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THE EVALUATION OF PROCEDURE AND TREATMENT OUTCOME IN PATIENTS WITH TENSION PNEUMOTHORAX

OCENA SPOSOBU POSTĘPOWANIA I WYNIKÓW LECZENIA U PACJENTÓW Z ODMĄ PRĘŻNĄ

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Streszczenie

Wstęp: Odma prężna stanowi stan bezpośredniego zagrożenia życia. Celem pracy była ocena wyników leczenia odmy prężnej u pacjentów urazowych.

Materiał i metody: Oceniono wyniki leczenia 22 chorych urazowych hospitalizowanych w latach 2000–2010, u których w chwili przyjęcia do szpitala stwierdzono objawy odmy prężnej. Chorzy ci stanowili 18% pacjentów urazowych, u których w chwili przyjęcia do szpitala, w trakcie badania wstępnego, rozpoznano odmę. W analizowanej grupie było 17 mężczyzn i 5 kobiet. Wiek chorych wynosił 21–85 lat (średnio 48,8). W 19 przypadkach odma związana była z urazem wielonarządowym. W większości przyczyną były wypadki komunikacyjne. Stłuczenie jednego lub obu płuc stwierdzono u 16 pacjentów. Typowy oddech paradoksalny występował u 2 chorych. Liczba złamanych żeber wynosiła średnio u jednego chorego 6,3.

U każdego z chorych bezpośrednio przy przyjęciu, po postawieniu rozpoznania na podstawie objawów klinicznych odbarczono odmę prężną, zakładając drenaż jamy opłucnej. Po wykonaniu drenażu uzyskiwano rozprężenie płuca i poprawę stanu klinicznego chorego w ciągu kilku minut. Wówczas kontynuowano dalszą diagnostykę i postępowanie terapeutyczne. Pełny czas pobytu chorych w związku z wielonarządowym charakterem urazu wynosił średnio 58,6 dni. W trakcie leczenia urazów wielonarządowych zmarło 2 chorych. U żadnego z chorych przyczyną zgonu nie była odma.

Wniosek: Standard terapeutyczny nakazujący odbarczenie odmy prężnej już bezpośrednio przy przyjęciu chorego do szpitala pozwala na przeżycie, pomimo ciężkiego charakteru obrażeń.

H a s ł a: odma prężna – uraz klatki piersiowej – dekompresja – drenaż – urazy wielonarządowe.

Summary

Introduction: Tension pneumothorax is a directly critical illness condition. The aim of this study was to evaluate the outcome of tension pneumothorax treatment in trauma patients.

Material and methods: We assessed the results of treatment of 22 patients hospitalized for trauma in 2000–2010, in whom at the time of admission tension pneumothorax symptoms were found. This constituted 18% of trauma

patients who at the time of admission to the hospital, during the initial examination, were diagnosed with pneumothorax. In the study group there were 17 men and 5 women. The patients' ages ranged from 21 to 85 years (mean 48.8). In 19 cases tension pneumothorax was associated with polytrauma. Traffic accidents were the cause of most cases. Injury to one or both lungs was observed in 16 patients. Typical paradoxical breathing occurred in 2 patients. The number of fractured ribs averaged 6.3 per patient. In each of the patients, immediately on admission, after diagnosis based on clinical symptoms, tension pneumothorax decompression was performed by pleural drainage. Lung decompression and improvement of the clinical condition of the patient were obtained in a few minutes after pleural drainage. Then, further diagnostic and therapeutic procedures were continued. Full time of hospitalization due to polytrauma injury was on average 58.6 days. Two patients died during treatment for polytrauma. Pneumothorax was not the cause of death in either of the patients.

Conclusion: In summary, the therapeutic standard ordering of tension pneumothorax decompression, directly on admission to the hospital, allows the patient to survive in spite of the grave nature of the injury.

K e y w o r d s: tension pneumothorax – chest injury – decompression – drainage – polytrauma.

Introduction

Injuries are "the largest epidemic of the 20th century" and "the severest and most expensive war of the present world". Statistics inexorably indicate that every year more people die in accidents in the USA than in all American wars. 60 million people in the USA (population: 309 million) suffer from an injury per year, 30 million require obligatory medical specialized therapy, while 3.5 million persons require hospitalization due to traumas. As a result of accidents in the United States 150,000 people are killed, i.e. ca. 50/100,000, and 300,000 people suffer from disability. In Poland (population: 38 million) 3 million injuries occur annually. 300,000 people need specialized medical diagnostics and therapy. As a result of injuries 30,000 people are killed, which constitutes ca. 75/100,000, while 75,000 people suffer from disability. Injuries are the third largest cause of death. In Poland 500 persons out of 100,000 die from circulatory diseases, 200 persons out of 100,000 because of neoplasms, and 75 out of 100,000 due to injuries [1, 2, 3, 4].

However, deaths and disability due to injury concern mainly young people. As a result of injuries in the Polish population, within one year there is a loss of 500,000 years of life and 300,000 years of work. Injuries are a major economic problem. The losses caused by injury are not just the costs of treatment, i.e. direct costs. They are only 1/10–1/20 of the general costs of the injuries. Indirect costs are 9/10–19/20 of the total costs of traumas. Indirect costs include, inter alia, indemnity, disability pension, and mainly the loss of years of work. The number of injuries in Poland grows continually. Their severity also increases. Consequently, economic losses grow in the form of direct and indirect costs [3, 5].

The incidence of chest trauma is 12.3% in the case of simple injuries, while in the case of polytrauma 47.3%. Chest injuries may be the state of direct threat of life, in contrast to the more frequent limb injuries. Chest injuries often require immediate therapeutic intervention at the place of accident, or in the hospital emergency room. Tension pneumothorax is one of the life-threatening conditions demanding urgent intervention. Advanced life support and advanced trauma life support standard direct attention to this [6, 7].

The aim of this study was to evaluate the outcome of tension pneumothorax treatment in trauma patients.

Material and methods

The study group comprised 22 patients (17 men, 5 women), aged 21–85 (mean 48.8). These were patients with trauma and tension pneumothorax at the time of admission to the hospital. In this group there were 18% of patients with pneumothorax at the time of admission (fig. 1, 2). The most frequent cause of injury was traffic accident – 16 cases (tab. 1).

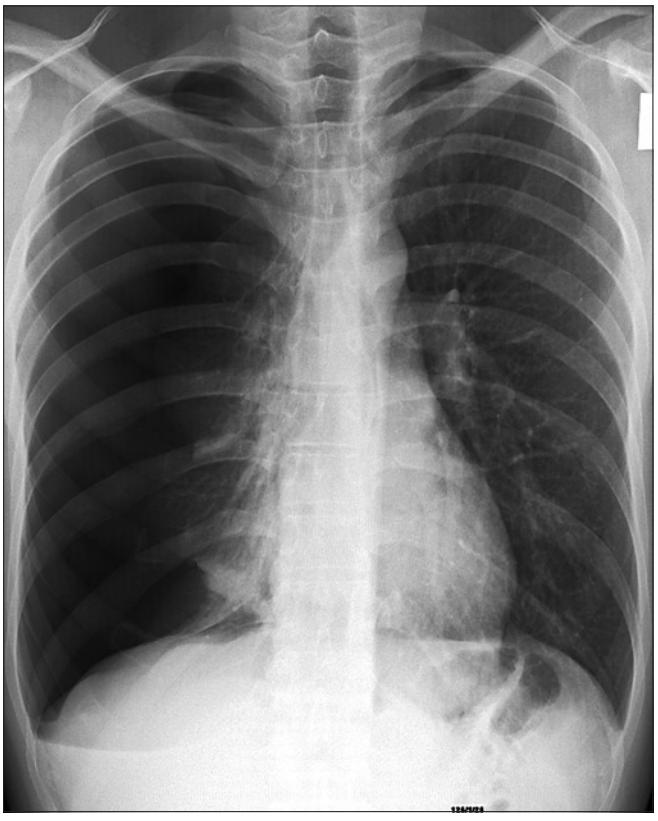

Fig. 1. Tension pneumothorax – chest X-ray

Fig. 2. Tension pneumothorax – CT scan

T a b l e 1. **Cause of injuries in the study group**

Cause of injuries	Number of cases
Traffic accident – drivers	3
Traffic accident – passengers	4
Traffic accident – pedestrians	9
Falls	5
Assault	1

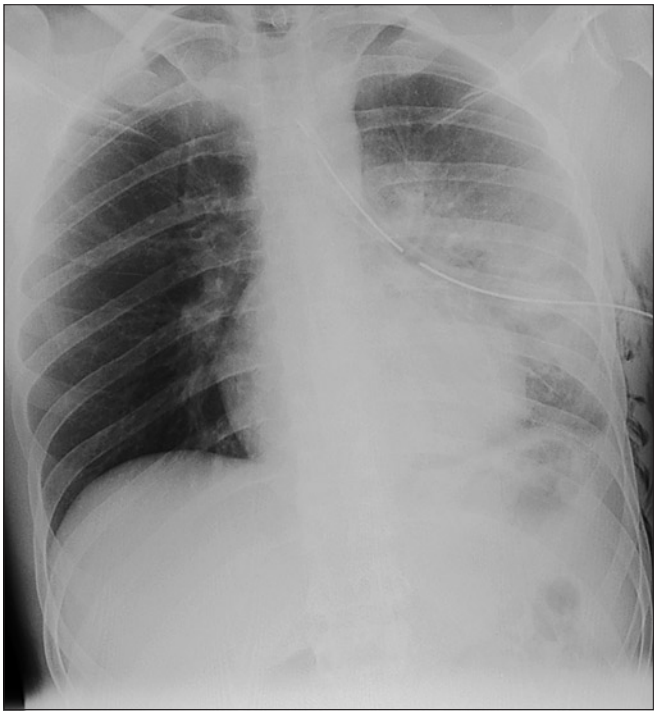

Fig. 3. Tension pneumothorax after decompression using drainage – chest X-ray

In each of the patients, immediately on admission, decompression of tension pneumothorax was performed (fig. 3). They were put under physical examination. Diagnostics were supplemented in each case with imaging studies (typically a CT body scan, less frequently only standard radiological examination and FAST ultrasound examination). The control chest X-ray was performed in the anterior posterior projection, and the control examination was supplemented with lateral projection in some cases. Diagnostics were also supplemented with routine blood tests. In addition to standard tests (complete blood count, electrolytes, glucose, urea, activated partial thromboplastin, international normalized ratio) patients' arterial blood gases were immediately measured after admission, together with diagnosis of pneumothorax. Diagnostics were repeated during the patients' stay in hospital. Chest X-ray was usually repeated 1 and 2 days after the injury, and then 4, 7 and 14 days after it, respectively. Arterial blood gases were checked many times during the first days of hospitalization.

Evaluation of the results of the polytrauma treatment was performed. We took the main results of the management of pneumothorax into consideration.

Results

Unilateral chest injury was found in 17 patients (7 cases of right side, 10 cases of left side) and bilateral in 5 cases (tension pneumothorax in one side only). In 21 cases fracture of the ribs was revealed in radiological examination (tab. 2). In 1 case of chest stab wound pneumothorax was confirmed. The following other injuries were diagnosed within the chest in the examined group: 2 cases of paradoxical breath due to multiple bilateral rib fractures, 5 cases of a small hemopneumothorax, and 16 cases of lung contusion.

In each of the patients, immediately on admission, after diagnosis based on clinical symptoms, tension pneumothorax decompression was performed by pleural drainage. Lung decompression and improvement of the clinical condition of the patient were obtained in a few minutes after pleural drainage. In all cases it was necessary to apply pleural drainage due to pneumothorax from this time to day 5–8 of hospitalization. Then, further diagnostic and therapeutic procedures were continued (tab. 3). Short-term oxygen therapy (advanced trauma life support standard) was necessary for all patients. There was full normalization of respiratory parameters two hours after the drainage of the pleural cavity. The drain was removed after 5–8 days, and radiographic control confirmed complete lung decompression in this time. During treatment 16 patients were diagnosed with radiographic symptoms of lung contusion. The most important procedures were 2 cases of unsuccessful resuscitation. They were not the results of tension pneumothorax but of other polytrauma complications.

The treatment of patients in the study group included other injuries. In 19 cases tension pneumothorax was associated with polytrauma, and the described injuries included mainly head traumas – 13 cases and musculoskeletal injuries – 12 cases (tab. 4). Isolated thorax injuries were diagnosed in 3 patients. Multi-organ injuries were not treated

Table 2. **Number of fractured ribs in the examined group**

Number of patients with ribs fractures	21
Number of rib fractures (dominant side of injury)	
maximal	9
average	6.3

Table 3. **Treatment of thorax injuries**

Treatment of thorax injuries	Number of cases
Cavum pleurae drainage	22 (whole group)
Oxygen therapy	22 (whole group)
Rehabilitation	22 (whole group)
Antibiotic therapy	22 (whole group)
Artificial ventilation	7
Tracheostomy	5
Resuscitation	2

Table 4. **Injuries associated with lung injuries in patients with polytrauma**

Type of associated injuries	Number of cases in group
Head injuries	13 cases (including 3 serious injuries)
Craniofacial injuries	4
Spine injuries	3 cases (including 1 associated with paraplegia)
Haematoma of mediastinum	1
Abdominal injuries	6
Fracture of pelvis	3
Fracture of upper extremity	3
Fracture of lower extremity	3

Table 5. **Surgical treatment of injuries associated with other than respiratory system organs**

Type of surgical treatment of associated injuries	Number of cases
Craniotomy	1
Craniofacial fracture	1
Laparotomy	5
Surgical treatment of fractures of extremities	6

only in these cases. 10 patients at the time of injury and admission were intoxicated.

A head injury was diagnosed in 13 patients, but there was only one neurosurgical operation performed, which was decompression and removal of an epidural haematoma. The second patient with head injury died during the treatment due to complications such as contusion of the brain with multifocal intracerebral haematoma with intracranial oedema. 12 patients did not require surgery, and just monitoring using CT scans of the head was performed. Maxilla and zygomatic bone fracture was stabilized by plate in 1 case. Laparotomy was performed in 5 cases; 2 cases of complete spleen lesion were diagnosed within this examined group, and therefore splenectomy was obligatory. Partial lesion of the spleen and liver, which was found in one case, did not require splenectomy, and only haemostasis using argonisation was performed. In two cases injuries of the intestine were found. One of these cases was connected with spine injury and paraplegia. This patient died due to complications. Fractures of limbs were not treated conservatively, but in all cases were stabilized using locking compression plate or AO plates or intramedullar nails (tab. 5).

Chest pathology treatment was monitored through radiological examination in the study group. There was significant normalization of blood gas tests and other laboratory tests in 20 cases, with good results of management. In all patients tension pneumothorax absorption during therapy was observed. Firstly, the absorption of pneumothorax on the X-ray image in the first control radiographs was noticed. The full absorption of pneumothorax removing of lung contusion symptoms was observed in each of 20 cases after one month.

Full time of hospitalization due to polytrauma was on average 58.6 days (1–151). Good results of treatment were achieved in 20 cases. At the approximately 6-month follow-up period no recurrence of pneumothorax or other respiratory illnesses was revealed in these patients; 2 patients died during the treatment of these polytrauma, but pneumothorax was not the cause of death in either of the patients. There was partial disability of the central nervous system or movement system in 10 cases, but without correlations with the respiratory system.

Discussion

Thoracic injuries are one of the most common injuries, and pneumothorax is one of the most important of them [8]. The management of pneumothorax has been a complex problem since it was first described over 200 years ago [9].

The *scoop and run* rule

It is no longer true that any action at the accident site taken by doctors or paramedics is a waste of time. The vast majority of authorities in the field of trauma surgery agree that accident victims should be treated according to generally accepted rules, that is: *stay and play.* A clinical examination of the victim aims to identify critical illness conditions using the ABC scheme [10, 11, 12].

The authors of this paper believe that the most important idea is that in the case of post-traumatic tension pneumothorax diagnosis has to be made at the accident site as soon as possible. This diagnosis should be confirmed by clinical examination. This was observed in our study group. The most important symptoms of tension pneumothorax are: sudden chest pain, respiratory distress, shortness of breath, chest tightness, a bluish colour of the skin due to lack of oxygen, increased heart rate (tachycardia), low blood pressure, decreased mental alertness, decreased consciousness, rapid breathing (tachypnea), bulging (distended) veins in the neck, and displacement of the trachea from the affected side [11, 12, 13, 14].

Immediately after the diagnosis of tension pneumothorax decompression should occur. Some articles suggest that the diagnosis should be based on an extensive FAST ultrasound examination. Such proceedings are possible if the patient's condition allows it. The patient's hemodynamic efficiency is absolutely necessary in order to use such a standard [15]. Cardiac arrest in the asystole or isoelectric distraction mechanism may occur at the drop of this efficiency.

It has been advised in the publications concerning emergency medicine which have appeared in recent years that decompressive pleural puncture should be replaced with immediate drainage of the pleural cavity in tension pneumothorax. The authors of these publications think so because the puncture of the chest (thoracocentesis) cannot effectively decompress pneumothorax, but puncture can cause bleeding inside the chest, invisible only in the case of needle puncture. It is also debatable which is the best chest spot for needle puncture [16, 17, 18].

Simulation study using CT has not resolved the problem. Some authors believe that the safest place for puncture is the middle axillary line where the distance from the skin of the pleura is 7 cm. Some authors consider that there is less likelihood of damage to the structures important for life than in puncture in the middle – clavicular line. The distance from the skin to the pleura is on average 4 cm at pneumothorax decompression in the middle-clavicular line, so it is more probable that damage to the subclavian artery and large vessels can take place during this procedure with an increased probability [13, 16, 19]. However, these problems are not the observations of the authors of this article. We have the following standards: rapid decompression of the tension pneumothorax using a needle in the second intercostal space in the middle of the clavicular line, and drainage of the pleural cavity under the pectoral major muscle, between the anterior and medial axillary line in about the 4th intercostal space.

Some authors draw attention to the fact that the effectiveness of pleurocenthesis is determined by appropriate needle length [19, 20]. It is important to examine the decompression carefully, the characteristic hiss, and then X-rays and even CT, and not to act in the reverse order [21, 22].

However, some authors believe that this is unnecessary because of the needle exchange on drainage after its decompression control throughout radiological tests [16]. The authors of this article have the same opinion and principles.

Some authors believe that a needle should not be used in order to perform pleurocentesis and decompression of tension pneumothorax, but it should be done by making and leaving a hole in the chest wall and wall pleura [23].

In exceptional cases tension pneumothorax cannot be connected with a direct threat to life and hemodynamic failure. Viewing the case of 86-year-old patients with efficient hemodynamic tension pneumothorax in the literature is something exceptional, but is certainly not a rule [11].

Bilateral tension pneumothorax always requires the immediate drainage of the pleural cavity, while pleurocenthesis does not protect the patient against respiratory failure and cardiac arrest on its own [12, 24].

The precise and accurate evaluation of the described cases requires an analysis of each case of polytrauma. This is not the subject of this paper. We would like to draw attention to the appropriate treatment of tension pneumothorax on the background of occurring polytrauma. We would like to note the importance and effectiveness of advanced life support and advance trauma life support principles concerning decompression of pneumothorax.

Conclusion

In summary, the therapeutic standard ordering of tension pneumothorax decompression directly on admission to the hospital allows the patient to survive in spite of the grave nature of the injury. Conflicts of Interest: The authors declare no conflicts of interest in relation to this article.

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