



Review

Resuscitative thoracotomy



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ABSTRACT

Resuscitative thoracotomy is often performed on trauma patients with thoracoabdominal penetrating or blunt injuries arriving in cardiac arrest. The goal of this procedure is to immediately restore cardiac output and to control major hemorrhage within the thorax and abdominal cavity. Only surgeons with experience in the management of cardiac and thoracic injuries should perform this procedure.

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1. Indications

Classic indications for resuscitative thoracotomy include patients with penetrating injuries suffering cardiac arrest during transport to the hospital and trauma patients with blunt or penetrating injuries suffering cardiac arrest witnessed by the trauma surgeon. There are also published series with extended indications, performing this procedure in blunt trauma patients with cardiac arrest prior to arrival at the hospital.

Classic indications:

1. Penetrating trauma injuries with pre-hospital cardiac arrest.
2. Blunt and penetrating trauma suffering cardiac arrest upon arrival to the hospital or while in the trauma bay.
3. Patients with blunt and penetrating trauma suffering cardiac arrest while undergoing surgical procedures in the operating room, e.g. laparotomy or repair of peripheral vascular injuries.

Expanded indications:

1. Blunt trauma with cardiac arrest prior to hospital arrival.

The indications for resuscitative thoracotomy in pediatric trauma patients are the same as in the adult population. Contraindications include trauma patients in cardiac arrest with obvious non-survivable traumatic brain injuries and patients with obvious signs of death like rigor mortis and dependent lividity.

2. History of resuscitative thoracotomy

Moritz Schiff first described open cardiac massage in 1874 [1]. Subsequently, the first successful repair of a cardiac injury secondary to a stab wound to the right ventricle was performed by Rehn in 1896 [2]. In 1901, Igelsrud reported the first successful resuscitation of a trauma patient in cardiac arrest undergoing resuscitative thoracotomy and open heart massage [3]. The classic left anterolateral thoracotomy incision used for the resuscitative thoracotomy was described by Spangaro in 1906 [4]. Subsequently, Beall and colleagues [5,6] pioneered and advocated the immediate resuscitative thoracotomy, hemorrhage control, immediate cardiac repair, and open heart massage in trauma patients in the emergency room or operating room in 1961 and the following years.

3. Objectives of resuscitative thoracotomy

1. Control of thoracic hemorrhage
2. Relief of cardiac tamponade

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3. Immediate repair of cardiac injuries
4. Open cardiac massage to restore cardiac output and circulation
5. Control of abdominal hemorrhage by cross-clamping of the descending thoracic aorta
6. Control of major thoracic vascular or pulmonary hilar injuries (Fig. 1).
7. Internal defibrillation in patients with ventricular fibrillation cardiac arrest.

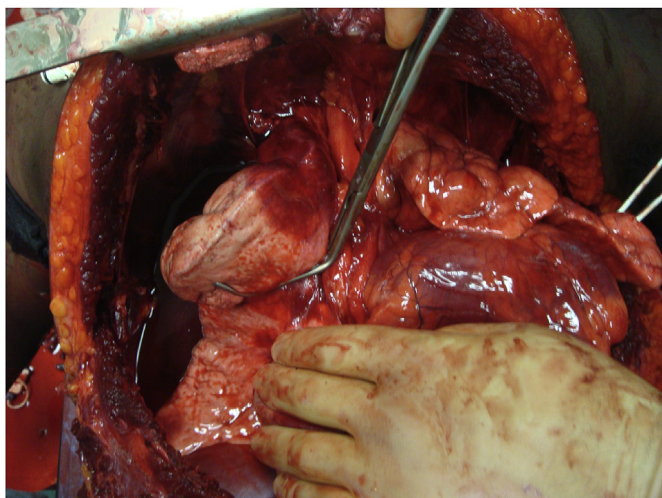


Fig. 1. Placement of Satinsky clamp at right upper lung lobe to control hemorrhage from pulmonary injury.

4. Surgical technique of resuscitative thoracotomy

4.1. Choice of incision

The incision of choice for resuscitative thoracotomy in patients in extremis or cardiac arrest is the left anterolateral thoracotomy in the fifth intercostal space as originally described by Spangaro [7]. This incision may be extended to the right chest utilizing a clamshell incision if hemorrhage in the right chest cavity is suspected. Median sternotomy as described by Duval [8] for anterior cardiac injuries is reserved for patients with sustained cardiac output and some degree of hemodynamic stability and should only be performed in the operating room.

The left anterolateral thoracotomy is initiated by making a skin incision just below the left nipple in male patients or pediatric patients and just below the inframammary fold in female patients. The incision begins at the left lateral border of the sternum and is extended in a curved fashion to the posterior axillary line following the fifth intercostal space. The intercostal muscles and pleura are divided using the scalpel. A Finochietto retractor is placed to spread the left chest wall wide open. If injuries and associated hemorrhage in the right chest are present or suspected, extension of the left anterolateral thoracotomy into a bilateral thoracotomy with division of the sternum in form of a clamshell incision is necessary to address injuries in the right hemithorax (Fig. 3). Both internal mammary arteries require ligation as soon as circulation is restored since they can contribute to significant blood loss.

4.2. Opening of the pericardium

The pericardium is elevated by grasping it between Allis clamps

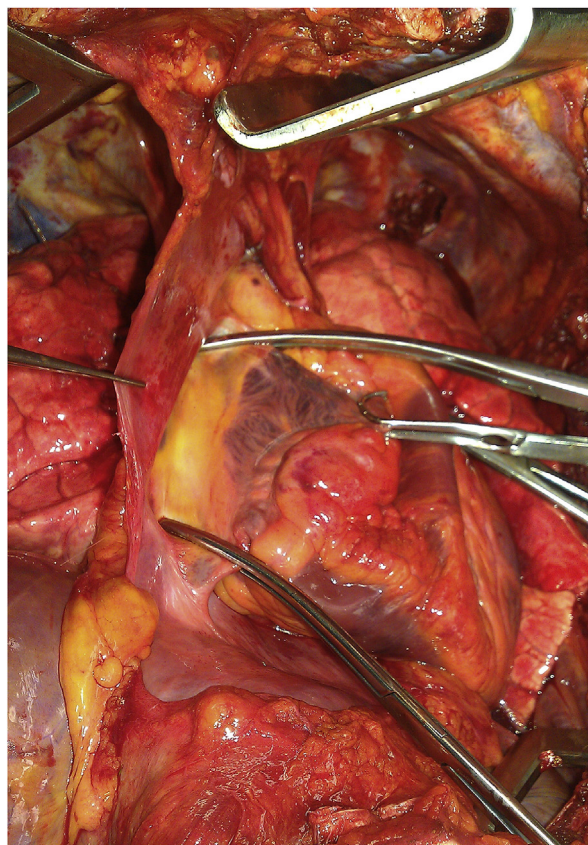


Fig. 2. Cross clamping of intrapericardial inferior and superior vena cava for total cardiac inflow control. This procedure is poorly tolerated and results fast in cardiac arrest. It should be avoided or only used in patients who are already in cardiac arrest and require a brief complete inflow control in order to repair a major cardiac defect with subsequent immediate open heart massage and resuscitation efforts.

or forceps. An incision is made between the Allis clamps utilizing a scalpel. In tense cardiac tamponade, it may be impossible to grasp the pericardium with Allis clamps. In this case the only way to enter the pericardium may be to create a very small incision in the pericardium with a scalpel, being extremely cautious not to lacerate the underlying heart. The incision is extended caudal and cephalad utilizing a Metzenbaum scissors. Care must be taken not to injure

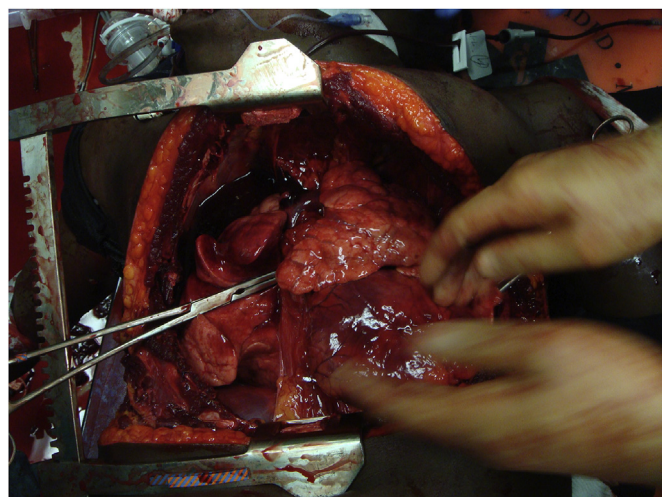


Fig. 3. Bilateral thoracotomy (Clamshell incision) allows simultaneous access to both thorax cavities in order to address right pulmonary injuries.

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