CRITERIA FOR THE SAFE PERFORMANCE OF VIDEOTHORACOSCOPY IN PATIENTS WITH CHEST WOUND

O.V. Voskresensky

N.V. Sklifosovsky Research Institute for Emergency Medicine of the Moscow Healthcare Department, Moscow, Russian Federation

RELEVANCE Hypotension caused by intrapleural bleeding or wound of the heart is an indication for thoracotomy in chest wound. Drainage of the pleural space is performed in normotensive patients in the absence of immediate threat to life and other indications for thoracotomy. Thoracoscopy allows diagnosing and fixing intrapleural damage in patients when thoracotomy is not indicated. The main condition for the procedure is stable hemodynamics.

MATERIAl AND METHODS Medical histories of 591 patients operated on between 2002 and 2012 with the use of traditional methods and videothoracoscopy have been studied. Four expert groups were formed (drainage of pleural space, atypical thoracotomy, videothoracoscopy and typical thoracotomy), consisting of 375 patients, to determine the value of shock index and the pace of intrapleural bleeding, enough for a safe thoracoscopy. We used binary logistic regression (ROC analysis), studying the findings.

THE RESULTS It was found that the safe performance of thoracoscopic surgery for a chest injury is reasonable when the value of shock index is less than 0.97 and the pace of intrapleural bleeding is less than 250 ml / hour.

CONCLUSION The retrospective study determined the safety parameters to perform thoracoscopy in patients with chest wound.

Keywords: chest wound, videothoracoscopy, shock index.

AT — atypical thoracotomy

CI — confidence interval

DPS — drainage of pleural space

HR – heart rate

IB — intrapleural bleeding

SI — shock index

TT — typical thoracotomy

VTS — videothoracoscopy

INTRODUCTION

The choice of method of surgery at the chest wound is based on an assessment of vital functions. Accordingly, the management for chest injuries consists of two main components: emergency thoracotomy for bleeding with threatening hypotension or heart hemotamponade and drainage of the pleural cavity in stable patients [1, 2]. Reasonability of thoracotomy with severe hypotension in intrapleural bleeding or wound of the heart is not undoubted [3, 4]. However, the choice of surgical intervention in patients with stable hemodynamics is debated [1, 5-7]. Over the last three decades, there have been a lot of reports about using videothoracoscopy (VTS) in the diagnosis and treatment of patients with penetrating wounds of the chest. The basic requirement for its implementation is the lack of evidence of injury to vital organs, signs of significant damage to adjacent anatomical regions and hemodynamically stable condition of a victim. Hemodynamic stability is a collective concept mainly based on systolic blood pressure and heart rate (HR) [8-16]. In turn, these parameters depend on the intensity of intrapleural bleeding [17, 18]. One of the tools in the assessment of hemodynamics is a shock index — SI (the quotient heart rate / systolic blood pressure), developed in the mid XX century by *M. Allgöwer* and *C. Burri* [19]. Some researchers believe that this criterion is not sensitive enough and cannot be used if there are other more accurate methods [3].

However, recent publications demonstrate its prognostic value in the assessment of hemodynamics during transportation and sorting upon admission [20-24]. Studies carried out by several authors show the importance of hypotension in the prognosis of the treatment for chest injury. Moreover, systolic blood pressure, characterizing hypotension, has increased from 90 to 110 mm Hg recently according to researchers [14, 17, 25, 26], although a proportion of patients with ongoing bleeding shows normal figures blood pressure (not less than 120 mm Hg) and there is a tendency to normocardia and bradycardia [9, 23, 27]. Shock index is not a competing parameter for physiological criterion *RTS* (the ratio of the level of consciousness according to the Glasgow Coma Scale, respiratory rate and systolic blood pressure), which is widely used to assess the severity of physiological disorders in trauma. Shock index is used to assess the severity of the shock, and *RTS* — for the prediction of survival / mortality.

Purpose of the study is to determine the threshold value of the two criteria relying on the on the SI analysis and calculated index of intrapleural bleeding rate, using the method of binary logistic regression *(ROC-analysis)* for predicting the safe performance of VTS intervention in patients with penetrating wound of the chest.

MATERIAL AND METHODS

We studied the group of 591 injured with penetrating wounds of the chest. In 109 of them (18.4%), the only treatment for chest wounds was drainage of pleural Space (DPS). One hundred and fifty two patients (25.7%) with low chest wounds underwent atypical (limited) thoracotomy (AT) in order to exclude thoracoabdominal trauma [28]. The typical thoracotomy (TT) was performed in 94 patients (15.9%) and 236 patients (40%) underwent videothoracoscopy (VTS). Two expert groups were formed of the total number of patients to compare conditions of these types of surgical procedures performance. We selected 64 patients (58.7%) with unilateral isolated (single and multiple) injuries chest of patients with DPS. Eighty three patients (54.6%) with one-sided diaphragmatic wounds to the chest area in the absence of data for thoracoabdominal injuries were selected of 152

patients with AT performed only to diagnose injuries of the diaphragm. Thirty one patients (33%) with unilateral isolated chest injury were selected of 94 victims who underwent TT, where thoracotomy was performed on the absolute medical grounds due to the intense intrapleural bleeding or hemotamponade heart. In addition, 21 patients from the group of victims who underwent AT (13.8%) were included into this group, but with a massive intrapleural bleeding, which is an absolute indication for thoracotomy. This expert group included 52 patients in total. Of 236 victims, who underwent VTS we selected 176 patients (74.6%) with unilateral injuries, where the main and only treatment for VTS was performed with no conversions and laparotomy. The number patients in the sample group was 375 (see Table). In the expert group, the average volume of hemothorax (HT) in patients with DPS and AT did not differ, and in patients undergoing VTS, it was higher than in the previous two groups ($p<0.05$). In patients from an expert group with TT, the HT volume was significantly higher than in patients with DPS, VTS and AT combined ($p<0.05$) (Fig. 1). In patients with DPS, VTS and AT, the time between injury and surgery did not differ ($p>0.05$), whereas in patients who underwent TT, the period between injury and operation was significantly shorter than in the other groups ($p<0.05$) (Fig. 2). This is associated with more severe injuries and more serious condition of patients initially with larger HT, which led to deterioration of hemodynamics (manifested in the growth of SI) and required immediate surgery. The average value of SI in patients with invariable indications for TT was 1.32±0.82, which was significantly higher than that of the patients who underwent other surgical procedures combined— 0.77 ±0.18 ($p<0.05$). No differences in SI of victims who had had other interventions were identified ($p>0.05$) (Fig. 3). Shock index was measured upon admission of the victim to the operating room. Before the surgery, patients underwent normal ultrasound and / or x-ray of the chest. In the presence of hemopneumothorax, DPS was performed. Further tactics depended on the results of drainage. The average rate of intrapleural bleeding amount was calculated using HT and the time between the injury and surgery. In groups with VTS, DPS and AT performed to exclude thoracoabdominal wounds, in the absence of intensive intrapleural bleeding it ranged from 10 to 515 ml/h (76±78 ml/h), whereas patients with absolute indication for thoracotomy — 120-2600 ml/h (772±531 ml/h) ($p<0.05$).

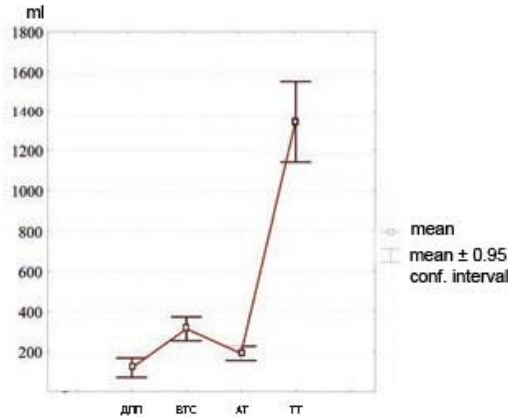

Fig1. Comparison of the volume of hemothorax in victims who underwent various types of surgical procedures. Notes: AT — atypical thoracotomy; VTS — videothoracoscopy; CI — confidence interval; DPS — drainage of pleural space; TT — typical thoracotomy

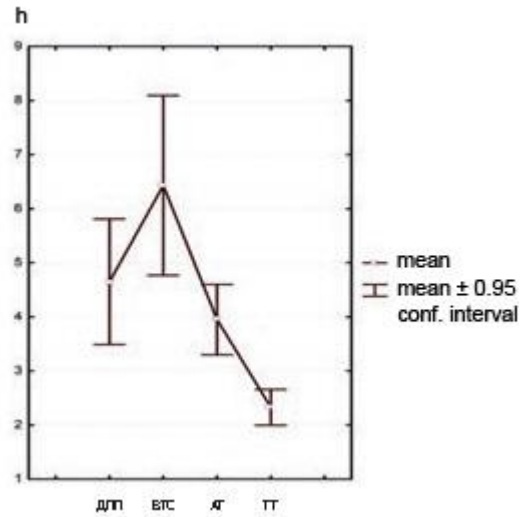

Fig 2. Comparison of the time between the injury and operation in patient of the expert groups undergoing various types of surgery. Notes: AT — atypical thoracotomy; VTS — videothoracoscopy; CI — confidence interval; DPS — drainage of pleural space; TT — typical thoracotomy

Table

The main parameters of the expert groups

Type of surgery	Parameters				
	Shock index	ISS	Hemothorax	Time between injury and surgery, h	Expert group, n
Drainage of the pleural cavity	0.75 ± 0.12	6 ± 2	146 ± 193	4.61 ± 4.54	64
Videothoracoscopy	0.76 ± 0.15	7 ± 3	340 ± 396	6.43 ± 10.31	176
Atypical thoracotomy	0.75 ± 0.11	9 ± 4	218 ± 160	3.95 ± 2.79	83
Typical thoracotomy	1.28 ± 0,81	13 ± 7	1373 ± 699	2.33 ± 1,12	52

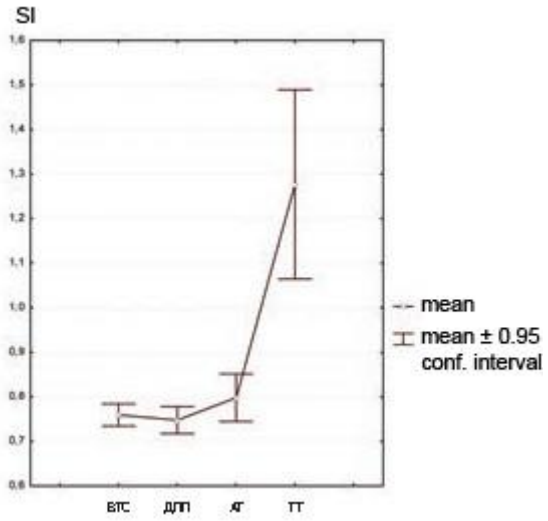

Fig 3. The average value of SI in victims who underwent thoracoscopy (VTC), drainage of pleural space (DPS), atypical thoracotomy (AT) and typical thoracotomy (TT)

For comparison of the average values, the median *Kruscal-Wallis* test from the statistical package *Statistica* 7.0. was made. We used software statistical package IBM SPSS Statistics v.19 for the *ROC-analysis*. The value of the regression level as"1" indicated an obligatory thoracotomy, "0" completely excluded thoracotomy.

RESULTS

As seen on Fig. 4, for the criterion of "shock index" area under the curve *(Area Under Curve)* was 0.836, confidence interval (CI) was 95% (0.767-0.905). The cutoff threshold (Tr_{0}) was calculated by adding the sensitivity *(Se)* to specificity *(Sp)* and corresponded to the value of SI — 0.97 (sensitivity — 60.4%, specificity — 94.2%). As seen on Fig. 5, for the criterion of "the rate of intrapleural bleeding", AUC was 0.992, CI — 95% (0.985-0.998), Tr_0 corresponded to the rate of bleeding of 255 ml/h (sensitivity — 95.6%, specificity — 96.6%).

RESULTS AND DISCUSSION

In patients with penetrating wound of the chest, not requiring emergency thoracotomy, VTS can be an alternative to other surgical methods. For safe use of the VTS, it is necessary to determine the optimal parameters of hemodynamics. In order to prevent undue bleeding during thoracoscopic hemostasis we should define a threshold rate of bleeding, which allows hemostasis during the VTS to be safely performed.

Application of *ROC-test* showed a lack of sensitivity of SI in the prognosis of thoracotomy, but high specificity of this criterion. This means that a value of SI less than 0.97 excludes indications for thoracotomy in 94.2% of the victims. As seen on Fig. 5, the rate of bleeding is a highly informative criterion, but requires a certain volume of HT. Experience has shown that the most informative and rapid method for determining the volume of HT in stable victims not requiring thoracotomy, is the computed tomography. For greater accuracy of the prognosis, both these criteria (SI and rate of bleeding) should be evaluated in parallel.

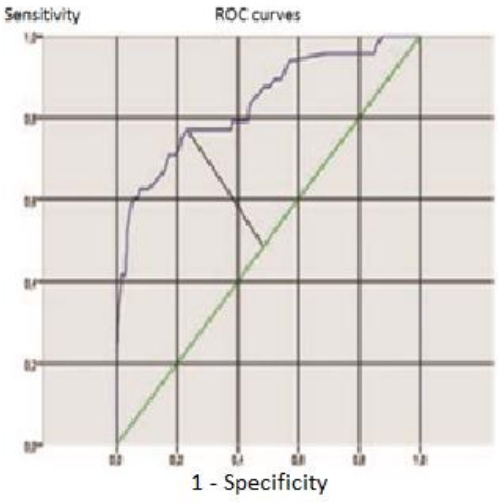

Fig. 4. Diagram. *ROC*-curve: determining a threshold value of "shock index"

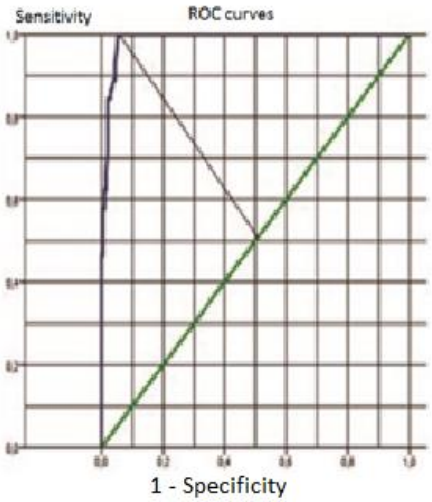

Fig. 5. Diagram. *ROC*-curve. Determination of the threshold parameter "rate of intrapleural bleeding"

CONCLUSION

In contrast to the empirically calculated average values of shock index and the average rate of intrapleural bleeding, binary logistic regression method allowed to find the threshold values of these parameters, below which the probability of safe performance of videothoracoscopy is 94.2% according to the criterion of shock index and 96.6% according to the criterion of intrapleural bleeding intensity.

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For correspondence:

Voskresensky Oleg V.,

Senior Researcher of the Departament of Thoracoabdominal Surgery,

N.V. Sklifosovsky Research Institute for Emergency Medicine of the Moscow Healthcare Department, Moscow, Russian Federation

e-mail: olegvskr@mail.ru

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