Emergency Medicine: Open Access
ISSN: 2165-7548

Kleber and Tille, Emergency Med 2018, 8:2
DOI: 10.4172/2165-7548.1000371

Case Report Open Access

Primarily Successful Resuscitation of Traumatic Aortic Rupture after high-Energy Car Accident: A Case Report

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Abstract

We present the case of a 54-year-old male involved into a high-impact car accident as driver of a transport van suffering traumatic aortic rupture and primarily successful resuscitation. The casualty presumably missed the ending of a traffic congestion and crashed into the rear of a semitrailer leading to entrapment of his abdomen between the steering wheel and the driver's seat. After technical salvation the initial trauma load and injury severity of the patient was misjudged. HEMS was consulted 65 minutes after the accident finding the patient placed in a supine position developing progressive loss of sensitivity of the lower extremities and hemodynamically in extremis condition. In the course of events traumatic cardiac arrest due to hypovolemia resulted and extensive resuscitation was performed. An emergency sonography displayed free abdominal fluid, raising the suspect of abdominal hemorrhage. The patient was admitted to a level 1 trauma center with "vita minima" due to exsanguination (Hb 1,1 mmol/l, lactate 16 mmol/l). The full body computed tomography (CT) confirmed multiple abdominal vascular injuries, aortic transection with auto tamponade due to intima roll in, thoracic trauma with bilateral hematopneumothorax and multiple musculoskeletal injuries. Laboratory analysis revealed a complete clotting breakdown. After 4 days in hospital the patient died due to hypoxic brain damage and intracranial hemorrhage.

The purpose of this case report is to underline the importance of emergency tactic, correct estimation of trauma load and the power of new prehospital algorithms for traumatic cardiac arrests including invasive emergency measures.

Keywords: Traumatic aortic rupture; Injury; Prehospital trauma; Symptoms; Traumatic aortic injury

Abbreviations

A: Arteria; AHA: American Heart Association; AMPT: Air Medical Prehospital Triage; aPTT: Partial Thromboplastin Time; Bpm: Beats per minute; BTAI: Blunt Traumatic Aortic Injury; CPR: Cardiopulmonary resuscitation; CT: Computer Tomography; ERC: European Resuscitation Council; EVAR: Endovascular Aortic Repair; eFAST: Extended Focused Assessment with Sonography in Trauma; EP: Emergency Physician; $etCO_2$: expiratory Carbon Dioxide; GCS: Glasgow Coma Scale; Hb: Hemoglobin; HEMS: Helicopter Emergency Medical Services; Hk: Hematocrit; INR: International Ratio; i.v: intravenous; mg: milligram; min: minute; minutes ml: millilitre; mmHg: millimeter of mercury; PEA: Pulseless Electric Activity; ROSC: Return of Spontaneous Circulation; SBP: Systolic Blood Pressure; sTBI: severe Traumatic Brain Injury; TAI: Traumatic Aortic Injury.

Introduction

Over the last decades the number of car accidents with fatal and non-fatal victims in Germany has been declining constantly. Higher safety standards, medical innovation, standardized trauma management and regulatory measures (i.e. speed limitations) make driving generally safer, reduce the incidence of severe injuries and improve survival and outcome [1,2].

Yet there is still a high risk for life-threatening injuries, especially in high-energy deceleration trauma as described in the underlying case. High-energy trauma primarily causes damage to the musculoskeletal system, but also - and even more life-threatening harm internal organs and major vascular structures such as the aorta. This is posing a particular threat to the patient and requires for absolute awareness of the emergency responder, since undetected injuries can contribute to an unexpected and severe worsening of a patient's condition with a potentially lethal outcome [3]. As multiple former studies have proven in severely injured patients appropriate prehospital resuscitation combined with immediate transportation to a level-one trauma center is crucial for survival [4]. Studies revealed the positive effect of helicopter emergency medical services (HEMS) [5,6].

The purpose of this case report is to describe how powerful modern prehospital trauma management can be, to sharpen the focus for blunt traumatic aortic injury (BTAI) as a life-threatening condition, to underline the role of correct estimation of trauma load, to describe the effect of prehospital emergency ultrasound on operational tactics and to emphasize the advantages of fast HEMS transportation after high-impact trauma.

Case Presentation

The patient described in this case report is a 54-year old male who suffered from a severe car accident crashing with his unbraked transport van (Mercedes Sprinter) into a semitrailer at the end of a traffic congestion. The accident took place on the highway of a rural area. The patient was trapped with his abdomen between the driver's seat and the steering wheel. Bystanders called emergency services and were able to free the driver and move him into supine position by tearing down the metal partition wall between passenger and transport compartment using tension belts. Finally, the fire department was able to rescue the driver of entrapment from the vehicle and transferred him to the ambulance.

The first, ground based emergency physician (EP) arrived

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Received June 30, 2018; **Accepted** July 17, 2018; **Published** July 23, 2018

Citation: Kleber C, Tille E (2018) Primarily Successful Resuscitation of Traumatic Aortic Rupture after high-Energy Car Accident: A Case Report. Emergency Med 8: 371. doi:10.4172/2165-7548.1000371

approximately 15 minutes after the accident. At this point the patient presented with a systolic pressure of 105/40 mmHg, a regular heart rate and full consciousness. Analgosedation and volume resuscitation were administered. In the course of the events the patient described an increasing loss of sensitivity in the lower extremity. Furthermore, a progressive cardiopulmonary destabilization was observed. After 53 minutes due to the combination of the aforementioned symptoms HEMS was requested in order to provide quick transportation to a level-one trauma center.

The HEMS landed 65 minutes after the initial trauma at the scene of the accident. On arrival of HEMS the now agitated patient displayed an insufficient hemodynamic situation with a systolic blood pressure of 70mmHg, heart rate of 120 beats per minute and respiratory rate of 28/min with unmeasurable oxygen saturation. The mentioned vital parameters were accompanied by slightly faint breathing sounds on both sides, flail chest and reduced consciousness (GCS 8). Furthermore, a well definable marbling of the skin starting just underneath the mammillary line spreading over the entire thorax and extending distally without palpable pedal pulse was observed (Figure 1).

At this point the ground-based EP had established two i.v. lines, administered 1000 ml of crystalloids, analgosedation with ketamine and midazolam, cervical spine protection and oxygen supply.

Due to respiratory insufficiency the patient was immediately assisted ventilated and intubated with 0.2 mg Fentanyl and 15 mg midazolam. Correct tube placement was verified via expiratory carbon dioxide ($etCO_2$) measurement (highest 14 mmHg), underlining the critical physical state of the patient. Due to massive trauma 1 g tranexamic acid was administered to prevent potential hyperfibrinolysis. Soon the patient required high ventilation pressures leading to the suspicion of a pneumothorax. Simultaneously the patient presented with pulseless electric activity (PEA) 80 min post trauma. Cardiopulmonary resuscitation was started immediately and chest decompression via minithoracotomy and chest tube placement was performed. Shortly after beginning of the resuscitation and administration of 1mg adrenaline return of spontaneous circulation (ROSC) with palpable carotid pulse, $etCO_2$ 14 mmHg, spO_2 76% and not absent blood pressure occurred. However, the patient was still instable and had repetitive PEA within the next minutes. An extended focused assessment sonography (eFAST) revealed an empty left ventricle with massive free abdominal fluid. In combination with the absence of pedal

Figure 1: Marbling of the skin after blunt aortic trauma in a similar patient due to reduced perfusion.

pulse and marbled skin the suspected diagnosis of aortic injury with major bleeding was assembled. The concept of permissive hypotension with maintenance of minimal circulation to minimize blood loss was established and the EP aimed for urgent admission to a level 1 trauma center for emergency surgery. Due to repetitive PEA with intermittent CPR, volume substitution and catecholamine therapy (adrenalin bolus and continuous administration) the transportation via helicopter was delayed until 126 min after trauma. Finally, the patient arrived 145 min after trauma at the level 1 center. Upon arrival the patient had stabilized and presented with a sufficient circulation. In total 3000 ml of crystalloids and 15mg adrenaline were administered prehospital.

Blood gas and biochemical analysis emphasized the injury severity and in extremis situation displaying an extreme anemia (hemoglobin (Hb) 1,1 mmol/l, hematocrit (Hk) 0,06%, a thrombocytopenia (11 Gpt/l), complete coagulation breakdown (Quick <2%, aPTT > 180s, INR >4.0, Fibrinogen <0.41 g/l, factor XIII 15% i.P.), lactate acidosis (lactate 16 mmol/l) and increased myoglobin (1491 µg/l) as well as D-dimer (>4000 ng/ml) levels. Enhanced whole body computed tomography (CT) revealed an insufficient perfusion of the abdominal organs due to rupture of the truncus hepatomesentericus, traumatic dissection of the arteria (A.) mesenterica superior and the infrarenal part of the aorta abdominalis. The intima tear caused an obstruction (auto-tamponade) of the left distal A. iliaca communis and the complete A. iliaca externa. The right A. iliaca communis and the A. renalis presented with low to missing contrasting. In addition, massive amounts of free air and multiple perforations of the small intestine and the colon were detected. Also, the CT-scan displayed a pneumothorax and serial rib fractures (costa 4-9 right; costa 1, 4-9 left) on both sides and a multifragmentary fracture of the distal femur and the patella bone (Figure 2).

After emergency management with mass transfusion protocol an endovascular aortic repair (EVAR) of the Aorta abdominalis with stenting of the A. iliaca communis was performed. Subsequently followed damage control surgery of the intestines (clip and drop) with abdominal packing, external fixation of the femur fracture and dermatofasziotomy of both legs. In the course of the events, the patient underwent multiple further surgical procedures and critical care treatment. Sadly, due to hypoxic brain damage with intracranial hemorrhage, the patient died on the 4th day after trauma (Figure 3).

Discussion

We present a case of massive major vascular trauma and primarily successful resuscitation after traumatic cardiac arrest. This emphasizes the power of new algorithms and modern prehospital trauma management giving even patients with aortic tear a survival chance. Despite the primarily successful management especially primary operation tactic, underestimation of injury severity and delayed alerting of HEMS occurred in this case. This inspired us to present the case in order to sensitize for the topic of major trauma in the preclinic and to motivate emergency personal to provide invasive medical measures and apply modern prehospital trauma management strategies. Studies of our working group (AG Polytrauma) revealed good outcome after traumatic cardiac arrest, proposed the first prehospital algorithm for traumatic cardiac arrest and moved in international (AHA, ERC) resuscitation guidelines [2].

The primarily successful management of our case highlights the power of this new management strategies even in situations appearing hopeless. The outcome of traumatic cardiac arrest cannot certainly be allocated in preclinical setting. Therefore, CPR should be provided even confronted with situations with definitive clinical death signs [7].

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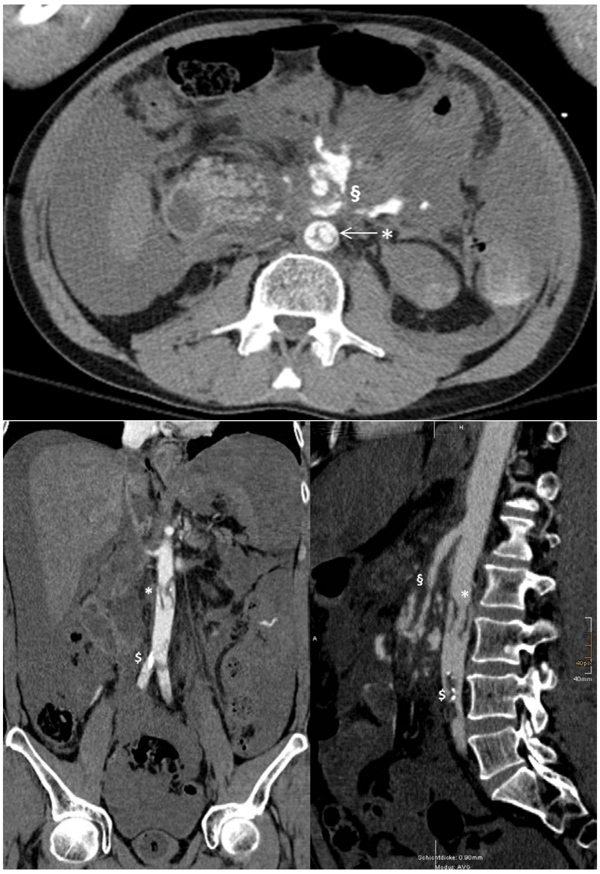

Note*: Infrarenal Dissection of the A. abdominals with dissection membrane. §: Dissection membrane clotting the left A. iliaca communis. §: Traumatic rupture of the Arterie mesenterica superior

Figure 2: Excerpt of the initial CT-scan.

Prehospital classification of the injury severity is not reliable and has a low sensitivity and specificity. In our case the patient was entrapped at the belly with seat belt sign. After technical rescue the patient`s blood pressure dropped. The injury severity and major internal bleeding was misjudged by the primary EP, leading to delayed alert of HEMS. Beside the time benefit of air rescue regarding transportation to level 1 trauma centers in rural areas, HEMS also provides survival benefit for trauma patients [8-10]. Studies have shown that survival time is also being improved by usage of a correct emergency tactic. Especially in rural areas patients admitted to hospital via HEMS tend to have a better outcome, even if initially presented with a worse overall condition [8,9,11]. In order to identify cases in which HEMS should be considered different scoring systems have been developed to help the emergency responder. Exemplary the Air Medical Prehospital Triage score (AMPT) is listed in Table 1 [12].

Therefore, HEMS should be alerted primarily in rural areas by the rescue coordination center, especially in high energy trauma with entrapped patients presenting with high risk of internal bleedings. Patients with internal bleeding or major vascular trauma as seen in our case are endangered from exsanguination. Therefore, these rescue missions are time critical. Uncrucial or not indicated medical measures should be waived in favor of rapid clinic admission. Otherwise, lifesaving procedures like chest decompression in tension pneumothorax, intubation and ventilation in severe traumatic brain injury or external bleeding control have to be performed [13,14].

Additionally, we suggest a new understanding of modern prehospital trauma management, the "golden period of trauma" with patient tailored decision making referring "scoop and run" vs. "stay and play" [10]. Furthermore diagnostic means, such as sonography (if available) can help strengthen the suspected verdict and have an important impact upon the medical decision making (volume management, selection of hospital, etc.) [15].

High-energy trauma such as car accidents can result in fatal aortic injury in up to 10% [16]. Therefore, injury of the aorta must be considered in prehospital emergency treatment in these cases of accident. While traumatic injury of the thoracic aorta is the more common (especially in the Isthmus area) entity, traumatic aortic injury (TAI) of the abdominal aorta also poses a threat to patient's life. Blunt traumatic aortic injury (BTAI) and resulting exsanguination – even though overall being rare - is one of the most common causes of death in trauma patients (9,5%) following polytrauma (45,7%) and severe traumatic head injury (38%) [17,18].

The primary mechanism for BTAI are car accidents and motor vehicle crashes accounting for more than 70% of the cases. Especially trauma involving high collision forces (i.e. impact against roadside-fixed objects) can result in traumatic aortic injury [19]. The kind of accidents rapid deceleration in combination with chest or abdominal compression induce torsional and shearing forces that result in transverse laceration and finally rupture of the aorta and/or other abdominal vessels [20,21]. Only 20% of these patients even reach a trauma center. Another 50% die within the first 24 hours [17,22]. Therefore, immediate diagnosis, treatment and transport of the patient to an adequate trauma center is essential for survival. Bleeding

Figure 3: Patient after initial surgical treatment at the intensive care unit.

Air Medical Prehospital Triage Score (AMPT)	
Criterion	**Points**
Glasgow Coma Scale <14	1
Respiratory Rate <10 or >29 breaths/min	1
Unstable chest wall fractures	1
Suspected hemothorax or pneumothorax	1
Paralysis	1
Multisystem trauma	1
physiologic + anatomical criterion *	2
Consider helicopter transport if AMPT score ≥ 2 points	
* any 1 physiologic criterion plus any 1 anatomic criterion present from American College of Surgeons Committee on Trauma national field triage guideline (Table 2) [13].	

Table 1: Air medical prehospital triage score [12].

criterion	Item
physiologic	SBP <90 mm Hg, GCS score ≤ 13, Respiratory rate <10 or >29 bpm
anatomic	Penetrating injury to head, neck, torso, extremities (proximal to elbow and knee); chest wall instability (flail chest); ≥ 2 proximal long bone fractures; rushed, degloved, mangled or pulseless extremity; open or depressed skull fractures; pelvic fracture; amputation; Paralysis; Multisystem trauma
Mechanism of injury	Fall >6 meter; high-risk car crash with intrusion, ejection (partial or complete) from automobile, death in same passenger compartment and/or vehicle telemetry data consistent with a high risk for injury; automobile versus pedestrian/bicyclist thrown, run over, or with significant (>30 km/h) impact; or motorcycle crash >30 km/h
Special consideration	Age >55 years; children; known anticoagulants and bleeding disorders; burns; pregnancy (>20 weeks)

Table 2*:* Severe trauma criteria as described in the Guidelines for field triage of injured patients by the American College of Surgeons Committee on Trauma, 2011 [13].

control in the prehospital setting is usually not possible. Therefore, in absence of neurotrauma (sTBI, spinal cord injury) the permissive hypotension concept within the damage control resuscitation protocol and prevention or therapy of hyperfibrinolysis via tranexamic acid administration are the only feasible medical measures.

Traumatic injury of the aorta always needs to be considered after high-energy trauma. Patients usually present with a severe hemodynamic instability including hypotension (systolic blood pressure (SBP) <90 mmHg), increased or decreased respiratory rate, tachycardia and hypoxemia which can hardly be controlled and is therefore often described as “meta-stable” (patients respond to fluid resuscitation and then present with a drop in blood pressure in a cyclical manner). In addition, BTAI of the abdomen can be accompanied by abdominal pain and/or resistance, hematoma, cold and clammy skin, anxiety, anemic skin tone or marbling of the skin and loss of function of supplied body areas. In complete ruptures there is almost always a cardiac arrest and the need for resuscitation. It is important to note that stable vital signs do not rule out aortic injury since incomplete ruptures can cause only minor bleedings or tamponade itself temporarily [3,23]. Multisystem trauma and accompanying injuries (i.e. pelvic fracture, flail chest) are associated with severe trauma and occur regularly associated with BTAI [24]. Table 2 is displaying tested criteria that has proven valuable in the prehospital diagnosis of aortic injury [13].

Conclusion

Blunt and high-impact abdominal trauma can lead to traumatic abdominal aortic injury – an injury that is representing a severe threat to the patient’s life if not managed correctly. Even though preclinical management can prove to be extremely difficult in extremis situations with a “vita minima” or already present clinical signs of death (as shown in our case) do have a chance of survival. In order to better these chances quick transportation to an adequate level one trauma center is essential. Unnecessary or not lifesaving measures should be waived by the emergency physician. This requires a sharp situational awareness, correct estimation of the initial trauma load and an uncompromising decision-making to allow for quickest possible transfer. Standardized algorithms (i.e. regarding the treatment of traumatic cardiac arrest and evaluation of transportation mode) can help the emergency physician in this straining process. HEMS is – when available – the most effective mode of transportation with an increased long-term outcome and should therefore be used primarily in high-energy trauma, especially if polytraumatic injury, severe traumatic brain injury or blunt traumatic aortic injury is suspected.

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