Severity Factor in the First Forty-Eight Hours of Thoracic Trauma in University Hospital Center Joseph Ravoahangy Andrianavalona Antananarivo

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ABSTRACT

Introduction: Severe thoracic trauma is the second leading cause of death in multiple traumas after head trauma. Our objective is to research the profound factors of thoracic trauma at the Joseph Ravoahangy Andrianavalona Antananarivo University Hospital Center.

Patients and Methods: This is a retrospective cohort study on patients with closed and open chest trauma hospitalized in the thoracic surgery department from January 1, 2015, to December 31, 2022.

Results: We collected 331 patients with a male predominance (82.2%), with the median age of 29 years. Many of our patients were treated by chest drainage (62.8%), and 17.2% received a thoracotomy. The mortality rate is 36.2%.

Keywords: chest; mortality; risk factors; surgery; trauma; wounds.

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Results: We collected 331 patients with a male predominance (82.2%), with the median age of 29 years. Many of our patients were treated by chest drainage (62.8%), and 17.2% received a thoracotomy. The mortality rate is 36.2%. Several factors were found: age ≥ 55 years (RR=2,7 [2,2-3,4]); chronic respiratory disease including obstructive pulmonary disease and asthma (RR=2,8 [2,3-3,4]); the comatose state (RR=2,1[1,6 -2,8], hemodynamic instability and respiratory distress syndrome, the patient victim of penetrating trauma and neurological lesion associate; severe anaemia ≤ 70g/l (RR=2,4 [1,7-3,1]); chest flap, compressive pneumothorax (RR=5,5 [2,5-6,7]) and large hemothorax ≥ 1500 ml (RR=3,6 [2,4-5,4]; delay in management beyond six hours (RR=2,1 [1,6-2,8]); massive blood transfusion, Chest tube flow ≥ 250 ml/h.

Conclusion: Profound thoracic trauma leads to a high mortality rate. Several factors have been implicated: clinical, biological, scannographic and therapeutic factors.

Keywords: chest; mortality; risk factors; surgery; trauma; wounds.

I. INTRODUCTION

Thoracic trauma is a common situation in emergency. It is the second leading cause of death in multiple trauma patients after head trauma [1]. The United States, thoracic trauma is the most common cause of death related to trauma, accounting for 20% of deaths [2]. In Europe, thoracic trauma is one of the leading causes of death in all age, penetrating and blunt chest trauma accounted for 25 to 50% of all injuries [3]. There is currently no recommendation for the management of thoracic trauma. In our context, where the technical platform is still limited, other severity factors apart from those described in the literature may affect the morbidity and mortality rate of thoracic trauma in Madagascar. Our objective is to research the profound factors of thoracic trauma at the Joseph Ravoahangy Andrianavalona Antananarivo University Hospital Center (CHU-JRA).

II. METHOD

It is a retrospective cohort study of the files of patients hospitalized in the thoracic surgery department at CHU JRA for closed and open thoracic trauma. We included in this study all patients aged 15 years and over, victims of closed or open thoracic trauma by bladed and ballistic weapons and by zebu goring, over for seven years, from January 1, 2015, to December 31, 2022.

III. RESULTS

We had retained 331 cases of closed and penetrating thoracic trauma out of 375 cases recorded during our study period, giving an average of 47 patients per year, with a median age was 29 years (figure 1) with a male predominance. The sex ratio was 4,6 in favour of men. The majority of our patients had no antecedent's pathology in 62,5% cases, chronic respiratory diseases were found in 5,7% cases and ischemic heart disease, heart failure 2,1% cases (table I). Our patients were victims of blunt chest trauma in 58,01% cases and penetrating in 34,44% cases (table II). The thoracic injuries were mainly represented by a syndrome of pleural effusion such as hemothorax in 44,4% (n=147) and pneumothorax in 18,4% cases followed by a rib fracture in 23,1% of which 9,9% (n=33) of them presented a thoracic flap, vascular and tracheobronchial wounds are rare, represented respectively 13,5 et 4,8% cases. (Table III). The injuries were isolated in 47,83%, and they were associated with abdominal lesions in 37,1% (n=123), limb injuries in 9,3% (n=31), and neurological injuries in 6,6% cases (n=22). (Table IV)

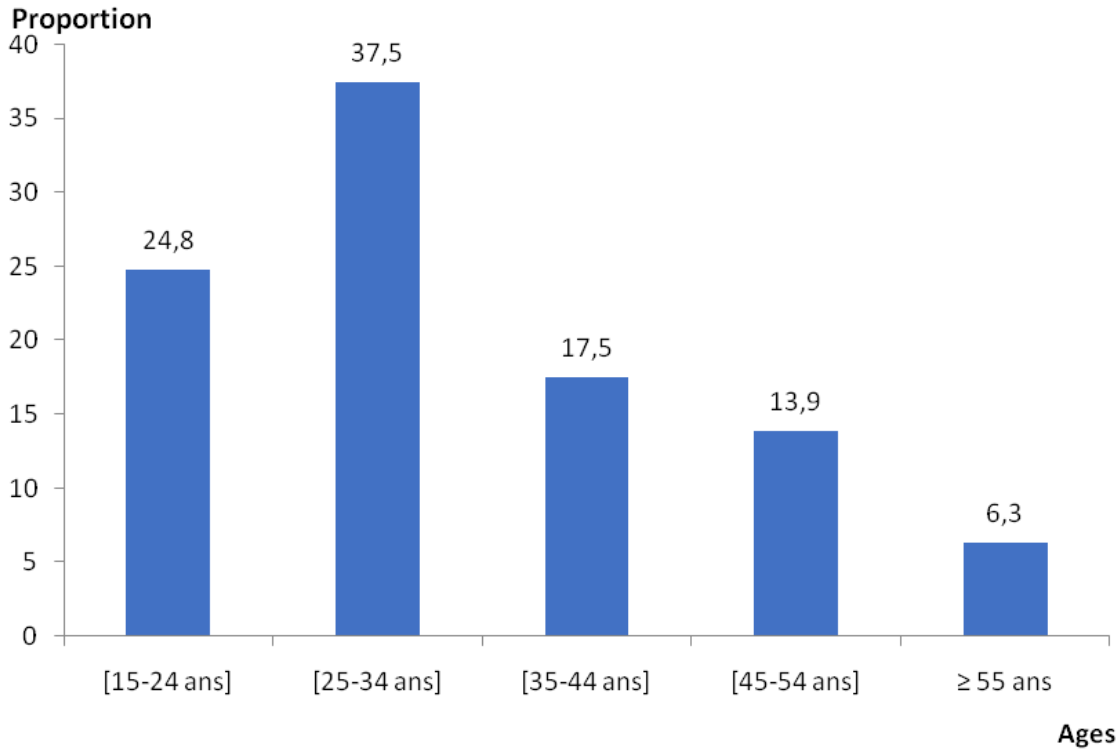

Figure 1: Distribution of Patients by Age Group

Table I: Distribution of Patients According to Antecedent

Antecedent	Effective (n)	Percentage (%)
Asthma	8	2,4
BPCO	11	3,3
Diabetes	4	1,2
High blood pressure	7	2,1
Heart disease	17	5,1
Tobacco	77	23,6
Anticoagulant	0	0
No antecedent	207	62,5

Table II: Distribution of Patients According toType of Thoracic Trauma

Type of trauma	Effective (n)	Percentage (%)
Penetrating trauma	114	34,44
Closed trauma	192	58,01
Parietal wound	25	7,5

Table III: Distribution of Patients According to Thoracic Lesion

Thoracic lesion	Effective (n)	Percentage (%)
Hemothorax	147	44,4
Pneumothorax	61	18,4
Diaphragmatic rupture	21	6,3
Pauci-costal fracture	44	13,2
Thoracic flap	33	9,9
Tracheobronchial wound	16	4,8
Vascular wound	45	13,5

We found a delay in care in 41,09% of our patients. The most of our patients were treated by a thoracic drainage (62,08%), only 17,2% of our patients benefited from an emergency thoracotomy. We analyzed several factors, and we found that the presence a history of chronic respiratory pathologies in particular asthma and chronic obstructive pulmonary disease increase the risk of mortality (Tableau V), age greater than or equal to 55 years is a significant factor in the severity of thoracic trauma, the risk of mortality is multiplied by 2,7 avec IC95 [2,2-3,4], $p=0,1.10^{-5}$.

Low Glasgow score ≤ 7, hemodynamic instability with PAM ≤ 80 mm Hg and tachycardia > 120 battements/min increases 1,9 times the risk of mortality with IC95 [1,4-2,5], hypoxemia avec Sa02 ≤ 92% are factors that increase the mortality risk by 2,5 times with IC95 [1,9-3,3] the patients suffering from chest trauma. (Tableau VI). Patients with penetrating chest trauma had a higher risk of mortality compared with patients with blunt chest trauma. The risk is 2,5 times with IC95[1,9-3,3], $p=0,2.10^{-8}$. Head trauma combined with chest trauma increases the risk of mortality 3,2 times with IC95[2,4-3,5]. Other associated injuries, including abdominal injury and limb trauma, are not significant (Tableau VII). The mortality risk in patients with a thoracic arch is 4,1 times with IC95 [2,2-7,5] higher compared to patients with a pauci-costal fracture. Large hemothorax increases the risk of mortality 3,5, the tension pneumothorax increases the risk of mortality 5,5 times, compared to patients without pleural effusion, low haemoglobin levels ≤ 70 g/l are risk factors for mortality in patients with chest trauma (Tableau VIII). Delay in treatment beyond six hours, massive blood transfusion are factors that increase the risk of mortality. A chest drain flow rate greater than or equal to 250 ml/h indicates the seriousness of thoracic trauma from the outset. (Tableau IX).

Table IV: Treatment-Related Severity Factors

Therapeutic factor	Deceased N(%)	Alive N(%)	RR [IC 95%]	p-value
Delay in treatment Yes No	 72(52,9) 48(24,6)	 64(47,1) 147(75,4)	 2,1 [1,6-2,8]	 $0,2.10^{-5}$ S
Bood transfusion Yes No	 19(70,4) 14(14,1)	 8(29,6) 85(85,9)	 4,9 [2,8-8,5]	 $0,3.10^{-7}$ S
Chest drain flow Yes No	 25(89,3) 95(31,4)	 3(107) 208(68,6)	 2,8 [2,3-3,5]	 $0,1.10^{-8}$ S

S: significant

NS: No significant

Table V: Severity Factors Related to Comorbidites

Comorbidites	Decreased n(%)	Alive n(%)	RR [IC 95%]	p-value
High blood pressure Yes No	 1(14,3) 119(36,7)	 6(85,7) 205(63,3)	 0,1	 0,21 NS
Diabetes Yes No	 0 120(36,7)	 4(100) 207(67,3)	 0	 0,16 NS
Chronic phatology respiratory: asthma, BPCO Yes No	 17(94,4) 103(32,9)	 1(5,6) 210(67,1)	 2,8 [2,3-3,4]	 $1,8.10^{-7}$ S
Ischemic heart disease Yes No	 15(88,2) 105(33,4)	 2(11,8) 209(66,5)	 2,6 [1,8-3,4]	 $0,2.10^{-6}$ S
Tobacco Yes No	 4(5,2) 116(45,7)	 73(94,8) 138(53,3)	 0,2 [0,07-0,9]	 0,03 NS

Table VI: Clinical Severity Factors

Clinic factor	Decreased n(%)	Alive n(%)	RR [IC 95%]	p-value
Age 55 years Yes No	 19(90,5) 101(32,6)	 2(9,5) 209(67,4)	 2,7 [2,2-3,4]	 $0,1.10^{-5}$
Low Glasgow Yes No	 65(55,1) 55(25,8)	 53(48,5) 158(74,2)	 2,1 [1,6-2,8]	 $1,2.10^{-4}$
Low blood pressure Yes No	67(51,5) 53(26,4)	63(48,5) 148(73,6)	1,9 [1,4-2,5]	$0,1.10^{-7}$
Respiratory rate Yes No	 66(58,9) 54(24,7)	 46(41,1) 165(75,3)	 2,4 [1,8-3,2]	 $0,1.10^{-7}$
Desaturation Yes No	 67(60,4) 53(24,1)	 44(39,4) 164(75,9)	 2,5 [1,9-3,3]	 $0,1.10^{-8}$

Table VII: Morphological Severity Factors

Morphologic factor	Deceased n(%)	Alive n(%)	RR [IC 95%]	p-value
Penetrating trauma	68(59,6) 52(24)	46(40,4) 165(76)	3,2 [2,4-3,5]	$0,2.10^{-8}$ S
Heard trauma	21(95,5) 99(32)	1(4,5) 210 (68)	3,2 [2,4-3,5]	$0,2.10^{-8}$ S
Associated abdominal trauma	11(8,9) 109(52,4)	112(91,1) 99(47,6)	0,1 [0,09-0,3]	0,01 NS
Associated limb trauma	3(9,7) 117(39)	28(90,3) 183(61)	0,2 [0,08-0,7]	0,01 NS

Table VIII: Paraclinical Severity Factors

Paraclinc factor	Deceased N(%)	Alive N(%)	RR [IC 95%]	p-value
Low haemoglobin	71(56,3) 49(23,9)	55(43,7) 156(76,1)	2,4 [1,7-3,1]	$0,27.10^{-6}$
Large haemothrax	38(77,6) 21(21,4)	11(22,4) 77(78,6)	3,6 [2,4-5,4]	$0,1.10^{-7}$ S
Tension pneumothorax	20(87) 6(15,5)	3(13) 32(84,2)	5,5 [2,5-6,7]	$0,4.10^{-6}$ S
Thoracic flap	28(84,8) 9(20,5)	5(15,2) 35(79,5)	4,1 [2,2-7,5]	$0,13.10^{-6}$ S
Pulmonary contusion	5(2,9) 115(73,7)	170(97,1) 41(26,3)	0,03 [0,01-0,09]	0,01 NS

V. DISCUSSION

In our study, we found that age greater than or equal to 55 years is significantly a factor in the severity of thoracic trauma with a risk multiplied by 2,7 on IC_{95} [2,2-3,4], $p=0,1.10^{-5}$ compared to young patients. This result differs from reported by Battle et al. who found from 65 years [4]. This difference is explained by the low life expectancy of the Malagasy population compared to Europeans. This high mortality in older people is due to a loss of physiological reserve or to underlying comorbidities common in the elderly. In our study, a statistical analysis showed that patients with chronic lung diseases, including asthma and chronic obstructive pulmonary disease, had 2,8-fold increased risk of mortality IC_{95} [2,3-3,4] $p=1,8.10^{-7}$ compared to patients without a history. This result is identical to that reported by Bergeron et al, who said that the risk of mortality was 2,98 on (1,1–8,3 IC95) [5]. Christin et al. said the pre-existing pathology aggravates the respiratory distress secondary to a pulmonary contusion. Pre-existing pathologies are added so that the elderly subject tolerates hemodynamic instability less well and has less physiological reserve, mainly respiratory, to respond to the increase in need during a thoracic trauma [6]. In our study, hemodynamic instability was found in 39,2% of cases (n=130), including 51,5% (n=67) of which died. This instability is due to a lesion of the internal mammary artery and intercostal artery in 13,5% of cases; in other cases, they are secondary to a hemothorax of great abondance, we found significantly that the patient presenting a hemodynamic instability had a risk of mortality 1,9 times more with IC à 95% [1,4-2,5], $p=0,3.10^{-4}$ compared to the hemodynamically stable patients, this results is similar to that reported by Roberto et al. said that a hemodynamic instability of the patients is a bad prognosis of this patients victims of the thoracic trauma [7]. In a study by Roberto S et al. significant correlation between low Glasgow

scores, less than or equal to 7 on admission and high mortality (p< 0,001) [7]. This result is identical in our study, and this poor neurological state is due either to cerebral hypoxia secondary to respiratory distress due to pulmonary collapse or due to an associated brain lesion [7]. This study is identical to our result; we found that 33,8% (n=112) of our patients presented a respiratory distress syndrome, of which 58,9% (n=66) of them died, a statistical analysis showed that the patient presenting respiratory distress increased the risk of mortality by 2,4 times high with IC à 95% [1,8-3,2] p=0,1.10^{-7}. This respiratory distress is due to damage to the ventilatory mechanism and inadequate ventilation-perfusion due to pulmonary collapse during a compressive pneumothorax or a large hemothorax or during pulmonary compression of digestive contents during a diaphragmatic breach which aggravates hypoxia [8].

In a study by Ottochian et al., they found that penetration trauma increases the risk of mortality by 2,6. with IC à 95% [2,42–2,85]) [9]. Overall mortality from penetrating trauma was found to be 2,63 times higher than from blunt mechanisms with IC à 95%: 2,42-2,85 p < 0,0001 [9]. This result is similar in our study, we have found that penetrating trauma is more deadly than blunt trauma. The mortality risk is multiplied by 2,5 IC à 95% [1,8-3,2] p=0,2.10^{-8}.

Kollmorgen et al. showed that the existence of associated extra thoracic lesions, notably craniocerebral, is a determining element of the severity of the trauma [10]. Our study was similar to this study, the neurological lesion represented 6,6 % of case (n=22) of which 95,5% of them died in the first 24 hours, a statistical analysis showed significantly that thoracic trauma associated with a head trauma increases the risk of mortality to 3,2 with IC à 95% [2,4-3,5] p=0,2.10^{-8}. Marasco S F et al. said, the mortality rate of isolated chest injuries is in the range of 4% to 12% but increases to é à 13% to 15% if there is another system involved especially abdominal; and 30% to 35% when two or mor systems are involved. Early mortality is usually due to haemorrhage, catastrophic injury and associated abdominal trauma, while late mortality is often due to sepsis [12].

Duranteau et al. said that the haemoglobin level must be kept above 70 g/l to have a good vital prognosis for patients who are victims of penetration chest trauma to ensure good cerebral oxygenation while avoiding aggravated tissue hypoxia [13]. In our series, our patients had a drop in hemoglobin level in 39,8% cases (n=132), 56,3% of which died. We found that the hemoglobin level ≤ 70 g/l is a factor that can engage the vital prognosis of patients who are victims of chest trauma, a haemoglobin level lower than or equal a risk of mortality of 2,4 with IC à 95% [1,7-3,1] p= 0,27.10^{-6} more compared to patients whose haemoglobin level was normal. Meyer et al. a said, large hemothorax signifies the severity of the intra thoracic lesion, it increases the mortality risk by de 3 à 4 times (p<0,0001). In the face of massive bleeding with instability of the hemodynamic state, the patient's vital prognosis was immediately engaged. Anterolateral thoracotomy is urgently necessary to control the bleeding [14]. Our study is identical to that of Meyer et al. significantly showing that patients with a large hemothorax had a 3,6 times higher risk of mortality IC to 95% [2,4-5,4] p=0,1.10^{-7}.

In our study, a delay in care greater than or equal to six hours is found in 41,8% of cases (n=136), of which 52,9% of them died. A statistical analysis showed that a delay in care beyond six hours increases the risk of mortality, it is multiplied by 2,1 with IC à 95% [1,6-2,8], p= 0,12.10^{-5}. Our result was identical to Raherinantenaina F et al [15]. This delay in transporting patients to the hospital is due to multiple reasons, the transport where the patients is brought by their means of transport, personal car or taxi. And our center is the only reference center to manage profound chest trauma in Madagascar.

Thoracic drainage is the first choice in emergencies for any thoracic trauma with associated pleural effusion [16]. In our series, emergency thoracic drainage was used in many of our patients 62,8 % cases (n=208). Michelet P said, the mortality rate increases linearly with the quantity and flow rate of the thoracic drain [16].

This result is identical to our study; we found that the flow rate of the thoracic drain is greater than or equal to 250 ml per hour in the first three hours or a hemothorax of 1500 ml immediately increases the risk of mortality 2,8 with IC95 [2,3-3,5] sur $p=0,1.10^{-8}$. But O'connor et al. recommend repeat chest x-rays a monitoring element to assess whether surgery is necessary, because decreased blood flow through the drain does not mean that the bleeding has stopped. It could be from clots blocking the drain [17]. Surgical indication was proposed in the drain returns 1500 ml immediately or returns more than 250 ml per hour, in the first three hours with hemodynamic instability [40]. In our study, we performed a hemostasis thoracotomy in 17,2% cases with an anterolateral approach and sternotomy to control active bleeding from injury to the internal mammary artery and for aerostasis of a tracheobronchial lesion or even a segmental resection of the lung.

According to Avaro et al., massive blood transfusion promotes the development of Perico-tissue oedema during a pulmonary contusion greater than or equal to 20% of pulmonary collum, causing acute respiratory distress syndrome, which aggravates the mortality of patients massively transfused greater than or equal to ten bags of packed red blood cells, because massive transfusion aggravates the hemostasis disorder caused by massive haemorrhage due to platelet micro aggregates, responsible for pulmonary oedema, an alteration of the alveoli-capillary membrane by shock mediators and free radicals, which aggravates metabolic acidosis and increases the risk of mortality by two times [18]. In our study, we found that 8,1% cases (n=27) received massive transfusion, of which 70,4%of them died due to disseminated intravascular coagulation and multiorgan failure, a statistical analysis was performed, which significantly showed us that patients with severe chest trauma that required massive blood transfusion greater than or equal ten bags had a high risk of mortality to 2,3 times with IC à 95% [1,7-3,1] and $p=0,2.10^{-7}$. This result was similar to the study conducted by Avaro et al [18].

VI. CONCLUSION

Severe chest trauma had a high morbidity and mortality rate in developing countries. The present study made it possible to determine the severity factors of chest trauma; they are categorized into clinical factors: age ≥ 55 years, comorbidities such as chronic respiratory pathologies including asthma and chronic obstructive pulmonary disease, hemodynamic instability, comatose state, acute respiratory distress; in morphological factor: penetrating trauma and associated neurological lesion and paraclinical factors notably severe anaemia ≤ 70g/l, chest flap, compressive pneumothorax and large hemothorax ≥ 1500 ml; treatment-related factors notably delay in treatment beyond six hours, massive transfusion and chest drain flow ≥ 250 ml/h in the first three hours. The search for these different severity factors should be systematic for all patients' victims of closed or penetrating thoracic trauma. Which will allow a standardized protocol to be established and lifesaving therapeutic actions to be carried out.

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