Chapter 13
Choice of Thoracic Incision

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Deployment Experience:

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BLUF Box (Bottom Line Up Front)

1. We are not here to cure cancer or treat angina; trauma is the game.
2. Positioning is the key to keeping your options open.
3. If you find yourself putting the patient in anything other than supine position for an exploratory trauma operation, think about it again.
4. Keep your options open – you may be wrong about where to go first a third or more of the time.
5. Get the exposure *you need* to get to the ABCs.
6. Do not let anatomical barriers interfere with your ability to get to the ABCs (the sternum is just a bone, so is the clavicle).
7. Chose your incision and know when and how to modify, extend, or abandon it.
8. Don't worry about the injuries you've found – worry about the possible injuries you haven't found yet and how you're going to get there.
9. The first maneuver if you find yourself struggling should be to enlarge the incision.

Pray before surgery, but remember God will not alter a faulty incision.

Arthur Keeney, 1920

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Why This Chapter Matters to You

No one is going to thank you for leaving fewer or smaller wounds on a corpse – leave your handbook of minimally invasive and aesthetic technique at home – this is not boutique surgery. Also, don't get confused – we are not here to cure cancer or treat congenital or age related cardiovascular disease. That stuff you will find in the handbook of *elective* cardiothoracic surgery. That all applies where the specialized and circulatory-supported are the only surgeons regularly entering the chest. We are going to a place where the general surgeon is likely the only hope a patient has for surviving after a thoracic wound. That hope will be vested in *you*. Fortunately it is also a place where the experienced general surgeon is likely to know a lot about the priorities and pitfalls of thoracic surgery for trauma. But the rub is that even among seasoned trauma and combat general surgeons, there is limited (though highly intense) *individual* experience. It's a very difficult area in which to get a wealth of experience because only a small minority of thoracic injuries, even penetrating or combat related, require a major operation. In those that do require an operation the stakes are extremely high. Mortality and morbidity will stand next to you in the OR and stalk your patient long after you have placed the last staple in the incision (or incisions) you chose. Let me be frank – there may be a few personal case series experts in combat thoracic surgery, but it's highly unlikely that one will show up in your OR. Fortunately for us mere mortals, there is a collective experience on which to draw. So this chapter is written by and for the "grunt" of combat thoracic surgery – the trauma and general surgeon, with the hope that together we may tip the scale in a favorable direction for our patients and their families.

Rules of Engagement

This chapter is not about when to operate. It is not about how to perform an operation. It is about how to begin and adapt an operation based on the knowledge and skills *you bring* to the situation you face. Utility for exposure and control of the thoracic vessels and organs *in your hands* is the single most important factor in choosing an incision and for keeping your options open. With that being said, let's keep a few things in mind. There is no mandatory imaging required prior to making an incision in the chest. Though imaging may be helpful in terms of understanding trajectories or injured structures, it does nothing for fixing airway, breathing, or circulation. So be ready to make an incision based on limited information when the patient doesn't have the luxury of waiting for the exposure of an X-ray cassette. Also, be ready to modify or abandon your initial incision based on what you do – or maybe even more likely – *do not find*. The utility of the incision you choose (e.g. the extent of exposure and control potential it provides) is going to be inversely proportional to the amount of pre-operative information – especially imaging information – you have available.

"This Guy is Dying; I Need to Open His Chest…"

In addition to how to begin a thoracic operation, the decision of where to begin an operation will depend on your initial intention. If that intention is resuscitative then you may choose to begin the operation in the combat emergency department. The decision to proceed with "ED" resuscitative thoracotomy, beyond potential for salvage, should be guided by the availability of instruments, lighting, suction, and skilled assistance as well as the proximity and availability of an operating room. I recommend moving the patient quickly to the OR and beginning the resuscitative thoracotomy with the patient on the litter in the OR if an OR is immediately available and in very close proximity to the ED. The incision of choice for the resuscitative thoracotomy is a left anterior lateral thoracotomy (Fig. 13.1). This incision gives the best starting point for initial and adequate exposure of the structures in the left hemithorax and mediastinum including the pericardium, pulmonary hilum, distal aortic arch, proximal left subclavian artery, and descending aorta. If injury is not detected or controllable from the left hemithorax the incision can be extended across the sternum toward the right hemithorax as either a limited trans-sternal extension to gain better visibility for control of the left hilum (Fig. 13.2) or full extension to right anterior lateral thoracotomy or the "clam shell"

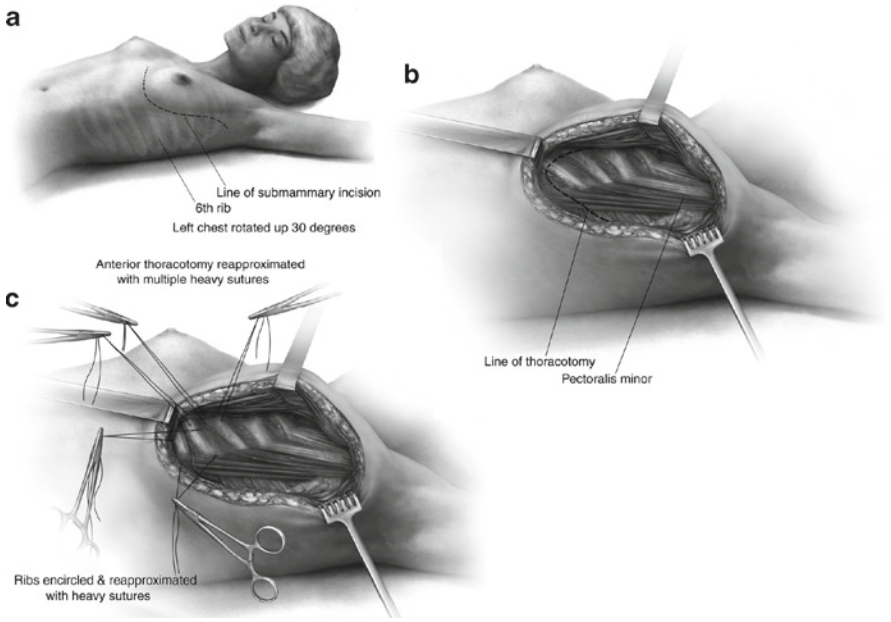

Fig. 13.1 Resuscitative anterolateral thoracotomy. (**a**) The patient should be supine, ipsilateral arm elevated, and place a roll under the back to elevate the chest anteriorly. The incision is along the inframammary crease (females) or the ribspace below the nipple (males) and extends superiorly and laterally to the table. (**b**) Deep exposure with pectoralis incised medially. (**c**) Closure with heavy sutures encircling the ribs. (Reprinted with permission from Campell, Operative Techniques in General Surgery 2008;10:778–786)

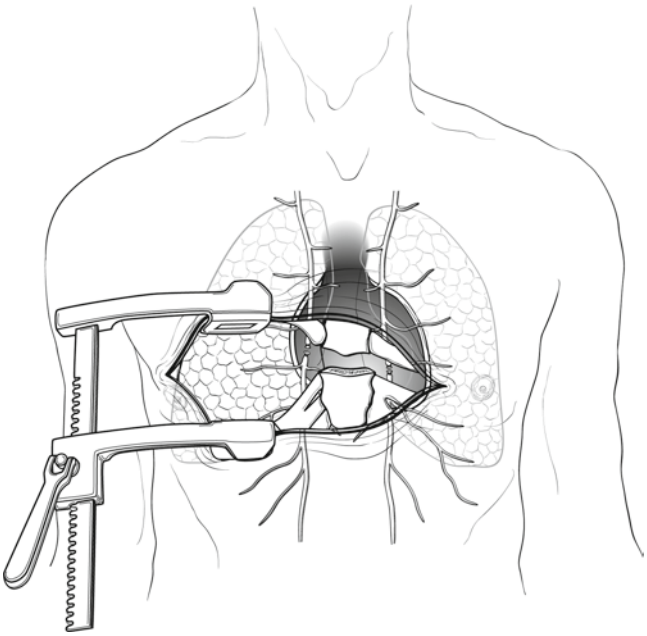

Fig. 13.2 Trans-sternal extension of an anterolateral thoracotomy. The internal thoracic arteries should be identified and clamped or ligated

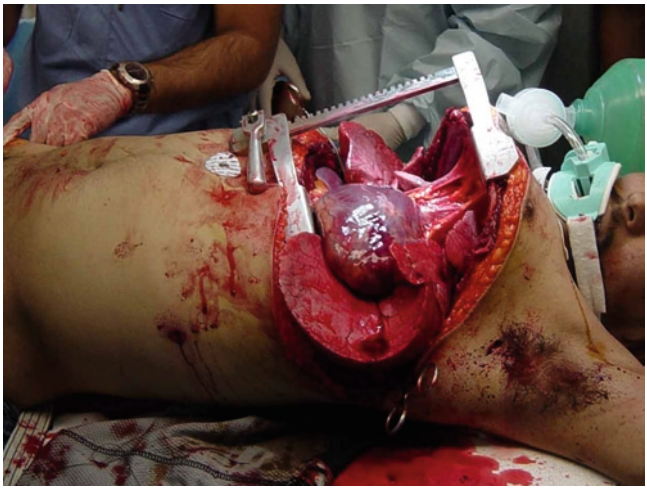

Fig. 13.3 Exposure of the thoracic and mediastinal structures by a full clamshell thoracotomy

incision (Fig. 13.3). The clam shell will provide incredible exposure of the heart and great vessels as well as the thoracic inlet. The limitation of the anterior thoracotomy is exposure of the posterior mediastinal viscera – particularly the esophagus and the posterior wall of the trachea and its major branches. Though injury to these structures

is potentially life threatening, the trade off to optimal exposure is the range of options provided for exposure and control of more immediate life-threatening injury.

"We Have a Pressure We Can Work With…"

If the hemodynamic status permits transfer from the litter to the operating table owing to resuscitation or initial operative intervention, things may seem to be headed in the right direction. Perhaps you relieved a tamponade and deftly repaired an injury to the right ventricle. Perhaps the patient has been stable enough to avoid a resuscitative thoracotomy, but has concerning drainage from a chest tube and a "soft pressure." Don't get greedy. Though it is tempting to position the patient in lateral decubitus with the intent of exploring the ostensibly bleeding hemithorax via a posterior lateral thoracotomy – remember the second BLUF bullet. Simultaneous life-threatening neck, thoracic, abdominal and extremity injury is by no means uncommon with combat wounding. In the patient where the potential for multicavitary injury exists – like the initially unstable patient with limited pre-operative imaging or examination – do not close the door on going down into the abdomen, out to the proximal extremities, or up into the neck. Correct patient positioning is the pre-requisite to preserving the option of entering any of the three thoracic spaces (both hemithoraces and mediastinum), the abdominal cavity, and exposure of the proximal extremities, and the neck. That position is supine with the patient prepped from chin to knees. The most common reasons for choosing the wrong initial incision are misleading chest tube output and relying on the accuracy of physical examination to detect abdominal injury. Here is a short cautionary tale about keeping your options open.

"So what's the deal?" I ask the SOD (Surgeon of the Day).

"Shot in the right chest, posterior exit wound – just had a laparotomy at a FOB (Forward Operating Base) – he's got packs around his liver – the abdominal vac and chest tube aren't draining much – they packed the chest wound too. He looks pretty good, but the chest dressing's soaked through so I am going to scan him and then change the dressing in the OR."

Three hours later I head toward the ICU tent. The patient is in the first litter on the left.

"How much out since the OR?" asks the SOD.

"About 400 from the chest tube and about 200 from the abdominal vac," says the tech.

"Well, he dumped about 300 out of the chest tube when we turned him, but otherwise there's not been much out of that since then. But the chest dressing has soaked through," says the nurse.

I follow the tubes to the hanging bags. PRBC, FFP, and some drips…fentanyl, ativan, levophed… "When did he get started on levo?" I ask. "His pressure has been good till the last hour – we just started it – might be dilating out because he's warmed up now, but that's why I paged the SOD," says the ICU doc.

"What did you find in the OR?" I ask the SOD

"He was bleeding off the chest wall wound – but I got it stopped with some suture and more packing, that's why I didn't wake you up – thought we had it pretty well controlled, but I think we better take him back and take another look," says the SOD

We position him in lateral decubitus, get him prepped and unpack the wound. The gauze is completely saturated. We suction the chest through the wound and see that it is full of blood. We make a posterior lateral thoracotomy and evacuate the blood which we now see is welling up into the chest from a big hole in his diaphragm.

"Damn – he's bleeding from his liver – we need to get him on his back so we can get into his belly guys."

I see a heart rate of 140 and a systolic blood pressure of 70 on the monitor as we pack the chest and whip stitch the skin closed on the thoracotomy. "C' mon guys – he is trying to die on us," says the anesthesiologist as we tear down the drapes and roll the patient supine.

Two hours later he is back in the ICU after we debrided what was left of the right lobe of his liver, got the bleeding controlled and closed the hole in his diaphragm.

"I've Seen This Before…"

In addition to sharing this story as a means of illustrating the importance of keeping your options open, I also share it to illustrate the importance of recognizing pattern of injury. In the anecdote, the thoraco-abdominal wound pattern was recognized by the surgeons at the FOB. They chose to operate in his abdomen and they chose correctly. At our second operation we were misled by the chest tube output and abdominal examination (minimal vac drainage). Penetrating thoracic wounds may have a 40% or greater chance to be associated with abdominal injury (especially gunshot wounds). The likelihood is greatest in the thoraco-abdominal region (costal margin to nipples in front and scapular tips in back). Moreover, thoraco-abdominal wounds requiring thoracotomy and laparotomy have an extremely high mortality. If you're not convinced yet, then consider that in these life-threatening injuries you may be wrong about which cavity to enter first more than one-third of the time. The thoraco-abdominal injury pattern has a high lethality and requires positioning and exposure with the greatest versatility to gain control of injured organs and vessels in the chest and abdomen. The position of choice is the patient supine, allowing for anterior lateral thoracotomy, sternotomy, and laparotomy with options to go up to the neck or out into the proximal extremities.

"Stem to Stern Potential"

The median sternotomy is the incision with the most utility to reach the heart and great vessels. It also provides access to the pulmonary hilar structures and to a lesser extent the lungs (Fig. 13.4). It is versatile in that it can be extended into the neck and via the "trap door," out into the proximal upper extremities. The trap door will provide access to the subclavian artery and its branches including the proximal vertebral, the internal mammary and the axillary arteries (Fig. 13.5). It also allows the option for laparotomy. The disadvantage to this incision is that it provides sub-optimal access to the lungs, particularly the left lower lobe, and provides no exposure

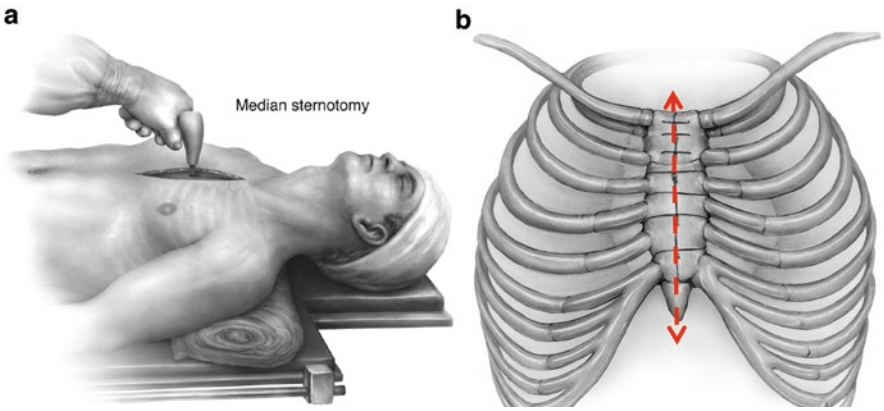

Fig. 13.4 Median sternotomy incision from 2 cm above sternal notch to 2 cm below xiphoid (**a**). The sternum is then opened with a power sternal saw (**b**) or a Lebske knife, with no lung ventilation during sternal division. (Reprinted with permission from Campell, Operative Techniques in General Surgery 2008;10:778–786)

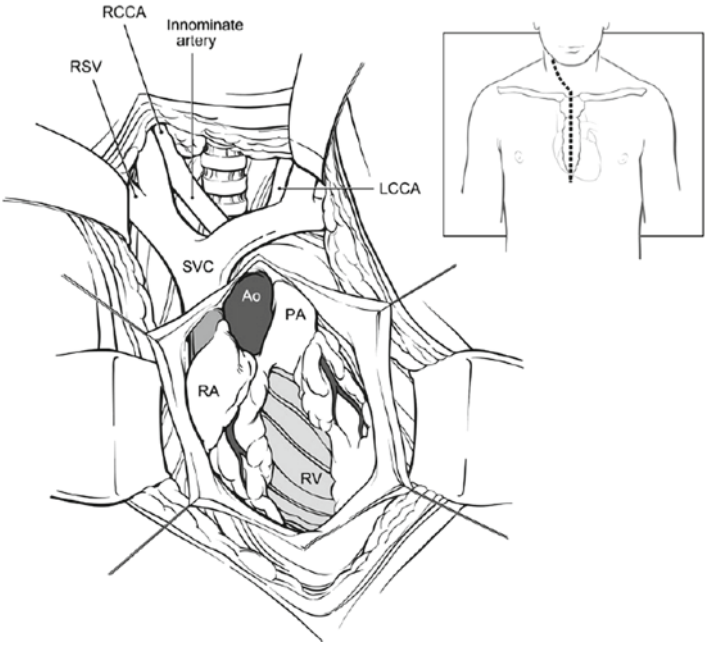

Fig. 13.5 Extension of the sternotomy incision into the right neck (*inset*) or supraclavicular area provides excellent exposure of the proximal right subclavian and right common carotid arteries. (Reprinted with permission from Meredith et al., Surgical Clinics of North America 2007;87:95–118)

to the posterior mediastinal structures, particularly the descending aorta. Dividing the adult sternum will require either a sternal saw or a Lebske knife. Know how to use both. Power tools may not be an option in the combat zone.

One Way In and Only One Way Out

If you were fighting a house fire you'd want to be able to get into more than just one room of the house – unless you were certain the fire was only in the one room and it had no chance of spreading. The same applies to incisions that limit your options of dealing with injury that is not confined to just one cavity. That's the trouble with the posterior lateral thoracotomy (Fig. 13.6) – if the fire is outside of the room you entered there is no door you can use to get to it. Certainly this incision provides the best exposure for repair of the lung and the only exposure with access to the posterior mediastinum and chest wall. This is the incision to use when you have a known injury that requires this approach for exposure (i.e. proximal left subclavian artery) and are relatively sure there is nothing going on in another body cavity or area of the chest. I am occasionally asked (usually by a resident) if we can rotate the patient's spine such that the abdomen is more accessible in case a laparotomy

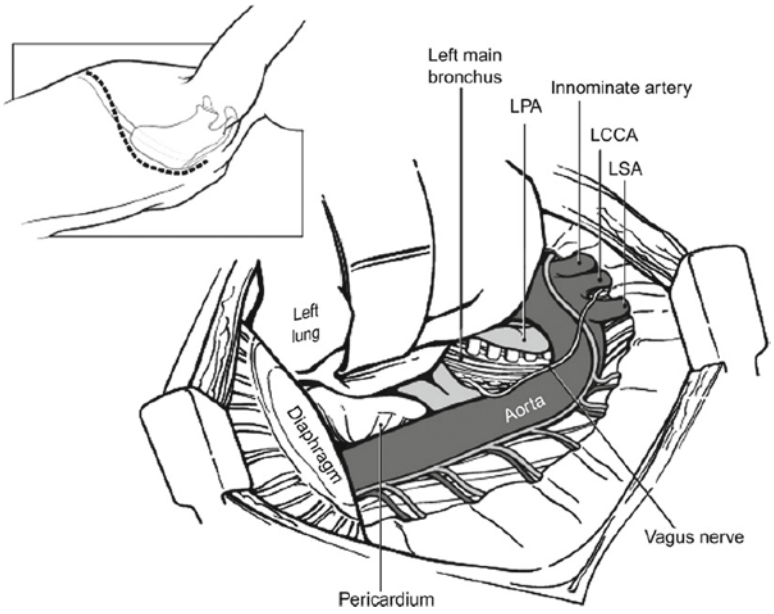

Fig. 13.6 Left posterolateral thoracotomy provides excellent exposure of the posterior mediastinum and particularly the aorta, esophagus, left common carotid (LCCA) and left subclavian (LSA) arteries. (Reprinted with permission from Meredith et al., Surgical Clinics of North America 2007;87:95–118)

is required. While an option, the patient will be positioned less than fully decubitus, supine, or both. So exposure in the chest or abdomen (or both) will be compromised. Because of the lethality associated with thoraco-abdominal injury requiring both laparotomy and thoracotomy – not to mention the questionable safety of rotating the patient's spine – this maneuver doesn't give me a warm feeling in *my* chest. So reserve the posterior lateral thoracotomy for the patient with a known unilateral injury complex requiring only a thoracic operation. One last caution – the bronchi have no valves so fluid will freely flow out of one lung and into the other. Rotating the patient to lateral decubitus position without a bronchial blocker or dual lumen tube is ill-advised. Keep your perspective – if the options of dual lumen tube or bronchial blocker are outside your scope of care and you are operating on a bleeding chest you should think again before risking drowning the patient in his own blood.

Variation on BLUF #6: The Costal Margin is Just Cartilage

The thoraco-abdominal incision is an option for gaining exposure in both the inferior thorax and upper abdomen. This incision is virtually never used for emergent exploration, but it may be the approach of choice for exposure of spine injuries in the T10–L1 area or complex thoraco-abdominal vascular repairs. The patient may be positioned either supine or in semi- or full lateral decubitus (Fig. 13.7). On the left, opening the diaphragm will provide exposure to the gastroesophageal junction, the structures in the posterior mediastinum including the spine, distal esophagus and descending aorta, and the abdominal organs in the left upper quadrant including the stomach, colon, spleen and kidney. The hemithorax, liver, vena cava, and kidney

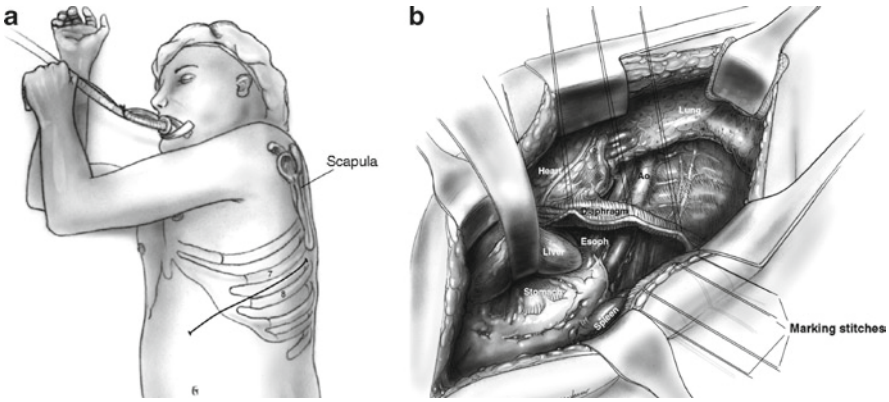

Fig. 13.7 Thoraco-abdominal incision through the seventh or eighth intercostal space and extended onto the anterior abdominal wall (**a**). Note the wide exposure provided of both thoracic and abdominal structures by opening the diaphragm (**b**). The diaphragm should be opened circumferentially preserving at least a 2 cm cuff attached to the chest/abdominal wall and use marking sutures to help with the subsequent repair. (Reprinted with permission from Gusani et al., Operative Techniques in General Surgery 2008;10:107–110)

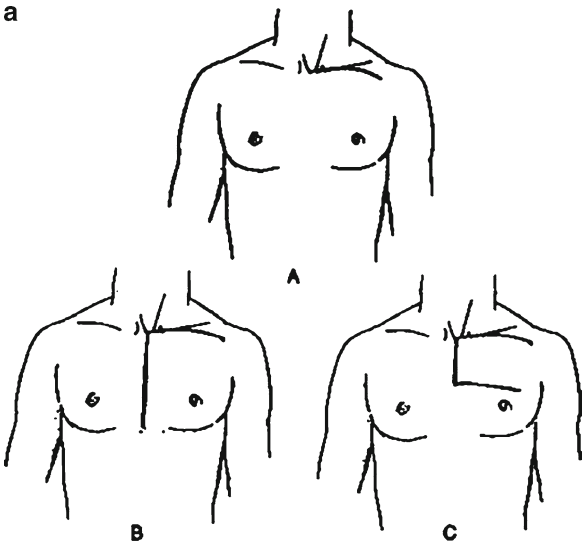

Fig. 13.8 (**a**) Variety of clavicular incisions and extensions for exposure at the thoracic inlet. (**b**) Resection or dislocation of the clavicle to obtain full exposure of the subclavian vessels. (Reprinted with permission from Demetriades et al., Current Problems in Surgery 2007;44:1–73)

can be simultaneously approached with a right thoraco-abdominal incision. The thoracic portion of the incision is made in the sixth or seventh interspace and then carried across the cartilage of the costal margin. A principle disadvantage of this incision

is the pain associated with a costochondral nonunion and the potential for injury to the phrenic nerve – which is greatest for incisions involving the medial aspects of the diaphragm.

And So Goes the Clavicle…

As you may have figured out by this point, unlike the abdominal cavity there is no single incision or exposure that gets you everywhere you need to be in the chest. You will quickly realize this when you have a patient hemorrhaging from a difficult to expose structure or area. Another of these areas is the junction between the chest and neck or the chest and upper extremities – i.e. the subclavian vessels, proximal carotids, or even vertebral arteries. Do not let the skin or the clavicle stand between you and gaining adequate exposure and control. Figure 13.8a demonstrates several key clavicular incisions which can provide excellent exposure alone or in combination with a sternotomy. If the injured vessel or the site for obtaining control is behind the clavicle, then you can resect the midportion of the clavicle or dislocate and elevate the clavicle. This quickly turns a difficult exposure of these vessels into a "chip shot" (Fig. 13.8b).

Bottom Line

Don't confuse trauma and combat thoracic surgery with elective practice. Positioning is the key to utility and versatility. Keep your options open and be ready to extend, modify, or abandon an incision to get to the ABCs. Don't delay operative control or resuscitation for X-rays when the patient is trying to die on you. Recognize the lethality of the injuries that actually require a thoracic operation, particularly the thoraco-abdominal injury that requires operations in both the chest and the abdomen. Understand that you have a good chance of going into the wrong cavity first and can be fooled by chest tube output and abdominal examination. So again – *keep your options open!* Realize that there may be a few personal case series experts in combat thoracic trauma, but it's very, very unlikely that one is going to show up in your OR. You are going to be the best hope the patient has to survive the initial operation for a thoracic injury. If you do this long enough you will get some cases under your belt. But don't get overconfident. Add what you learn to our shared knowledge base. I wish you success in our noble cause to give the combat wounded the best opportunity for survival and recovery.