

Emergency department sternotomy – report of a case with indications and technique overview

Hitna sternotomija u hitnom bolničkom prijemu – prikaz slučaja s pregledom indikacija i kirurške tehnike

Antoine Council, Jakov Mihanović, Emilio Dijan, Laurine Paquier, Ivan Bačić*

Summary

The Emergency Department thoracotomy and Emergency Department sternotomy are solutions of the last resort for traumatic cardiorespiratory arrest. Time is the most important factor in terms of survival and sparing potential neurological damage, therefore surgery should not be delayed as it can be done in an emergency room, intensive care unit or in the operating room. We will present a case of a 45-year-old man with a knife stab in his chest and cardiorespiratory arrest during transport in ambulance. Upon arrival at the Emergency Department, sternotomy was performed followed by decompressive pericardiotomy and cardiorrhaphy with successful and uneventful recovery. We will discuss the indications, necessary equipment and surgical technique.

Key words: thoracotomy, sternotomy, emergency departments, thoracic injuries, resuscitation

Sažetak

Hitna torakotomija i hitna sternotomija predstavljaju očajničke zahvate u pokušaju spašavanja života bolesnika s traumatskim kardiorespiratornim arestom. Kako je vrijeme odlučujući čimbenik za preživljenje, zahvat se pod određenim uvjetima može napraviti u Objedinjenom hitnom bolničkom prijemu (OHBP), Jedinici intenzivnog liječenja ili operacijskoj dvorani. Prikazati ćemo slučaj 45-godišnjeg bolesnika s ubodnom ranom nanesenom kuhinjskim nožem u desnu parasternalnu regiju i kardiopulmonalnim arestom tijekom transporta u vozilu hitne medicinske pomoći. Odmah po dolasku u Objedinjeni hitni bolnički prijam indicirana je i učinjena hitna medijana sternotomija i perikardiotomija s dekompresijom srčane tamponade, te kardiorafija ubodne rane desne klijetke, nakon čega je uslijedio dramatičan oporavak hemodinamskog statusa. Poslijeoperacijski oporavak prošao je bez infekcije kirurške rane i bez neuroloških posljedica. U našem radu raspravljamo o indikacijama za hitnu torakotomiju/sternotomiju, potrebnoj opremi, te samoj kirurškoj tehnici.

Ključne riječi: torakotomija, sternotomija, hitni prijam, ozljede prsnoga koša, resuscitacija

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Introduction

The Emergency Department thoracotomy (EDT) and Emergency Department sternotomy (EDS) are controversial but potentially life-saving surgical procedures. Opening the patient's chest represents the ultimate measure in an effort to save a human life. Although considered standard in elective cardiac

surgery, emergency sternotomy is seldom performed and reported. The indications for EDT and EDS are still considered controversial due to a low survival rate, considerable costs and potential exposure of personnel to infectious diseases. The necessary equipment should be available in every emergency room, and surgical trainees should be familiar with the indications and surgical technique.

* **School of Medicine, Claude Bernard University Lyon, France** (Antoine Council, student; Laurine Paquier, student); **Zadar General Hospital, Department of surgery, Croatia**, (Jakov Mihanović, MD; Emilio Dijan, MD; Ivan Bačić, MD, PhD); **University of Zadar, Department of health studies, Croatia** (Jakov Mihanović, MD; Ivan Bačić, MD, PhD)

Correspondence address / *Adresa za dopisivanje*: Jakov Mihanović, dr. med., General hospital Zadar, B. Peričića 5, 23000 Zadar, Croatia Tel. +385 23 505 283; E-mail: mihanovic@gmail.com

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Case presentation

In the evening hours, an ambulance brought in a 45-years-old male to the Emergency Department (ED) with a knife stabbed in his chest. According to the ambulance staff, the patient stopped breathing at the hospital gate so ventilation with laryngeal mask was performed. The patient's face was covered in vomit, and he was pulseless and cyanotic at arrival. The anesthetist intubated him immediately. The patient's chest was exposed with a carving knife protruding parasternal right at the middle of the sternum body (Picture 1 and 2).



Picture 1 The knife after extraction.
Slika 1. Nož nakon odstranjenja.

EKG showed electrical activity with bradycardia but still without palpable pulse over the carotid arteries. An sternotomy emergency room was decided. The Emergency asepsis was accomplished with alcohol splash and sternotomy was performed using a scalpel for skin incision and a pair of heavy trauma scissors for cutting through the sternum. The knife was removed when interfered with access to the heart. During the sternotomy, the anesthetist noticed ventricular fibrillation on ECG. In the absence of wound retractor, the nearest medical technician held one side of the wound and a surgical assistant was pulled the other side. The exposed pericardium appeared tense and ballooned. Pericardiotomy released the heart tamponade which was causing circulatory collapse. Immediately after decompression, the heart started slowly pumping out blood through the 8 mm hole in the right ventricle where the tip of the knife had been inserted. Blood clots were removed with



Picture 2 The patient after surgery with the red arrow pointing to the wound entry site
Slika 2. Bolesnik nakon operacije – crvena strelica pokazuje mjesto penetrantne rane.

gauzes. Next, the heart was dislocated with the left hand and polypropylene 3-0 were used to place a U-suture which successfully stopped the bleeding. The wound was irrigated with saline. Thoracic drains were placed in both chest cavities whilst stable blood pressure came back. The patient was transferred to the operating room to check the hemostasis and close the chest. The thoracic cavity was repeatedly irrigated with warm saline, hemostasis was sufficient, drains were placed into the pericardium, mediastinum and the sternotomy was closed with wire sutures followed by skin sutures. Double antibiotic therapy (vancomycin and meropenem) was initiated intravenously during the chest closure. Preliminary blood tests were available at that time. White blood cells were elevated ($24.4 \times 10^9/L$), there was a mild hemoglobin level drop (135 g/L), mild decrease in hematocrit (38.4%) with normal red blood cells ($4.39 \times 10^9/L$) and platelets count ($192 \times 10^9/L$). The patient was in hyperglycemia (12.3 mmol/L), and mild hypocalcemia (1.91 mmol/L). No signs of coagulopathy were noticed (INR 1.1; APTT 32 seconds). The next morning the patient was extubated and without pressure support. His vital parameters were normal. He regained full consciousness and he could sit on the bed. He tolerated oral fluid intake well and he talked clearly but was amnesic due to the traumatic event. The drains were inactive and were removed successively.

The patient recovered completely without neurological impairment and without signs of surgical site infection.

Discussion

Several clinical scenarios of cardiac or circulatory collapse after chest injury may represent an indication for EDT/EDS. These include injuries to the heart, injuries to the intrathoracic vasculature, cardiac tamponade and tension pneumothorax. EDT/EDS provides the best chance for addressing possible haemorrhage, cardiac tamponade, direct heart repair, mediastinal blood vessels and lung damage as well as facilitation of internal cardiac massage and exposure of the descending aorta for cross-clamping.^{1,2} Two main elements comprising the indication for EDT/EDS are the presence of signs of life and the mechanism of injury. Survival after blunt injury is significantly lower than for the penetrating injury because cardiac contusion, cardiac rupture, and aortic rupture have a deleterious outcome.

Established indication for EDT/EDS for penetrating wounds is the previously witnessed cardiac activity with unresponsive hypotension. The indications for blunt injuries are previously witnessed cardiac activity, rapid exsanguination from the chest tube (>1,500 mL upon placement) or an unresponsive hypotension. Relative indications include the thoracic injury with traumatic arrest without previously witnessed cardiac activity, penetrating nonthoracic injury with traumatic arrest with previously witnessed cardiac activity or blunt thoracic injuries with traumatic arrest and previously witnessed cardiac activity.³

There are also contraindications to the EDT/EDS where it seems they have no benefit: blunt injury without witnessed cardiac activity, penetrating abdominal trauma without cardiac activity, non-traumatic arrest, severe head injury, severe multisystem injury, blunt trauma with more than 10 minutes of prehospital cardiopulmonary resuscitation (CPR) without response or penetrating trauma with more than 15 minutes of prehospital CPR without response and asystole without cardiac tamponade.³⁻⁵ In all cases, quick recognition of indication and immediate action is of paramount importance in order to avoid neurological damage. Time is limited to 10 minutes for blunt trauma and 10-15 minutes for penetrating trauma.⁶

The most common access to the thoracic cavity is left anterolateral thoracotomy. It provides quick access to the left lung, aorta, heart and it can be readily extended across the sternum to the right side in a “clamshell” fashion. Median sternotomy is

slower, but provides a better visualization of the heart and mediastinal contents, as well as both pleural contents. In our case, sternotomy was chosen due to the right parasternal position of the wound. Basic thoracotomy set readily available in the Emergency Department, Intensive Care Unit or in the Emergency OR is the prerequisite for the procedure (Picture 3). The team involved in the procedure should be protected against exposure to blood and sharp objects, therefore it is recommended to wear sterile gloves, gown and face shield. Surgery requires skin antiseptic, sterile drapes, scalpel, sternum saw, heavy trauma scissors, Gigli saw or Lebsche knife, heavy wound retractor, lung retractor or lung clamps, vasculars clamps, potent suction device, needle-holder and appropriate suturing material e.g. polypropylene 3-0. Additional material may be required at the end of the successful surgery e.g. pericardial and thoracic drains and wire sutures for sternotomy closure.



Picture 3 Key instruments for the EDT/EDS
Slika 3. Osnovni instrumentarij za hitnu sternotomiju/torakotomiju

On arrival at the ER, the patient was generally unconscious. According to ABC resuscitation algorithm, effective ventilation through endotracheal tube was a priority. The patient was placed in supine position with the anterior part of the thorax exposed. Rolled sheet under the interscapular area improved access to the sternum by extending the neck and elevating the sternal notch.⁷ Once the patient was positioned, the area had to be made as sterile as possible but without delaying the procedure. Skin asepsis is usually performed with betadine or alcohol as in our case. Draping is optional and usually means a waste of precious time. A determined single-stroke

with a scalpel is made to the bone surface, starting from the sternal notch to below the xiphoid process. The sternum is then cut with an available tool such as a sternotomy saw, Lebsche knife or, as in our case, the use of heavy trauma scissors. In order to have a good access to the thorax, the sternal or rib retractor should be positioned.⁷ Once the chest cavity is exposed, it is necessary to quickly remove the blood and clots with a combination of suction and surgical sponges. To make sure that the cardiac tamponade is not causing the arrest, pericardiectomy should be made, anterior and parallel to the phrenic nerve. If the cause of the cardiac arrest is not tamponade, supradiaphragmatic aortic clamping should be performed to redistribute the blood flow to the coronary arteries and to the brain. Clamping should not last more than 30 minutes in order to avoid ischemic lesion of the viscera. If the heart does not restart spontaneously after the release of the tamponade, we should commence with internal cardiac massage.^{8,9} The both hands technique has the advantage of producing 55% of the cardiac output instead of only 20% during external cardiac massage.⁹ After 20 minutes of unsuccessful internal cardiac massage, it should be stopped.⁸ If heart lesions are visualized, we can use temporary digital compression or occlusion with a Foley catheter balloon inflated inside the heart chamber. If definitive repair is possible, it should be performed with monofilament suture e.g. polypropylene 3-0 in U fashion or using sutures precharged with pledgets. Special attention should be made not to incorporate the coronary artery into the suture. If the visualized injury is too extensive or deemed irreparable, the procedure should be aborted. At the end of the surgery, pericardial, mediastinal and thoracic cavities should be thoroughly irrigated with saline and drained. The sternum should be closed with wire sutures and thoracotomy wound with heavy sutures.

EDT/EDS is a procedure burdened with complications, most commonly sternal wound infection, pneumonia and mediastinal infection, therefore antibiotic prophylaxis is mandatory.^{7,10} Other common complications are hemorrhage, heart dysrhythmias, sternal instability, pseudoarthrosis and brachial plexus injury.⁷

Conclusion

EDT/EDS represent the last resort action in case of posttraumatic cardiorespiratory arrest. Very few studies discuss EDS in contrast to EDT, which is better defined in the setting of trauma, but indications and evidence on efficacy of EDT could be

extrapolated to EDS. Management in remote operating room means unaffordable waste of time which could make a difference between life and death and, not less importantly, spare neurological impairment. This controversial surgical procedure is criticized by some authors who consider EDT a useless and potentially endangering procedure regarding the risks for the health workers like exposure to infectious diseases, sharp objects and significant costs. It differs greatly from the same procedure done in the operating room. It therefore requires high adaptability, both in terms of equipment and clinical presentation. When in a dilemma between certain death and slim chances of saving a patient's life, despite the potential complications that may occur, one should strive to choose the latter.

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