

Emergency Prehospital On-scene Thoracotomy: A Novel Method

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ABSTRACT

The necessity for prehospital thoracotomy is rare, but can be lifesaving. Occasionally an emergency practitioner or surgeon coincidentally arrives at a trauma scene before the arrival of emergency medical teams. In such a circumstance, even when thoracotomy may be indicated, it is not usually performed in view of the lack of equipment (e.g. dissecting tools or rib retractor). We present a novel technique of »L« shape thoracotomy, or Thoraco-sterno-costochondrotomy, whereby in a prehospital setting, and with minimal equipment (such as a penknife) a thoracotomy can be performed with adequate exposure of the heart and great vessels. The similarities of this pragmatic procedure are considered within the context of ancient Aztec and Mesoamerican thoracotomies.

Key words: emergency, thoracotomy

Introduction

On rare occasions a trained emergency practitioner or surgeon coincidentally arrives at a trauma scene before the arrival of emergency medical teams. In view of the infrequent and sporadic nature of these situations, the medical literature is lacking in discussion and advice regarding management of such trauma situations, limiting guidance to basic life support and triage, until the arrival of well-equipped emergency medical teams.

Some of these trauma scenarios include cases of penetrating thoracic injury that may warrant thoracotomy. Although prehospital thoracotomy has been traditionally seen as injudicious as a result of poor mortality, it has recently been shown to be an effective intervention for penetrating thoracic injury where there is loss of cardiac output.

The implementation of prehospital thoracotomy has evolved in response to local results, protocols and expertise. As it was initially associated with very poor results, it was abandoned in favour of emergency room thoracotomy within 30 minutes from injury. This was however must be weighed against results that demonstrate maximum times for survival in patients who undergo closed cardiopulmonary resuscitation is between 9 and 16 minutes, and patients would die if they had to wait 30 minutes to arrive at hospital for a thoracotomy. As a result,

some leading groups have successfully maintained a policy of pre-hospital thoracotomy within 10 mins of the loss of cardiac output if the closest surgical intervention is more than 10 mins away.

We purport that in cases where there is penetrating thoracic injury and a recent loss of cardiac output, when the emergency medical services are anticipated, but not yet arrived, then emergency prehospital thoracotomy can be considered and performed.

In such a situation, emergency medical teams would be on their way, but the critical priority would enable a trauma patient to maintain a cardiac output. The importance of ensuring this physiological parameter for life, leads us to assert that if a suitably experienced or trained individual was on-site, then he or she should carry out pre-hospital thoracotomy to preserve life, even in the absence of emergency medical teams – albeit with the knowledge of their imminent or anticipated arrival to take the patient to nearest trauma or cardiothoracic centre.

A search of the current literature revealed that to-date, there are no publications to describe such a pre-hospital thoracotomy in the absence of emergency medical services or equipment. Thus a new method has been devised to enable a suitably experienced practitioner to

carry out such an emergency prehospital thoracotomy, to some extent in response to the appeal from some of the author's emergency medical colleagues who found themselves in such a situation. A technique of this nature has until now, not been considered possible, unless emergency practitioners were to travel everywhere with formal thoracotomy sets. The reasoning being that incision down into the thorax without a toughened sharp instrument and rib retraction without rib spreaders would be impracticable and inconceivable.

Herein a practical technique is described whereby such a prehospital emergency thoracotomy can be carried out without advanced medical equipment, using a simple pen-knife, and this may allow adequate cardiac resuscitation until suitable medical equipped transport arrives.

Once such a thoracotomy ensues, further procedures to preserve life and maintain cardiac output include: Open cardiac massage, the release of pericardial tamponade, the control of intrathoracic cardiovascular haemorrhage, the control of massive air embolism or bronchopleural fistula and occlusion of the descending aorta to prevent massive distal haemorrhage.

Technique

Standard protocols of basic life support and trauma management should be adhered to, such as those set out by the Advanced Trauma Life Support (ATLS®) guidelines developed by the American College of Surgeons. Airway management, and oxygen delivery systems should be instigated and used if accessible. Call for help and assistance from passers by should be sought where available.

The patient should be placed supine with the left arm adducted to 90–120°, ideally with a physical support structure under the left back, not only to raise the chest for better access, but also to place the back into a lordotic extension further enhancing subsequent exposure. The Manubriosternal angle of Louis (Angulus Ludovici) is located as a landmark and an incision is made anteriorly from the left sternal border to the midaxillary line posteriorly in the 5th intercostal space.

Subcutaneous fascias and muscles (Serratus Anterior anteriorly, Latissimus Dorsi posteriorly and intercostals inferiorly) and incised closer to the upper rib border of the intercostal space in order to avoid the corresponding intercostal neurovascular bundle. At the anterior aspect of the incision (sternal border), the costochondral junction is palpated. This joint needs to be manually palpated, and is located at intersection where the softer costal cartilage meets the harder bony rib. At this point the incision takes a sharp perpendicular change of direction superiorly (Cephalad), cutting on the cartilage side of the joint (softer, easier to cut and lies more medial than the harder bone). The line of cut must be kept as close to the costochondral joint as possible, so as to limit the risk of injury to the internal thoracic artery, which typically lies 1 finger breadth (1–2 cm) lateral to the sternal edge underneath the median sagittal aspect of the costal cartilage, just medial to the costochondral joint (Figure 1a).

The incision therefore follows an »L« shape, and should be extended in the sagittal cephalad direction to incise the 5th, 4th and 3rd costochondral joints (which of course can be further extended in both cephalad and caudal directions if needed for further exposure). Freeing the anterior aspects of the ribs from their cartilaginous joints to the sternum now allows increased exposure to the thoracic cavity, as the ribs are now easier to retract manually without the use of a rib retractor (Figure 1b.). In the unlikely event that the pleural cavity has not been penetrated this is now either performed or completed, exposing the lungs and pericardium. The lungs can be manually retracted with the ribs and the pericardium exposed for the emergency procedures listed above. In the absence of specialist surgical equipment this equates to opening the pericardium and ideally avoiding the phrenic nerve to relieve tamponade, digital pressure to stop bleeding and open cardiac massage, allowing some degree of cardiac output until specialist emergency medical personnel and equipment arrive on the scene.

Sternocostochondrectomy has been described for pectus deformities and emphysema surgery, although these procedures are currently applied less frequently. We however for the first time describe a »release« sternocostochondrotomy in such a setting which is performed in con-

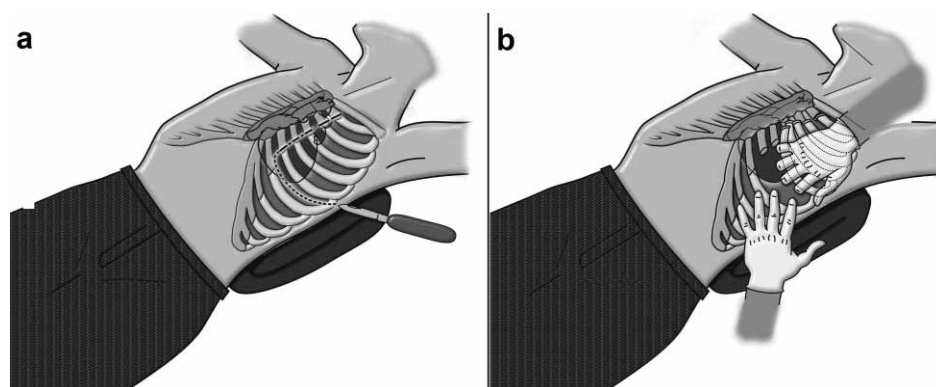


Fig. 1. Depiction of thoracosternochondrectomy. a) The »L« line of incision, b) exposure following technique.

junction with a standard anterolateral thoracotomy taking the form of an »L« shape thoracotomy, or Thoraco-sterno-costochondrotomy.

This technique has the advantage of exposing the thoracic and mediastinal structures using only a simple sharp utensil that needs to cut soft tissue and cartilage, without having to incise the harder bones such as the sternum or ribs. Furthermore it can also be done in the absence of specialist rib spreaders. The mechanism by which this works is due to the fact that the procedure entails costochondrotomy, which releases the ribs from the sternum, allowing easier rib retraction, with much less force required. Furthermore, it has been shown that these sternocostal joints are amongst the most stabilising joints in a sagittal plane motion in the thoracic spine, second only to the structures removed at radical discectomy (namely spinal facet joints and laminae). Sternocostal joint release therefore allows significant increases in thoracic spine flexion/extension, but also lateral bending and axial rotation. With the ribs freed and thoracic spine more compliant, intrathoracic structures are more easily accessed and treated. It should be noted that in the presence of likely spinal neurological injury, the relative extension of the back for thoracotomy exposure, and secondary loss of stability of the thoracic spine can be a contraindication to this procedure.

History

Therapeutic intentional thoracotomies have been performed since at least between the first and third millennium BC in Ancient Egypt, however it is largely overlooked that at approximately 1200BC-1521AD in Mesoamerica numerous examples depict non-therapeutic in-

tentional thoracotomies to expose the heart and great vessels for ritual sacrifice. Accounts from the Aztecs, one of the better known Mesoamerican cultures to perform these sacrifices reveals that although historically different routes to the chest were used (e.g. sternotomy, thoracotomy, clam-shell and anterior thoracotomy), anterolateral thoracotomy was most commonly depicted and performed on a supine patient with the thoracic spine in extreme lordosis. This would be carried out by individual practitioner-priests without any modern specialist equipment such as rib retractors. In such cases, priests would extract the heart and great vessels (Brachiocephalic, left common carotid and subclavian) (Figure 2), to present the myocardium whilst still beating or more likely fibrillating. Experience from cardiac transplantation reveals that for recipient cardiectomy where no cardioplegia solution is used, the removed heart still fibrillates for 5–10 minutes after excision. Archaeological and historical evidence to-date demonstrates that the preferred tool for cardiectomy was the obsidian knife, which is typically not strong enough to cut bone, but can cut soft tissue and cartilage. This would therefore make sternotomy or clam shell unlikely due to the hard bony sternum which by definition needs to be transected in these procedures. One feasible method of thoracic access is the technique described above (Thoraco-sterno-costochondrotomy), whereby rapid access to the heart and great vessels could be performed by one practitioner without a rib retractor or saw. Sacrifice experts could instead cut through the intercostal spaces and the cartilaginous area of the sternocostal joints with simply a knife, giving them access to a larger area of the thorax and mediastinum to expose the heart and great vessels by freeing the ribs anteriorly. In 2700 years of human sacrifice, it would be likely that the Mesoamericans would have refined their techniques and skills to perform these rapid thoracotomies. As a result, this method of »Aztec Thoracotomy« could be a possible operative manoeuvre.

Conclusion

This technique of »L« shape thoracotomy, or Thoraco-sterno-costochondrotomy has the advantage of speed and simplicity, giving rapid access to the thorax for life-saving manoeuvres, allowing time for the arrival of a prehospital emergency team and subsequent transport to hospital. It is not intended to replace standard methods of emergency thoracotomy, but rather to enable practitioners who on a rare occasion find themselves unaccompanied with no specialist equipment in a trauma situation to attempt a salvage thoracotomy where necessary. By doing so, they can contribute to the preservation and support of the trauma victim's life and vital functions until access and transport to definitive care can be achieved.

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Fig. 2. Detail from the *Codex Magliabechiano* (mid-16th century), depicting Aztec ritual cardiac sacrifice. The victim placed in extreme thoracic lordosis whilst supine on a sacrifice stone/table whilst a single priest exposes his heart and great vessels. (Biblioteca Nazionale Centrale, Florence, Italy).

REFERENCES

1. HUNT PA, GREAVES I, OWENS WA, Injury, 37 (2006) 1. — 2. ATHANASIOU T, KRASOPOULOS G, NAMBIAR P, COATS T, PETROU M, MAGEE P, UPPAL R, Eur J Cardiothorac Surg, 26 (2004) 377. — 3. FREZZA EE, MEZGHEBE H, J Cardiovasc Surg (Torino), 40 (1999) 147. — 4. GERVIN AS, FISCHER RP, J Trauma, 22 (1982) 443. — 5. BRANNEY SW, MOORE EE, FELDHAUS KM, WOLFE RE, J Trauma, 45 (1998) 87. — 6. DURHAM LA, 3RD, RICHARDSON RJ, WALL MJ, JR, PEPE PE, MATTOX KL, J Trauma, 32 (1992) 775. — 7. COATS TJ, KEOGH S, CLARK H, NEAL M, J Trauma, 50 (2001) 670. — 8. RAVITCH MM, Ann Surg, 129 (1949) 429. — 9. ROBICSEK F, FOKIN A, J Cardiovasc Surg (Torino), 40 (1999) 725. — 10. NAEF AP, Ann Thorac Surg, 64 (1997) 1506. — 11. HORTON WC, KRAIWATTANAPONG C, AKAMARU T, MINAMIDE A, PARK JS, PARK MS, HUTTON WC, Spine, 30 (2005) 2014. — 12. WATKINS RT, WATKINS R, 3RD, WILLIAMS L, AHLBRAND S, GARCIA R, KARAMANIAN A, SHARP L, VO C, HEDMAN T, Spine, 30 (2005) 1283. — 13. BREASTED JH, The Edwin Smith Surgical Papyrus: Hieroglyphic Transliteration, Translation and Commentary V1. (University of Chicago Press, Chicago, 1930). — 14. ROBICSEK F, HALES DM, Maya Heart Sacrifice: Cultural Perspective and Surgical Technique. In: BOONE EH (Ed) Ritual Human Sacrifice in Mesoamerica (Dumbarton Oaks, Washington, 1984).

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HITNA TORAKOTOMIJA NA LICU MJESTA: NOVA METODA

SAŽETAK

Potreba za torakotomijom na licu mjesta, prije hospitalizacije, je rijetka, no može spasiti život. Povremeno bolničar Hitne službe ili kirurg slučajno stigne na mjesto nesreće prije dolaska cijelog medicinskog tima Hitne službe. U takvim okolnostima, čak i kad je potrebno učiniti torakotomiju, obično se ona ne izvodi zbog manjka opreme. U ovome radu se prezentira nova tehnika torakotomije u obliku slova »L«, pomoću koje se torakotomija može izvesti i izvan bolnice, uz minimalnu opremu (kao na primjer džepni nožić), a s adekvatnim pristupom srcu i glavnim žilama. Također su ustanovljene sličnosti između ove pragmatične procedure i torakotomije koju su izvodili drevni Asteci i ostale populacije Srednje Amerike.