Multiple organ failure after a fall from heights complicated by cardiac rupture and subacute cardiac tamponade

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ABSTRACT

Accidents and posttraumatic injuries are one of the most important health and social problems. Most of them require immediate medico-surgical intervention. Accidents are the leading cause of death among young people under age of 40. In 25% of cases they lead to disability. Fall from height causes inter alia blunt chest trauma, and internal organs contusion (e.g. heart and lungs), and may be fatal to substantial number of trauma victims. Excluding criminal injuries, this kind of trauma may occur during accidental fall or deliberate suicide attempt. Paper describes polytrauma victim who fell down from the eight floor (suicide attempt). Subacute pericardial tamponade, caused by cardiac wall rupture, occurred several hours after accident. The patient survived polytrauma with severe cardiac injury complication thanks to effective multidisciplinary and multistage surgical treatment.

Key words: multiple organ failure, fall from heights; multiple organ failure, thoracic contusion, blunt cardiac injury; thoracic contusion, pericardial tamponade

INTRODUCTION

Accidents and resultant injuries are considered one of the major health and social problems. The majority of emergency medical interventions are attributable to them. Moreover, they are the main cause of deaths of individuals under the age of 40 years and lead to disability in 25% of cases. Falls from heights often induce blunt thoracic and cardiac injuries which mortality rates are high. Besides criminal cases, such injuries result from accidents or attempted suicides.

The present report describes a case of multiple organ failure caused by a fall from heights (suicidal attempt). During the early post-accident period, the patient developed subacute cardiac tamponade resulting from cardiac rupture.

Despite the large extent of injury and severe circulatory complications, multidisciplinary and multistage treatment yielded good results.

CASE REPORT

A 30-year-old man was admitted to hospital due to multiple organ failure caused by a fall from heights (the eighth floor of an apartment block). According to the history taken from family members, the patient suffered from schizophrenia treated for many years and it was his second suicidal attempt.

Immediately after the accident, the patient was conscious, with the GCS score of 14, and remembered the trauma circumstances but was agitated. Arterial blood pressure ranged from 110/60 to 130/80 mm Hg, and heart rate was 80–85 min⁻¹. At the accident scene, paramedics immobilized the cervical spine with an orthopaedic collar. The victim received fentanyl 0.1mg i.v. and the infusion of 1000 ml of 0.9% NaCl was initiated. During transport and in the hospital emergency department, the patient breathed spontaneously and calmly (16–17 respirations min⁻¹) via the oxygen mask; his blood pressure was stable, pulse regular and oxygen saturation normal. The abdomen on light palpation was tender and there was no bowel sounds. Diuresis was maintained (urine output from a catheter — 80–150 mL h⁻¹). The patient did not sustain any injuries to the urinary system (US); no urinary haemorrhage was observed. The single-
-phase whole-body CT trauma scan revealed numerous fractures of the facial skeleton, spine and thorax as well as foci of lung and liver contusion. No injuries to the central nervous system (CNS) and limbs were found.

The detailed results of diagnostic imaging tests are present in Table 1.

Based on the clinical picture and laboratory tests, the patient’s condition and prognosis were assessed using the following scales: the Glasgow Coma Scale (GCS) — 14 pts., Injury Severity Score (ISS) — 66 pts., Revised Trauma Score (RTS) — 7.841 pts. According to the Trauma Injury Severity Score (TRISS), the risk of death was estimated at 40.6%.

Both pleural cavities were drained. The thoracic X-ray taken after pleural drainage demonstrated the enlarged cardiac silhouette.

Following neurosurgical, surgical and orthopaedic consultations, laparotomy was decided to be most urgently required. The spine was temporarily immobilized with the Camp collar.

The CT scan of CNS did not indicate that urgent neurosurgical interventions were necessary; the patient’s orthopaedic condition was not life threatening and surgical repair was postponed. The patient gave the informed consent for surgery and anaesthesia. He was assigned to group IV (E) according to the ASA classification. General, combined anaesthesia was provided with intravenous and inhalation (sevoflurane) anaesthetics. During rapid sequence induction of anaesthesia and intubation, the patient’s condition was stable. Intraoperatively, five ruptures of the right hepatic lobe through the segments 6, 7, 8 were found. Hepatic packing was performed. The drains were left in the peritoneal cavity. The patient was intraoperatively transfused with two units of red cell concentrate (RBC) and two units of fresh frozen plasma (FFP). During surgery, arterial blood pressure was 115–130/55–75 mm Hg, pulse 75–110 min⁻¹. SpO₂ 95–99%. Catecholamines were not infused. To prevent infections, cefo-

6 to 9 cm H₂O, whereas body temperature — 36.0–36.4 ºC. Ultrasound (USS, ultrasound scan) findings excluded abdominal haemorrhage. The emergent echocardiography was performed showing cardiac tamponade caused by bleeding to the pericardial sac. SpO₂ 95–99%, FiO₂ was 50%, a cannula was introduced using the Seldinger technique and left in the pericardial space as a drain. In total, approximately 500 ml of blood were drained. The heart rate, arterial blood pressure and CVP were normalised. The patient was transferred to the Department of Cardiac Surgery for surgical treatment; during thoracotomy, the right ventricular muscle was found ruptured on the “diaphragmatic” margin towards the apex and was surgically repaired. The patient stayed in the Department for 2 days and then was transferred to the ICU. After surgery, haemorrhage to the pericardial sac was not observed (confirmed echocardiographically). During the subsequent days, the patient underwent two laparotomies to remove perihepatic packing the drapes left around the liver. The first laparotomy revealed bleeding from the hepatic parenchyma; re-packing was carried out, which was ultimately removed during the second laparotomy (after 48 hours). Neither surgical nor anaesthetic procedures adversely affected the heart action. The patient required mechanical ventilation support (FiO₂ = 0.3–0.8; PEEP 4–10 cm H₂O) and drainage suitable to the dynamics of lung contusion sequels. His neurological state was assessed on everyday basis – no paresis or other

<table>
<thead>
<tr>
<th>Table 1. Posttraumatic injuries and results of tests carried out in the Emergency Department</th>
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<tr>
<td>Fractures</td>
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<tr>
<td>Spine</td>
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<td>Chest</td>
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<td>Concussions</td>
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<td>Liver</td>
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transferred to the ICU. Analgesedation was provided. The patient was mechanically ventilated (PaO₂/FiO₂ — 482.5), his circulation was efficient (arterial blood pressure 120–130/60–70 mm Hg, heart rate 80-110 min⁻¹). Diuresis was maintained. The test results on ICU admission are present in Table 2. On admission, ECG was normal (including the leads V₃₃–₄₄; the levels of troponin I and CK-MB were elevated, which could have been suggestive of cardiac contusion.

The patient’s APACHE II score was 12, SOFA score — 5 and TISS 28 — 49.

In the immediate post-operative period, the patient received 2 units of FFPs and 2 units of RBC.

About 15 h after trauma, the arterial pressure decreased to 80–90/40 mm Hg, heart rate accelerated, initially to 120–140 min⁻¹ and further to 170 min⁻¹, and CVP increased from 8 to 18 cm H₂O. The ultrasound (USS, ultrasound scan) findings excluded abdominal haemorrhage.

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trauma-related neurological consequences were observed. Based on the psychiatric consultation, antipsychotic therapy was instituted (haloperidol i.m. in a total daily dose of 40 mg and oral valproic acid — 1500 mg). During weaning from the ventilator, the patient developed symptoms of opioid withdrawal syndrome (excitation agitation, tachycardia, tachypnoea, drenching sweating), which were successfully controlled with the continuous infusion of clonidine (0.5–1.0 µg kg b.w.-1 h-1). The circulation was efficient, no heart rhythm and conduction disturbances were observed. One week later, mechanical ventilation was discontinued and the patient was extubated. Deficiencies of coagulation factors and albumins were supplemented until the liver resumed its full function. The intestinal passage was preserved; except for a short post-laparotomy period, the patient was fed enterally. No renal dysfunction was noted. The symptoms of opioid withdrawal syndrome subsided after 5 days of treatment with clonidine. The patient was conscious, calm, and responsive; no suicidal intentions or thoughts were noticed. He was discharged from ICU to the Department of Orthopaedics for conservative treatment of cervical and thoraco-lumbar spine fractures. The patient was provided with psychiatric surveillance; once the orthopaedic therapy was completed, he was transferred to the regional psychiatric hospital.

**DISCUSSION**

In Poland, injuries are the third leading cause of deaths, after cardiovascular diseases and cancers. Annually, injury-related deaths amount to about 30 thousand, with predominance of road traffic injuries [1]. Falls from heights can be of criminal nature yet most of them result from accidents or suicidal attempts, as in our case, which was the patient’s second attempted suicide. The majority of studies dealing with these issues analyse in detail the extent and patterns of injuries according to fall height, rate of falling and place of impact. The literature data are inconclusive as to the fall height that always results in death. Most findings suggest that the fifth/sixth floor falls usually cause death. However, survival cases were also reported after falls from higher heights, unless the victim had hit the hard ground (concrete, pavement). The overall mortality ranges from 22.7% to 37.6% [2]. Our patient survived the fall from the eighth floor without severe fall-attributable disability.

Severe head trauma is an unfavourable prognostic factor in patients after falls from over 6 metres [2]. Better prognosis in the case presented was most likely associated with the fact that the patient did not sustain severe injuries to the central nervous system and remained conscious until arrival to hospital (GCS 14). The only head injuries were fractures of the facial bones (nasal bone and bony nasal septum).

Falls from heights and traffic accidents are the main causes of spine and spinal cord injuries. The incidence of such injuries is 22% to 54%, including 2–5% of spinal cord injuries. Generally, such injuries are diagnosed in patients in the fifth and sixth decade of life, mainly in men; in 15–46% of cases, victims are mentally ill. Most injuries affect the thoraco-lumbar junction; injuries to the cervical, thoracic and lumbar spine are rarer [3]. The spinal injuries in such patients are often associated with numerous short-term complications but mostly with long-term disability, resulting in prolonged hospitalisation and higher costs of treatment [4]. In the case described, the patient sustained cervical and thoracic spine injuries that did not require surgical repair and were stabilised externally. The patient did not have any damage to the upper and lower limbs, which is most commonly found after falls from heights.

Blunt thoracic injury is common after falls from heights — 66% of victims are affected [5]. The extent of thoracic injury can be used to assess the force acting during trauma, e.g. the number of fractured ribs shows the relative value of the driving force whereas the topography of fractures can demonstrate the directions the force applied spreads. Falls from more than 7 metres are...

**Table 2. Physiological and laboratory parameters of the patient on ICU admission**

<table>
<thead>
<tr>
<th>Physiological parameters</th>
<th>CNS</th>
<th>CVS</th>
<th>RS</th>
<th>GIS</th>
<th>US</th>
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</thead>
<tbody>
<tr>
<td>Blood tests</td>
<td>WBC 10.12 G L⁻¹</td>
<td>HGB 110 g L⁻¹</td>
<td>RBC 3.31 T L⁻¹</td>
<td>HCT 32.5%</td>
<td>PLT 179 G L⁻¹</td>
</tr>
<tr>
<td>Coagulogram</td>
<td>INR 1.4</td>
<td>APTT 31.8 sec</td>
<td>prothrombin time 19.86 sec</td>
<td>fibrinogen 2.1 g dL⁻¹</td>
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</tr>
<tr>
<td>Biochemistry</td>
<td>troponin I 0.35 U L⁻¹</td>
<td>CK-MB 62 U L⁻¹</td>
<td>AST 889 U L⁻¹</td>
<td>ALT 1035 U L⁻¹</td>
<td>lactates 2.4 mmol L⁻¹</td>
</tr>
<tr>
<td>Diagnostic imaging</td>
<td>Chest X-ray: enlarged heart, poorly efficient circulation, lungs without inflammatory densities, smooth contours of diaphragmatic domes</td>
<td></td>
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<tr>
<td>procedures</td>
<td>ECG nomogram: regular sinus rhythm of 86 min⁻¹</td>
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SAS — Sedation Agitation Scale
likely to cause injuries to two or more thoracic organs with concomitant injuries to thoracic bones. Lung damage is observed in about 35% of fall victims. Our patient sustained typical injuries related to blunt thoracic trauma: bilateral pneumothorax and slight contusion of both lungs. His injuries required typical treatment, i.e. pleural drainage and mechanical ventilation using low PEEP.

The most common form of cardiac injury is its concussion, occurring in about 27% of patients after blunt thoracic trauma. The literature data regarding the incidence of myocardial rupture following blunt thoracic trauma are scarce as this kind of injury usually results in death. The case presented by us was the first post-traumatic cardiac rupture with positive outcome observed in our ICU during the period of over 20 years [6]. The findings of earlier studies demonstrate that the incidence of blunt cardiac rupture in trauma patients admitted to hospital ranged between 0.16 and 2% (according to autopsy findings — to 16%) [5, 7]. In our patient cardiac tamponade was subacute. The first symptoms, manifested in impaired circulatory efficiency, developed on day 2 of ICU stay. The echo-disclosed thrombi might however indicate that slight, self-limiting haemorrhage occurred earlier, which was likely to be evidenced by the enlarged heart silhouette visible on the thorax X-ray. The agitation the patient responded with to decreased sedation administered to assess his neurological state, might have led to thrombus detachment resulting in cardiac tamponade. The echo-guided placement of the drain improved the circulatory efficiency and enabled safe transport of the patient to the Department of Cardiac Surgery. The elevated levels of troponin I and tachycardia observed on the first post-injury day are suggestive of cardiac contusion as the symptoms are known to be poorly characteristic and therefore are sometimes called “the capricious syndrome” [8]. Blunt cardiac trauma can increase cardiac susceptibility to circulating catecholamines or inhalation anaesthetics [9]. Our patient received various anaesthetics during multiple anaesthetic and medical procedures, yet during none of them paroxysmal arrhythmia, conduction disorders or ECG changes were observed.

Blunt injuries to abdominal organs often cause haemorrhagic shock. Fall from heights, as any trauma caused by rapid deceleration and inertia forces, can result in injuries to internal organs. The mechanism of such injuries is attributable to partial tearing of these organs, which can move freely. When the body movement is rapidly stopped, the internal organs remain in quick motion for a split second or are crushed by other, rigid body parts, such as the spine and ribs.

In the case described, the right hepatic lobe was ruptured and was initially surgically secured during emergent exploratory laparotomy and two re-laparotomies.

Several factors appear to have affected the beneficial outcome of treatment of the patient who had fallen down from the height of about 24 metres. The first and well-known favourable prognostic factor in post-traumatic patients is age. Anatomical and physiological changes progressing with age markedly affect the type and severity of injuries. Therefore, the majority of researchers consider the old age an independent prognostic factor of death after falls from heights [2, 10]. Moreover, the fall surface is crucial. According to French authors, the mortality following falls onto hard surfaces was 59% compared to 19% in falls onto soft surfaces; the kind of surface and not the height was the prognostic factor in the group of patients studied [11]. In our case, the fall took place in January when the ground the patient fell onto was covered with snow, which absorbed the impact. The location of injuries to internal organs (right hepatic lobe, right ventricle) suggests that the right costal arch was likely to be the ground impact point. Another positive prognostic factor was the lack of injuries within the central nervous system.

Noteworthy, the ambulance team worked effectively and diagnostic imaging procedures were early instituted. Moreover, cooperation of the multidisciplinary team of specialists was essential, who undertook multistage therapy using the damage control method.

References:


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