

‘Torso-Tractotomy’- A New and Apt Terminology for a Novel Surgical Incision and Approach for Managing Penetrating Torso Injuries, Particularly Impalement or Transfixation Injuries: Naming and Report of a Technique

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Abstract

Objective: In surgical teachings and literature, there is a lack of terminology for a particular kind of surgical approach which is used by many by ‘joining the entry to exit wound’ for impalement and transfixation injuries. We propose a terminology to them and describe the technique in detail.

Material and methods: We describe the operative technique in two cases of penetrating torso injuries (impalement and gunshot) and discuss the pros and cons of this approach. We review the literature for management of impalement/transfixation injuries and type of surgical approaches/incisions used for them.

Result: We propose the term ‘torso’, ‘thoracic’ or ‘abdominal’ tractotomy as appropriately depending on the site of injury for these kinds of injuries which we found innovative, highly effective and versatile with respect to standard incisions. One of the technical aspects we described is ‘multiple costotomies’ and their fixation with steel wires and to the best of our knowledge this has rarely been described in literature.

Conclusion: Though ‘torso-tractotomy’ expands the horizon of surgical options for a particular surgery, they represent one type of surgical approach and must not be considered solution for every penetrating or impalement injury. They should be used judiciously taken into consideration the suitability for a particular surgery.

Keywords: Tractotomy; Torso-tractotomy; Thoracoabdominal tractotomy; Impalement; Transfixation injuries; Costotomy

Abbreviations: ED: Emergency Department; ATLS: Advanced Trauma Life Support; CECT: Contrast Enhanced CT scan; FAST: Focused Assessment Sonography in Trauma; ICD: Intercostal Drainage; ICS: Intercostals Spaces; OT: Operation Theatre

Introduction

The ease and success of a surgical procedure is significantly dictated by the pre-operative planning, type and placement of an incision and surgical approach along with positioning of the patient. The ultimate goal of incision and approach is adequate exposure of ‘area of interest’ along with optimal healing, cosmesis and functional outcome. Some of the general principles which should be followed to achieve these goals are use of minimal ‘possible’ length of incision, minimal tissue handling including minimal possible retraction of tissues, appropriate patient positioning, and avoidance of iatrogenic injuries especially

to important /vital structures like major vessels, spinal cord, bowels, etc.

a. There are many types of surgical incisions and approaches tailored to a particular surgery. Most of these are described in textbooks and literature and therefore well known with designated names like abdominal incisions can be ‘midline’, ‘sub costal’, ‘transverse’, ‘gridiron’, ‘Lanz’, etc. and thoracic incisions can be ‘posterolateral thoracotomy’, ‘sternotomy’, ‘clamshell’, ‘hemi clamshell’, ‘vertical midaxillary’, etc. A particular operation can be done

by different incisions and approaches usually dictated by the 'disease site' and surgical area of interest along with surgeon's preference and comfort. But there is a particular type of surgical incision surgeons had already been using especially for torso impalement /transfixation injuries, but which can also be used for other conditions like penetrating

injuries, tumors, etc [1-8] (Table 1). Though impalement cases are usually challenging and varied, these incisions can be used very effectively in an innovative way to suit a particular surgery by providing excellent exposure and outcome, thus can have advantages over classical incisions.

Table 1: Review of use of surgical incision / approach in torso impalements.

Year of case Report in journal	Authors	Diagnosis	Surgical incision / approach	Outcome/ mortality
March 1983 J of Trauma	Ketterhagen JP et al. [1]	2 cases of impalements	Tractotomy done (chest ?, abdomen ?)	survived
1994 Jpn J Surg	Shinji Shimokawa et al. [3]	Thoracic impalement No exit wound in 33yr/M	No thoracic tractotomy Rt 6 th anterolateral thoracotomy	survived
Nov 1999 J of Trauma	Eachempati Soumitra et al. [4]	Transabdominal impalement by a wooden plank	Abdominal Tractotomy	Survived
2000 J of Trauma	Benjamin N. J Thomson et al. [5]	Thoracoabdominal impalement by a wooden broomstick	No torsotractotomy (Lt thoracoabdominal incision followed by rt anterolateral thoracotomy)	survived
2001 Ann Thoracic Cardiovasc Surg	Hiroo Shikata et al. [6]	Multiple impalements of same patient, 36 yr old – Thorax (transmediastinal), rt thigh	No thoracic tractotomy (Median sternotomy Thigh impaled object pulled out)	survived
Aug 2002 J of Thorac Cardiovasc surg	Douglas M Bowley et al. [7]	Left side thoracic impalement by tail boom of ultralight aircraft	Thoracic tractotomy + Posterolateral thoracotomy	survived
July 2005 IJTCVS	Anshuman Darbari et al. [8]	2 cases of impalements a. 18yr/F rt anterior chestwall by a wooden piece b. 35 yr/M Rt anterior chest wall by a stump wooden object	No thoracic tractotomy a.Thoracotomy b. Thoracotomy	a. Expired aft 2 wks (Sepsis) b. survived
2005 J Thorac Cardiovasc surg	M Lanthaler et al. [9]	44yr/M triple impalement injury by iron rods: 2 lt thoracic cavity 1 rt thorax	No thoracic tractotomy Lt posterolateral thoracotomy	survived
2006 J Thorac Cardiovasc Surg	A Friedl et al. [10]	Abdominothoracic impalement of a 60yr/M	No torsotractotomy (longitudinal sternotomy + median laparotomy)	survived

2009 Scand J Trauma Resuscitation and Em medicine	Chhavi Sawhney et al. [2]	Thoracoabdominal impalement	Torso tractotomy	survived
June 2009 Ghana Medical J	F Edwin et al. [11]	2cases of impalements– a)22yr F, Lt side chest impalement by iron pipe b)18yr M Gun barrel impalement suprasternal notch (rt upper chest) 3 rd case is a retained FB reported in chest	a) ? thoracic tractotomy (Rt thoracotomy) b) No thoracic tractotomy (Rt thoracotomy)	a) survived b) survived
February 2012 Chinese J Traumatology	Maneesh Singhal et al. [12]	Impalement of 2 occupants in the same vehicle by the same reinforced steel tors (25mm diameter)	Tractotomy done in 1 patient	survived
March 2012 Prehosp & Disaster med	Omobilaji O Ayandipo et al. [13]	Multiple thoracoabdominal impalement by 3 iron rods 20yr/M	No thoracoabdominal tractotomy (midline laparotomy / no Thoracotomy)	survived
March 2013 IJS	R M Ruano et al. [14]	Left sided thoracic Impalement by 2 wheeled horse carriage shaft	Thoracic tractotomy	Expired 13 th POD due to septic shock
March 2015 Ulus Travma Acil Cerrahi derg	Sorinel Lunca et al. [15]	Rt thoracic impalement by a log (12 cm diameter) in 24 yr/M	Rt thoracic tractotomy	Survived

b. To the best of our knowledge, no terminology has been given to these kinds of incisions yet in literature though these same incisions are usually described by surgeons as ‘incision joining the entry and exit sites’ [1]. Also the detailed technique of these incisions is rarely described. We term these incisions as: ‘torso-tractotomy’- for thoracoabdominal incisions, ‘thoracic tractotomy’- for thoracic incisions, ‘abdominal tractotomy’- for abdominal incisions, ‘extended tractotomy’- when the incision is extended in line of incision and ‘composite tractotomy’- when the incision is combined with other classical incision (these terms have originally been proposed by the communicating author who also operated upon the thoracoabdominal impalement case in 2008 using thoracoabdominal tractotomy, described in the article by Chhavi Sawhney et al. [2].

c. We describe here two cases in short focusing on the technique and surgical approach.

Case 1

a) 22 year old male with iron angle impalement/transfixation injury of upper abdomen and thorax (Figure 1).

b) General anesthesia: Patient was intubated in semi reclining position.

c) Position of the patient: Right lateral, single operation theatre (OT) table used (also dictated by the protruding iron angle (Figure 1).

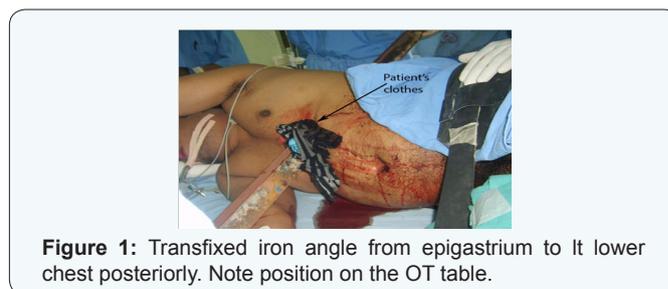


Figure 1: Transfixed iron angle from epigastrium to Lt lower chest posteriorly. Note position on the OT table.

d) Surgical technique: Left sided torso-tractotomy. Skin incision made joining entry and exit wounds (shortest possible length). Soft tissue including abdominal and thoracic muscles cut in the line of incision. Four ribs (left 6, 7, 8,9) were encountered in the line of incision, so they were sharply divided with saw (multiple costotomies) instead of trying to go through the intercostal spaces (ICS) which avoided extra tissue dissection as well as spreading (retraction) of ICS (Figure 2). Left sided pleural cavity entered which revealed 'the iron angle piercing through upper anterior abdominal wall (epigastrium) and anterior diaphragmatic attachments, then passing under the diaphragm through peritoneal cavity, coming out again into the left pleural cavity posteriorly injuring the diaphragm second time and exiting by shattering the left 10th rib through the chest wall posteriorly' (Figure 3).

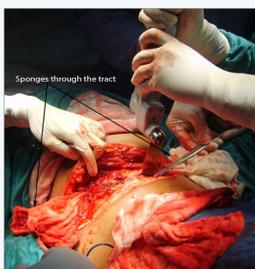


Figure 2: Multiple costotomies being done with saw in line of incision after incising the skin and soft tissues in line of incision.

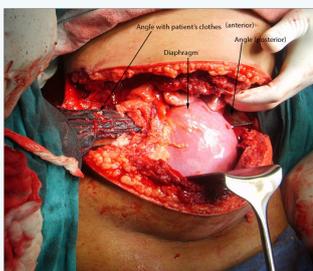


Figure 3: Thoracic tractotomy done exposing injured diaphragm.

Since the diaphragm was hiding intra-abdominal injuries, it was opened from entry to exit wounds from around the peripheral attachments (curvilinear incision: 'phrenotomy/phreno-tractotomy') so that injury to left phrenic nerve was avoided [9-11]. Now the peritoneal cavity was also exposed along with the left pleural cavity fully exposing the iron angle (Figure 4). The iron angle was carefully 'lifted out' (laterally) rather than 'pulled out'. Hemostasis secured for bleeding from stomach, splenic vessels and spleen. The intra-operative findings recorded: lacerated left lobe of liver, major lacerations of stomach at three sites, significant left sided diaphragmatic injuries both anteriorly and posteriorly, shattered upper half of the spleen, left lower lobe lung laceration (minor), comminuted rib fracture (10th rib), anterior abdominal and posterior chest wall defects.



Figure 4: Thoracoabdominal tractotomy completed exposing the whole length of the iron angle in the body.

e) The procedure done: stomach debrided and primarily repaired, splenectomy, liver laceration cauterized, primary repair of left lung laceration, thorough thoraco-abdominal lavage, abdominal drain placed and left intercostal drainage (ICD) tube placed. Tractotomy reconstruction done by repair and reconstruction of diaphragm with non absorbable sutures, the ribs were fixed with dental steel wires and muscles repaired in layers (Figure 5). Entry and exit wounds debrided and skin left open for delayed closure [12]. Patient had uneventful and dramatic post-op recovery.



Figure 5: Wire fixation of costotomies.

Case 2

22 year male with gunshot injury to right lateral chest wall ('through and through wound'). Contrast enhanced CT scan (CECT) of torso showed the trajectory of the bullet along with diaphragmatic rupture and liver injury. Focused assessment sonography in trauma (FAST) was negative. Patient was vitally stable but was bleeding continuously from the chest tube (probable cause was intermittent negative pleural pressure transmitted to lacerated liver). Patient was taken to OT for exploration [13-15].

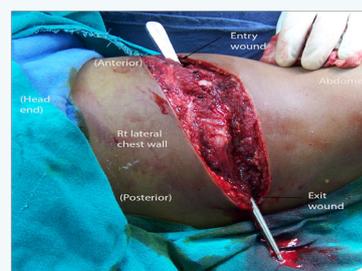


Figure 6: Thoracic tractotomy with forceps showing entry and exit wounds and defining the tract.

Surgical technique: Thoracic tractotomy done (Figure 6), costotomies of four ribs done in line of the incision, lacerated diaphragm and underlying bleeding liver exposed (without the need for mobilizing the liver or giving abdominal incisions). Phrenotomy done to expose the injured liver (Figure 7). Hemostasis secured, drain placed, phrenotomy primarily repaired, ribs fixed with dental steel wires, skin and soft tissues closed primarily. Post-op recovery was excellent with no significant post op pain.

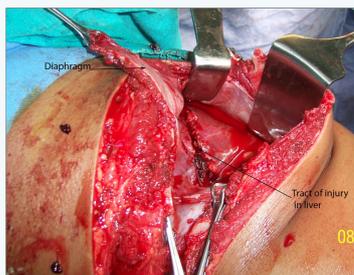


Figure 7: Phrenotomy done through lacerated diaphragm exposing tract of bullet through liver.

Discussion

The words impalement and tranfixation injury are often used interchangeably in literature. 'Impalement' has originally been defined as a method of execution, in the form of penetration of a human body by an object such as stake, pole, spear, etc. often by complete or partial perforation of torso. When impalement injury becomes 'through and through', it is called 'transfixation' injury. Thus transfixations have both entry and exit wounds but impalements may not have exit wounds. Transfixation is also a type of impalement injury.

General principles of management of impalement and torso-tractotomy:

- i. Cautious extrication and rapid transportation to nearest appropriate facility.
- ii. Appropriate shortening of impaled object from just outside the body. This may need metal cutter or special saws. Adequate protection of the patient from thermal injuries while cutting and minimal manipulation of the impaled object are also essential.
- iii. Initial management and resuscitation should be based on 'ABCDE' protocol of Advanced Trauma Life Support (ATLS).
- iv. Protrusion of impaled object may still cause difficulty in positioning of the patient on OT table. Therefore intubation and positioning may require innovation at times.
- v. The impaled object must never be pulled out (not even in the emergency department (ED)). It should be removed under full vision on the OT table, only after the patient is under anesthesia.

vi. Incision is made by joining the entry and exit wounds usually in the shortest possible length or as appropriate. Incision is deepened and tissue cut (fat, fascia, muscle, ribs etc.) in the line of incision till the impaled object is reached, taking special care not to injure any vital structures in which case the tractotomy is either not attempted or special care is taken. This is followed by retraction of the wound.

vii. The impaled object is handled carefully. It is 'lifted out' and not 'pulled out' and this is facilitated by tractotomy and not usually by standard incisions. This maneuver prevents friction injuries along with further contamination. Also surgeons can easily access the bleeder in the case of bleeding secondary to loss of tamponade by the removal of the impaled object. A word of caution here: proximal and distal control of vessels may not be possible in such cases.

viii. Debridement of tissues especially entry and exit wounds should be done.

ix. Wide drainage and debridement are warranted if contaminated or dirty material is present.

x. Injuries should be managed with appropriate multidisciplinary team.

Advantages of torso-tractotomy

- a) It is usually a quick incision.
- b) It allows 'lifting off' of impaled object.
- c) It provides good exposure to area of interest.
- d) It allows easy hemostasis and other repair/reconstruction procedure following removal of impaled object.
- e) It is usually the shortest possible incision with respect to other classical incisions.
- f) It requires less mobilization and retraction of tissues for exposure with respect to other standard incisions.
- g) Patient's OT table positioning usually is compatible but may require two OT tables together for appropriate positioning.
- h) If more exposure is needed, the incision can be combined with other standard incisions or the tractotomy incision can itself be extended along the line of incision.

In case 1, the tractotomy incision made the challenging surgery relatively easy which can be gauged by the fact that the iron angle was removed within twenty minutes of the start of the surgery. There were no post-operative residual complications or disabilities in both the cases. Though multiple ribs were divided (costotomies) in line of incisions, patients had no significant post-operative pain or neurological symptoms. In fact it is our observation that pain is significantly more when thoracotomy is done by retracting the intercostal spaces (by spreading the ribs) rather than performing costotomies in the line of incision. Also

soft tissue dissection is significantly less when costotomies are used as compared to thoracotomy using intercostal spaces. It is to be noted that costotomies are also routinely employed for excision of large chest wall tumors.

Disadvantages of torso-tractotomy

- i. This incision is not possible in all cases.
- ii. It has to be tailored according to a particular case.
- iii. It may not be appropriate in multiple impalements in a single patient.
- iv. It should not be done /very difficult to do if vital structures come across the line of incision.
- v. Proximal and distal control of vessels may be compromised until the incision is extended or it is combined with other standard incisions.

Justification for terminology

'Otomy' means 'to make an incision or cut into' and 'tractotomy' means 'laying open of the tract'. Such terminologies are already there in surgical practice like pulmonary tractotomy (used for penetrating lung injuries), fistulotomy (laying open of fistula tract), etc. The described torso-tractotomy is in reality 'opening up of the tract made by the impaled object through the torso' but in a major way.

Review of 'use of surgical incision / approach in torso impalements'

We have reviewed the literature of impalement injuries and found that many surgeons have already used this incision though in a different way (Table 1). But we could not find the use of costotomies in line of incisions anywhere; rather surgeons have used standard thoracotomy (entering the chest through retraction of ICS) in combination with tractotomy involving only soft tissues.

Conclusion and Recommendation

It is our humble suggestion that the term 'Torso-tractotomy', 'Thoracic tractotomy' or 'abdominal tractotomy' should be used as appropriately when such surgeries are performed for impalements or transfixation injuries. Though at times these types of incisions and approaches have excellent advantages, it must be remembered that they represent only one type of surgical approach and should be judiciously used taking into consideration the suitability of a particular surgery.

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