The greatest mistake in ED Thoractomy is not doing it early enough!

Thoracotomy in the ED should only be performed by an appropriately trained surgeon. **A trauma patient who loses vital signs in the ED may be saved by immediate thoracotomy, especially those with penetrating injury.**

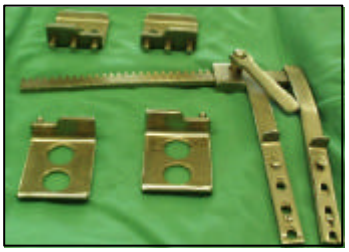
Therapeutic manoeuvres include:

1. Pericardial incision and evacuation of pericardial blood causing tamponade.
2. Direct control of exsanguinating thoracic haemorrhage.
3. Open cardiac massage.
4. Cross clamping of descending aorta to stop blood loss below diaphragm and allow heart filling to achieve cardiac and brain perfusion.
5. Cross clamping of pulmonary hilum to control exsanguinating pulmonary haemorrhage.

The consultant Trauma Surgeon should be informed of any haemodynamically unstable patient prior to arrival in the ED.

EQUIPMENT FOR THORACOTOMY

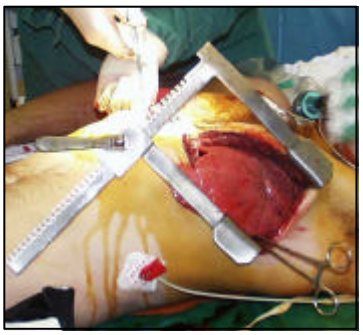
- Skin preparation – proviodine.
- Heavy Mayo scissors.
- Scalpel - #10 blade.
- Forceps.
- Long needle holders.
- Finochietto retractor.
- Lung retractor.
- Vascular clamps.
- Prolene vascular sutures.
- Protective goggles / clothing.



APPROACH

The approach is via an anterior left thoracotomy, which gives access to the left hilum, descending aorta, left ventricle and pericardium.

1. Haemopericardium should be relieved by incising the pericardium longitudinally anterior to the phrenic nerve.
2. A penetrating cardiac injury may be temporarily controlled with a finger or pledget sutures.



3. A bleeding lung or pulmonary vessel can be controlled by a hilar clamp. Consider extending incision across chest into a clam shell.

The aim of an ED thoracotomy is to salvage a dying patient until a definitive procedure is performed in the operating theatre.

Thoracotomy performed by untrained staff is not only futile, but also time consuming and can expose the trauma team to unnecessary risks.

INDICATIONS

1. **All** penetrating chest injuries with systolic BP <70 on arrival who do not respond within 5 minutes to blood i.e. the moribund patient!

2. **All** patients with **no** BP on arrival with penetrating chest injury who have had signs of life or ECG within 10 minutes (if tubed) or 6 minutes if not tubed.

3. Patients with a systolic BP >80 should go to theatre.

- **Remember – don't wait 5 minutes and then ask to open the thoracotomy tray.**
- **If the MIST information is good – have it open before patient arrives.**

REFERENCES:

1. *Advanced Trauma Life Support for Doctors. Instructor Course Manual Book 1 - Sixth Edition,* 1997, American College of Surgeons, Chicago.

CRICOTHYROIDOTOMY

Cricothyroidotomy is an emergency procedure by which an opening is made in the cricothyroid membrane to establish an airway. Surgical cricothyroidotomy is the use of a blade to create an opening; needle cricothyroidotomy is the use of a small cannula or needle which then allows jet insufflation to prevent hypoxic injury to an otherwise dying patient.

INDICATION:
The decision to perform emergency cricothyroidotomy is made to prevent hypoxic encephalopathy and death. It is a life saving procedure and must be accomplished quickly as hypoxic brain injury occurs within 3-5 minutes of the inability to effectively oxygenate.

The only indication is an inability to effectively oxygenate by other means.

Intubation is the usual method of obtaining airway control. In some situations this may be impossible or contraindicated and therefore mandates cricothyroidotomy. Team members should defer to those who have at least performed the procedure in a simulated environment (e.g. EMST, ELS, APLS or other course).

CONTRAINDICATIONS:

1. Patients who can be effectively ventilated by other means (LMA, bag-mask, via ETT).
2. Transection of the trachea with retraction of the distal end.
3. Known fractured larynx or other significant damage to the larynx or cricoid cartilage.

TECHNICAL ASPECTS:

Anatomy
The cricothyroid membrane is a dense fibroelastic membrane between the thyroid cartilage (above) and the circumferential ring of the cricoid cartilage (below). The laryngeal prominence or "Adams apple" (anterior superior edge of the thyroid cartilage) is the most important landmark.

Identify the cricothyroid membrane by feeling for a notch, indentation or dip in the skin inferior to the laryngeal prominence. The average size in the adult is 22-30mm wide and 9-10mm high, found usually 2-3cm below the laryngeal prominence.

In children less than 12 years, needle cricothyroidotomy is the preferred technique, as the cricothyroid membrane is not as well developed as in the adult.

SURGICAL CRICOTHYROIDOTOMY

Equipment:
- A #10 scalpel blade.
- Size 6.0 endotracheal tube.
- +/- tracheal spreader or artery forceps.

or
Use the Melker cricothyroidotomy set located at bed 3 in the resuscitation room.

Procedure:

1. Place patient in supine position with neck in neutral position. If there is no risk of neck injury consider extending the neck. Palpate the thyroid notch (Adams apple) and cricoid cartilage and locate the cricothyroid membrane.
2. Prepare the skin and anaesthetise the skin if there is time and the patient is conscious.
3. Stabilise the thyroid cartilage with the left hand.
4. For an emergency cricothyroidotomy make a central transverse skin incision about 3-4cm long. A longitudinal skin incision can be used as it can also be extended if placed too high or too low.
5. After the skin incision a short stabbing 1cm incision is made in the cricothyroid membrane in the lower half (to avoid the cricothyroid arteries), allowing only the tip of the scalpel blade to enter the trachea.
6. Insert artery forceps, scalpel handle or tracheal spreader into the incision to enlarge the opening.
7. Insert a cuffed tube into the hole directing the tube distally into the trachea. Stabilisation of the larynx is crucial to allow entry of the tracheostomy tube with the larynx lifted and held anteriorly in the anatomical position.
8. Remove the introducer.
9. Inflate the cuff of the tube, attach a connector to the tube, then a self filling bag.
10. Ventilate the patient and secure the tube into position.

NEEDLE CRICOTHYROIDOTOMY

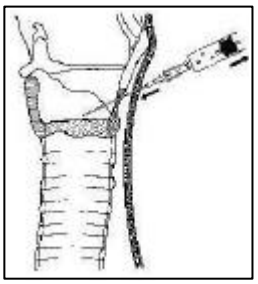
Use in children < 12 years age for jet ventilation.

Equipment:

- Long bore cannula 12 or 14 gauge.
- 5ml syringe.
- O_2 tubing.
- Y connector.
- Oxygen flow meter.

Procedure:

1. Attach a cannula to a 5ml syringe.
2. Place patient supine. If there is no risk of cervical spine injury extend the neck by plugging a folded towel under the shoulders.
3. Locate the cricothyroid membrane and surgically prep the skin.
4. Stabilise the neck with your left hand.
5. Puncture the skin in the midline directly over the cricothyroid membrane aiming directly downwards.
6. Aspirate as you advance as the aspiration of air indicates entering trachea.
7. When air is aspirated, aim the needle 45^{O} caudally and then advance the cannula over the needle taking care not to perforate the posterior wall of the trachea. Withdraw the needle and recheck air can be aspirated from the cannula.



8. Attach the hub of the cannula to a size 3 ETT adaptor and then an oxygen flow meter via a Y-connector.
9. Initially set the oxygen flow rate in litres at the child's age in years. This may well require adjustment to ensure oxygenation. In an adult set the oxygen flow at 15L/min (50 PSI).
10. Ventilate by occluding the open end of the Y-connector with the thumb for 1 second directing gas flow into the lungs. If this does not cause the chest to rise, increase the flow rate by 1 litre and reassess the effect of 1 sec occlusion of the Y connector.
11. Use a rhythm of 1 sec on, 4 sec off. Ensure there is chest movement confirming adequate ventilation.
12. Inspect the neck to ensure there is no swelling indicating flow of gas into the tissues rather than the trachea.
13. Secure the cannula.
14. Arrange for emergency management in theatre as a patient can only be effectively ventilated for 15 minutes using this technique.

PITFALLS & TRAPS:
Although a relatively simple technique when described, in reality the patient is often struggling as they are hypoxic, the surgical field may become bloody and the operator may not feel confident. Cricothyroidotomy is a lifesaving procedure and the literature supports the view that cricothyroidotomy is safe with relatively few complications.

SURGICAL CRICOTHYROIDOTOMY: avoid making blind stabs as controlled incisions minimise the risk of haemorrhage and damage to adjacent structures. Attempt to hold the scalpel with the thumb and index finger low on the scalpel handle, just above the blade so to control the depth of the scalpel blade insertion.

NEEDLE CRICOTHYROIDOTOMY: it is not possible to effectively ventilate a patient via a needle cricothyroidotomy using a self-inflating bag. Exhalation must occur via the upper airway, even when the upper airway is partially obstructed. Should upper airway obstruction become complete, the gas flow will need to be reduced. Insufflation provides oxygenation but little ventilation. This temporising measure may buy 15 minutes for an attempt at securing a definitive surgical airway.

COMPLICATIONS OF CRICOTHYROIDOTOMY:
- Hypoxia.
- Hypercarbia.
- Aspiration.
- Obstruction of ETT.
- Local bleeding.
- Creation of a false passage.
- Emphysema.
- Vocal cord paralysis.
- Pulmonary barotrauma.
- Subglottic oedema or stenosis.
- Oesophageal perforation.
- Cellulitis.

REFERENCES:

1. *EMST Course Manual*, 1992
2. *Clinical Procedures in Emergency Medicine*. Roberts & Hedges, 1998
3. *Advanced Paediatric Life Support, The Practical Approach.* 3rd Edition. Advanced Life Support Group, BMJ Publishing Group, 2001.

Pericardiocentesis is not a good idea in trauma patients because:

- the patient you are convinced needs it (in extremis) actually needs a thoracotomy,
- the patient you are considering it for (stable) usually needs a thoracotomy.

There are many risks:

- damage to organs (myocardium, lung, stomach, bowel, oesophagus, spleen, kidney),
- laceration of coronary artery,
- failure to aspirate blood from the pericardial sac because it is clotted (common).

By performing a pericardiocentesis you will be effectively committing a patient to a pericardial exploration, so, get an ultrasound if you can and a surgeon if you are suspicious of tamponade.

NEVER PERFORM A PERICARDIOCENTESIS IN LIVERPOOL HOSPITAL

Pericardiocentesis may be performed if the following criteria are met:

- You are unable to do a thoracotomy.
- A surgeon is not available.
- The patient is in extremis (about to die).
- You have a high degree of suspicion that tamponade is present.

MEDICAL ANTI SHOCK TROUSERS (MAST)

HISTORY

In 1903, Crile described a pneumatic rubber suit, a device he had designed so as to prevent or minimise the extent of postural hypotension in neurosurgical patients. This concept was further expanded for flight suits worn by military pilots for the prevention of G force induced blackout. The principle behind its use was that it prevented the pooling of blood in the lower extremities which otherwise resulted in decreased venous return and therefore cardiac output. All such patients were otherwise euvolaemic. The efficacy of the pneumatic device in these settings is firmly established.

HYPOVOLAEMIC SHOCK

Since the early 1970s that same concept was taken one step further to the treatment of profound haemorrhagic shock in the prehospital and hospital emergency department settings. The theory was that blood in the lower extremities would be displaced centrally and venous return, and thus cardiac output, would be enhanced. All such patients were obviously profoundly hypovolaemic.

The efficacy of MAST in this setting is unsupported. The evidence suggests that the use of MAST for such patients is associated with a greater mortality, increased ICU and hospital length of stay. It is contraindicated for patients with head, chest or penetrating abdominal injuries.

The development of MAST for haemodynamically unstable trauma patients was at a time when current Early Management of Severe Trauma (EMST) principles were in their infancy. The appreciation of the benefits of rapid control and management of hypovolaemic shock were much less appreciated than they are today. This principle very much underlies the approach to such patients by the Liverpool Trauma System.

LIMB FRACTURES / SPLINTING

More recently MAST has been applied for “splinting” of lower limb fractures. The basis to adequate splinting of any limb fracture is that early *realignment and immobilisation* reduces fracture-associated tissue damage, bleeding, pain, and subsequent multisystem organ dysfunction and mortality.

MAST, when utilised for lower extremity fractures, provides possibly *some immobilisation* but *no traction / realignment*. Any immobilisation would require the MAST to be inflated to some degree. In patients who are shocked, the application of external pneumatic pressure results in reduced arterial blood flow, increased venous stasis / engorgement and increased ischaemia / acidosis to an already injured extremity.

The effectiveness of the MAST in such circumstances has never been established, nor was the current design ever developed for such use. The same applies to its suggested use for pelvic fractures.

MAST is never used at Liverpool Hospital for hypovolaemic shock in the setting of trauma. It is however still occasionally used in the pre-hospital setting and, therefore, critically ill trauma patients may arrive to Liverpool Hospital with an inflated MAST in situ.

MANAGEMENT (see page 122)

The challenges faced by the trauma team from the pre-hospital application of MAST are:

Distraction: the trauma team may be distracted from the fact that such patients are likely to be severely haemodynamically unstable or partially resuscitated and in need of ongoing resuscitation and urgent definitive surgical care.

Reperfusion Problems: potentially life threatening systemic effects of sudden reperfusion of the lower limbs as MAST is deflated. The longer the application time of the MAST, the more severe the systemic consequences.

1. Ignore the MAST. Leave it inflated (if the abdominal compartment is inflated – which is rare – deflate it immediately).
2. Fully concentrate on completion of the ABCDE of the primary survey and resuscitation of the patient. Then formulate an assessment and definitive management plan for the patient.
3. Reperfusion issues are dependent on the patient having an adequate respiratory capacity and intravascular volume to compensate for the systemic consequences of MAST deflation. This mandates adequate volume resuscitation or surgical control of ongoing haemorrhage. Patients with reduced respiratory reserve (acute or chronic) should receive respiratory assistance including,

if necessary, intubation and ventilation *prior* to MAST deflation. All this may occur in the operating theatre.

4. MAST deflation should occur incrementally, each compartment being deflated as the systemic effects of the prior deflated compartments have resolved. Start with the most proximal compartment. Patients with any compartment of the MAST still inflated should be considered unstable and not taken to the radiology department.

If the MAST has been applied solely as a splint for lower extremity fractures, and no compartment is inflated, then remove it immediately following the primary survey / resuscitation and apply appropriate splints.

REFERENCES:

1. Dickinson K, Roberts I. Medical anti-shock trousers (pneumatic anti-shock garments) for circulatory support in patients with trauma. *The Cochrane Library (Oxford),* 2001.
2. Madigan V. The MAST suit in prehospital care — does it have a future? A discussion paper. *Aust J Emerg Care* 2000: 7(2); 10-5.

PACKING FOR MASSIVE NASOPHARYNGEAL BLEEDING

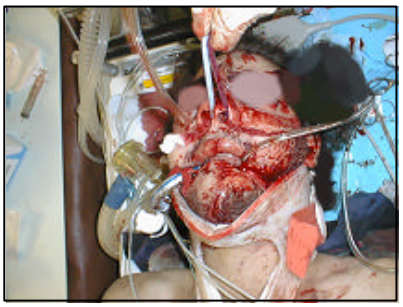
A small group of patients present to the trauma service with severe facial haemorrhage, and will exsanguinate from this injury without early recognition and definitive first aid.

These patients usually have high-speed motor vehicle crashes or are the victim of an assault with a heavy object (or have been kicked). Those with combined head and facial injuries have a high mortality and those with isolated mid-face fractures usually can be saved if treated properly.

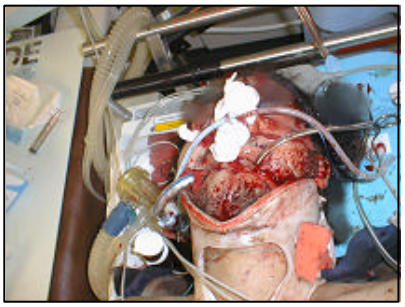
The severity of the haemorrhage may be insidious or obvious, with oozing and blood staining of the top of the bed, on the attendants and the floor. Attempts to CT scan these patients without control of the blood loss results in death by exsanguination, and damage to the CT scanner with expensive downtime.

1. The recognition and treatment of this condition follows securing the airway and ventilation in terms of priority. Two 22G Foley catheters are passed through the nostrils and hooked by the index finger into the mouth to avoid intracranial incursions. A matchbox-sized pack made of vaginal packing gauze is secured through the eyes of the catheters, with 0 nylon sutures incorporating a trailing retrieval stitch.

2. It is wedged into the postnasal space both by digital pressure and traction on the catheters. At least two bottles of 1.5 cm packing gauze is packed with blunt plain forceps into each nostril with the catheters on traction. The initial bottle must be layered well back in the nose to avoid a cavity between the posterior pack and the nostrils.



3. The Foley catheters are tied over a bolster with a reef knot under tension. Further anterior packing and/or inflation of the balloons may be required. Ongoing oral bleeding can be controlled with surgical packs into the oropharynx and oral cavity.



4. Definitive maxillofacial surgery is undertaken after the acute haemorrhage has been controlled and other life threatening injuries have declared their intentions. Embolisation of branches of the maxillary artery, and bilateral external carotid artery ligation may be of value in selected cases, but the first aid treatment should be undertaken first.

5. Prolonged pressure from the packing will sometimes cause necrosis of the soft palate requiring elective cleft palate type repair, but this is a trade off in favour of initial survival.

6. When the patient is stable, normothermic, with normal Hb and coagulation, the packing can be progressively removed leaving the Foley catheters in place for 24 hours.

7. The pack may be left for 48-72 hours if required with suitable antibiotic cover for oral flora and culture of the pack upon removal.