a hospital with the highest 3<sup>rd</sup> level of competence. The high level of competence of a hospital

means admission of patients with severe type of body traumas. That's why we had expected that the number of patients with multiple rib fractures and associated thoracic injuries would dominate. It was confirmed by our results. We had also confirmed the lung contusion as the most common associated thoracic injury in patients with rib fractures in blunt thoracic trauma.

We had established 16,98 % mortality rate in patients with rib fractures. Our data are comparable with the data citing in other clinical studies (8-14). We had hypothesized that the age would be factor that has influence the mortality in patients with rib fractures. This hypothesis was confirmed – according to our data, the age over 65 years is a risk factor for the mortality in patients with rib fractures - OR = 2,38. There are two explanations of this age dependency: demineralization (osteoporosis) in patients at age over 65 years and different accompanying diseases (respiratory, endocrine, heart, vascular and other diseases) that would affect the level of mortality.

Our study had established correlation between the number of fractured ribs and the level of mortality – coefficient of correlation = 0,85. We had confirmed that half a dozen ribs is a breakpoint for mortality in chest trauma patients. We had also established that bilateral rib fractures are a risk factor for the mortality in patients with thoracic trauma - odds ratio - OR = 8,69.

Many authors had pointed that rib fractures, on their own, are not threatening to the live of the patients with blunt thoracic trauma (12-17). It's known that the direct cause for the death in patients with rib fractures are associated thoracic injuries. Our results have confirmed that the lung contusion is the most common cause and risk factor of the death in patients with blunt thoracic trauma - OR = 7,26.

## CONCLUSION

This retrospective study has confirmed the role of rib fractures as a marker for the severity of blunt thoracic trauma. We conclude that:

1. Associated thoracic injuries are the cause of the death in patients with fractured ribs.
2. The mortality in patients with rib fractures correlates with the number of fractured ribs.

3. The age over 65 years, bilateral rib fractures and lung contusion are risk factors for mortality in patients with blunt thoracic trauma.

## REFERENCES

1. Whitson BA, McGonigal MD, Anderson CP. et al. , Dries DJ. Increasing numbers of rib fractures do not worsen outcome: an analysis of the national trauma data bank. *Am Surg*; 79:140-50, 2013.
2. Pressley CM, Fry WR, Philp AS. et al. Predicting outcome of patients with chest wall injury. *Am J Surg*; 204: 910-913, 2012.
3. Battle CE, Hutchings H, Evans PA. Risk factors that predict mortality in patients with blunt chest wall trauma: A systematic review and meta-analysis. *Injury*; 43: 8–17, 2011.
4. Ziegler DW, Agarwal NN. The morbidity and mortality of rib fractures. *J Trauma*;37:975-979, 1994.
5. Cameron P, Dziukas L, Hadj A, Clark P, Hooper S. Rib fractures in major trauma. *Aust N Z J Surg*; 66:530-534, 1996.
6. LoCicero J III, Mattox KL. Epidemiology of chest trauma. *Surg Clin North Am* 1989;69:75-82.
7. Dombi GW, Nandi P, Saxe JM, et al. Prediction of rib fracture injury outcome by an artificial neural network. *J Trauma*; 39:915–921, 1995.
8. Holcomb JB. Et al. Morbidity from Rib Fractures increases after age 45. *J Am Coll Surg*; 196: 549-555, 2003.
9. Fligel BT. Half-a-dozen ribs: The breakpoint for mortality. *Surgery*; 138: 717-725, 2005.
10. Barnea Y, Kashtan H, Skornick Y, Werbin N. Isolated rib fractures in elderly patients: mortality and morbidity. *CanJ Surg* 45:43-46, 2002.
11. Bergeron E, Lavoie A, Clas D, Moore L, Ratte S, Tetreault S, et al. Elderly trauma patients with rib fractures are at greater risk of death and pneumonia. *J Trauma*; 54:478-485, 2003.
12. Wagner RB, Jamieson PM. Pulmonary contusion: evaluation and classification by computed tomography. *Surg Clin North Am*; 69:31-40, 1989.
13. Hoff SJ, Shotts SD, Eddy VA, et al. Outcome of isolated pulmonary contusion in blunt trauma patients. *Am Surg*; 60:138-142, 1994.
14. Johnson JA, Cogbill TH, Winga ER. Determinants of outcome after pulmonary contusion. *J Trauma*; 26:695-697, 1986.
15. Stawicki SP, Grossman MD, Hoey BA, et al: Rib fractures in the elderly: A marker of injury severity. *J Am Geriatr Soc*; 52: 805–808, 2004.
16. Bulger EM, Arneson MA, Mock CN, Jurkovich GJ. Rib fractures in the elderly. *J Trauma*; 48:1040-1046, 2000.
17. Brasel KJ. Et al. Rib fractures: Relationship with pneumonia and mortality. *Crit Care Med*; 34:1642-1647, 2006.