18. Thoracic Vascular Injuries

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Introduction

Thoracic vascular trauma can present a significant clinical challenge. The relative inaccessibility of the vasculature, exsanguinating hemorrhage, and lack operator experience all contribute to the difficulty in treating these infrequent but potentially lethal injuries. Early recognition, appropriate utilization of imaging, and familiarity with surgical exposure and techniques of repair will improve survival. This chapter includes a brief history of thoracic vascular trauma, the evolution of treatment, specific operative techniques, management of surgical complications, and outcomes. Emphasis will be placed on decision making, clinical judgment, and operative techniques.

History

Although thoracic vascular trauma is not frequent, it is associated with significant mortality. The vast majority of thoracic vascular injuries are the result of penetrating trauma, all intrathoracic vessels are at risk, and the mortality is significant [1–5]. Blunt injuries most often involve the descending thoracic aorta just distal to the left subclavian artery and are also associated with high mortality [6]. Several studies report a prehospital mortality greater than 50 % following penetrating injury [1, 7] and a variable operative mortality ranging from zero to almost 40 % [8]. Parmley's landmark article described the natural history and lethality of blunt aortic injury (BAI) [6]. Unlike penetrating trauma, there have been

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major advances in the treatment and survival of BAI, including thoracic endovascular aortic repair (TEVAR), delayed operative management, and selective nonoperative management. Endovascular techniques have been less frequently employed in the treatment of penetrating vascular injuries. Improved imaging, particularly computed tomographic angiography (CTA), defines the nature, extent, and location of the vascular injury. This information influences the decision regarding nonoperative, endovascular, or open procedure. By characterizing the injury and its location, imaging will influence the choice of incision. Damage control, a widely used technique for selective abdominal and orthopedic injuries, has been successfully applied to both vascular and thoracic trauma.

Penetrating Vascular Injury

The thorax, especially the mediastinum, contains several large arteries and veins. The aorta and its intrathoracic branches and the innominate, subclavian, and proximal carotids can all be injured from blunt or penetrating injury. Intrathoracic venous structures including the superior and inferior vena cavae and right and left innominate, subclavian, proximal internal jugular, and azygos veins are all at risk. The pulmonary artery and veins may also be injured, especially at the pulmonary hilum.

The vast majority of the thoracic great vessel injuries result from penetrating trauma, and many victims die before reaching definitive care [9]. Patients arriving with suspected great vessel injury demand rapid assessment and evaluation. Not surprising, those presenting in shock generally have a higher mortality, reinforcing its lethality. This subset of patients requires an immediate operation; only stable patients should undergo advanced imaging.

Initial Evaluation

All patients presenting with penetrating thoracic trauma are at risk for great vessel injury and undergo the standard ABCs of trauma care. Vital signs, arterial saturation, and a rapid yet thorough physical exam, with particular attention to external bleeding, expanding hematomas, and upper extremity pulse differential, should be performed. Direct digital pressure should be applied to external bleeding. An absent radial pulse suggests an arterial injury, and an extremity neurologic deficit may be the result of a brachial plexus injury. A FAST examination including abdominal and pericardial views will detect hemoperitoneum and hemopericardium. A portable chest radiograph yields valuable information including hemothorax, pneumothorax, or widened mediastinum. A type and cross match and lactate and arterial blood gas should be included with the admission laboratory tests. With these data the clinician must make a judgment regarding hemodynamic stability, shock, and depth of shock. Hypotension, generally defined as a systolic blood pressure <90 mmHg, is an ominous sign with resultant shock and acidosis. A normal blood pressure on admission may represent a compensated shock state, which should be considered in the presence of tachycardia and a narrow pulse pressure. Lactate and base deficit are excellent markers for the presence and depth of shock.

The initial determination of shock and hemodynamic instability is the crucial first decision in the patient's management. Unstable patients require immediate operative intervention. Additional diagnostic studies and imaging should only be performed in stable patients. This point cannot be overemphasized; penetrating thoracic trauma with hemodynamic instability and shock requires surgery.

Hemodynamically stable patients, however, may benefit from additional imaging. CTA has supplanted angiography as the imaging modality of choice for both blunt and penetrating chest trauma. It defines the nature, extent, and exact location of the injury. Information gleaned influences open versus endovascular approach and, choice of incision if an open repair is indicated. CTA accurately diagnoses penetrating great vessel injuries, altering the operative approach in 25 % of patients [8]. Chest CTA has been shown to be the definite imaging study for penetrating mediastinal injuries, which historically required angiography, bronchoscopy, esophagoscopy, and esophagram to exclude an injury [10]. Blunt aortic injury is also accurately diagnosed with CTA [11].

Surgical Approach

The choice of the incision ("the incision decision") requires sound surgical judgment and is influenced by the patient's hemodynamics. Unlike abdominal exploration, which is almost always performed through a laparotomy incision, there are several surgical approaches to the thorax, each with advantages and disadvantages. Irrespective of the choice of incision, it must provide adequate surgical exposure and be versatile. The thorax can be explored through an anterolateral incision, which can be extended across the midline as a bilateral thoracotomy or

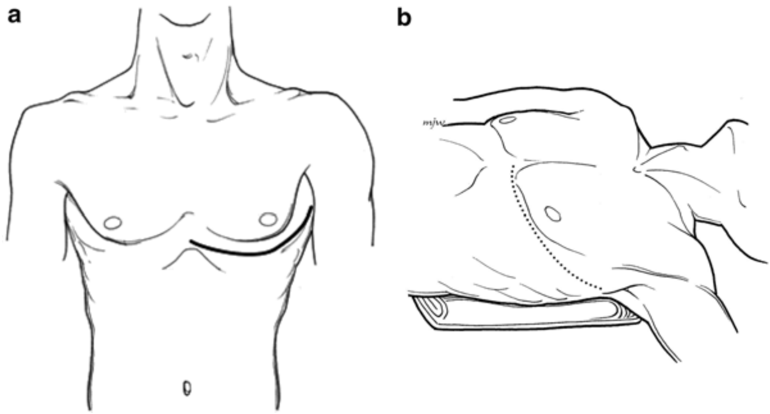

Fig. 18.1. (**a** and **b**) Anterolateral thoracotomy. The bump and extended ipsilateral arm greatly improves exposure of the pleural space. The incision can be extended across the sternum as a bilateral anterolateral thoracotomy ("clamshell").

"clamshell" (Figs. 18.1 and 18.2). This offers several advantages; it is rapid, allows excellent exposure of the anterior mediastinum and pleural spaces, and is an incision familiar to trauma surgeons. With the patient supine, a laparotomy can be easily performed. The disadvantages include inadequate access to posterior structures, and, if a clamshell is performed, the incision across the sternum may be placed too caudal, limiting superior mediastinal exposure. Placing a bump under the back and extending the ipsilateral arm improve exposure. When performing a clamshell thoracotomy, remember to ligate the internal mammary arteries. With profound hypotension they may not initially be bleeding but certainly will once blood pressure is restored.

Median sternotomy is an excellent choice for mediastinal exposure (Fig. 18.3). It is ideal for cardiac and great vessel injury, can be extended for neck or periclavicular exposure, and allows a laparotomy to be easily performed. A surgeon familiar with this incision can rapidly perform it, but less experienced operators may prefer the clamshell approach. As with the anterior lateral incision, sternotomy provides poor visualization of posterior structures. One area of controversy is the approach to the proximal left subclavian artery. While the right subclavian is exposed through a sternotomy with periclavicular extension, the optimal exposure of the left subclavian artery has been debated. Conventional wisdom favors a periclavicular incision coupled with a third or fourth

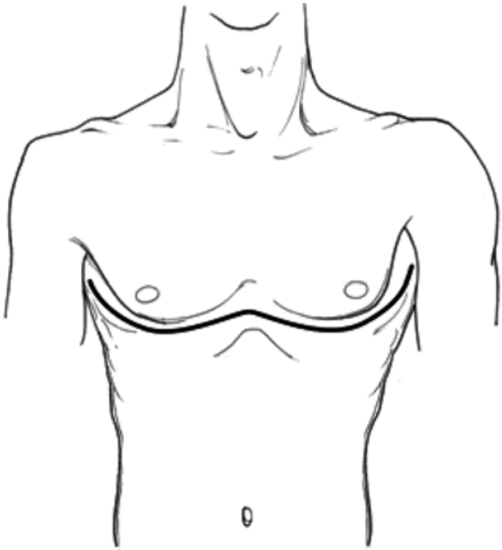

Fig. 18.2. Anterolateral thoracotomy extended as a clamshell. For optimal exposure the sternum must be divided as shown. Placing the incision more inferiorly will transect the xiphoid thereby limiting exposure to the superior mediastinum.

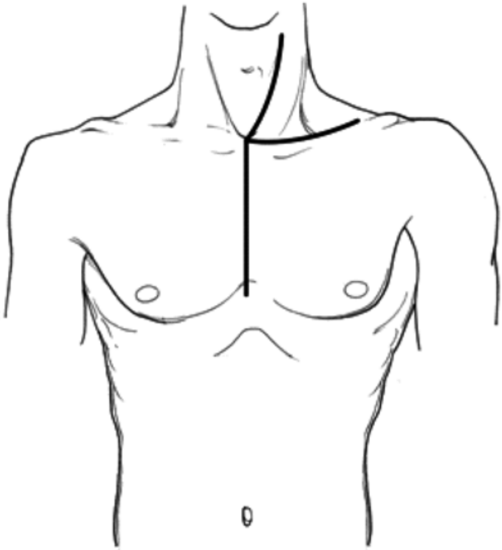

Fig. 18.3. Median sternotomy. It is the ideal approach to the heart and great vessels. This is a versatile incision as it can be extended to the neck or clavicle.

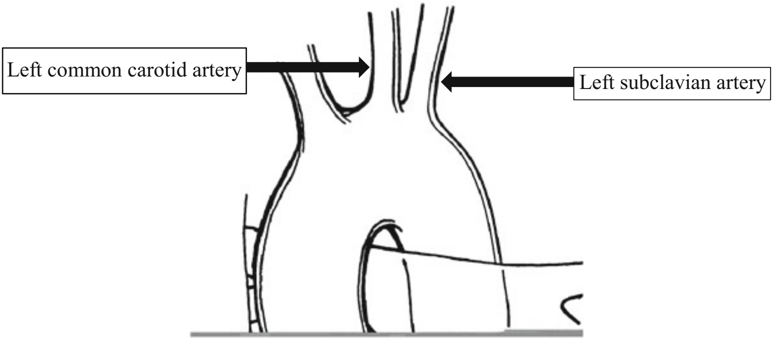

Fig. 18.4. Aortic arch and branches. The left subclavian artery is adjacent to the left common carotid and can be exposed through a sternotomy with left periclavicular extension. This is the authors' preferred approach.

interspace left anterior thoracotomy. This is curious since the operative approach to the proximal left carotid artery is median sternotomy and the left subclavian vessel is adjacent (Fig. 18.4). Combining sternotomy with a left supraclavicular extension provides excellent exposure of the left subclavian artery [12]. We have used this approach exclusively for left subclavian injuries, and clavicular resection is rarely needed [8]. Hemodynamically unstable patients require rapid evaluation, a thoughtful choice of incision and prompt surgical exploration. Anterolateral thoracotomy, clamshell, and sternotomy are all acceptable incisions in the hemodynamically unstable patients [8].

There are more options for surgical exposure in the hemodynamically stable patient with a great vessel injury. As opposed to an emergent operation, which is commonly exploratory in nature, imaging studies will have defined the location and nature of the vascular injury. The operation is performed to repair a definitive injury, thus allowing a more tailored approach. In addition to anterolateral thoracotomy (unilateral or clamshell) and sternotomy, periclavicular, partial sternotomy and posterolateral thoracotomy approaches can be used. The choice of incision depends on the specific injury, and each has its inherent advantages and disadvantages.

A periclavicular incision has the advantage of being rapidly performed and is versatile, as it can be extended to a sternotomy or for a neck exploration (Fig. 18.5). The main disadvantage is limited exposure, and clavicular resection is necessary and may prove more challenging than anticipated, especially for those with limited experience with the technique.

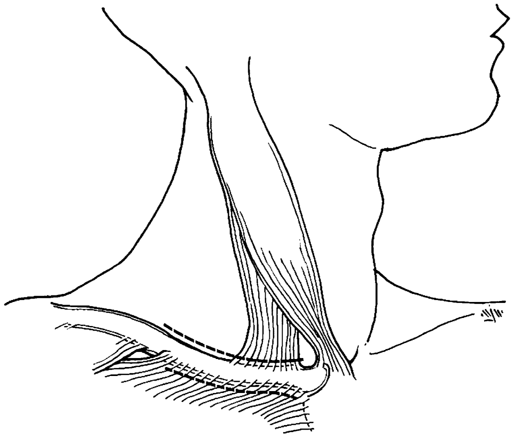

Fig. 18.5. Periclavicular incision. Either supra- or infraclavicular approach can be used. Resecting the clavicle may be challenging and take more time than expected. Unroofing a hematoma with proximal control can be problematic.

Posterolateral thoracotomy allows excellent visualization of the pleural space with the exception of the anterior mediastinum and is the preferred incision for elective thoracic surgery (Fig. 18.6). Disadvantages, in addition to the limited anterior exposure, include lack of versatility. Also hypotension may be exacerbated with lateral positioning. Single-lung ventilation will allow for excellent visualization of the pleural space. In stable patients partial sternotomy is an attractive option for superior mediastinal exposure (Fig. 18.7). The manubrium is divided in the midline from the sternal notch passed the angle of Louis. It is carried laterally as a "T" of "J" and a small sternal retractor (pediatric sternal retractors work well) is placed. It affords excellent exposure of superior mediastinum and is versatile, as it can be extended to the neck and clavicle or continued as a full sternotomy. The ultimate choice of incision for exploring the hemodynamically stable patient will depend on the location of the injury, experience, and surgical judgment.

Intraoperative Management

Operative management of intrathoracic vascular trauma depends on the specific vessel injured and the patient's clinical condition. Damage control is an attractive option in the hypotensive, acidotic, hypothermic,

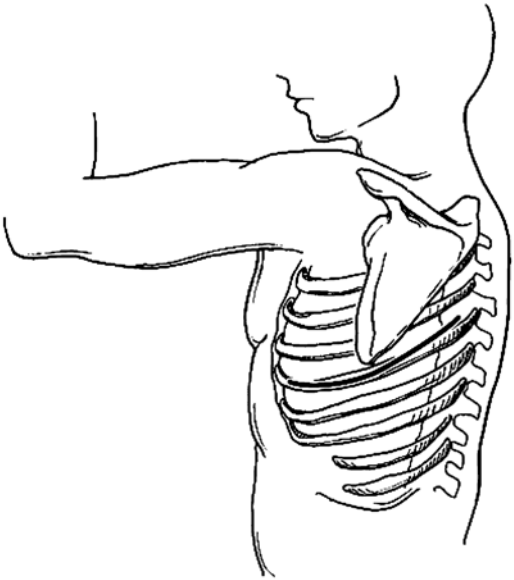

Fig. 18.6. A posterolateral approach is preferred for elective thoracic operations. Limited exposure of the anterior mediastinum and lack of versatility are its disadvantages. Exposure of the hemithorax is greatly improved with double lumen tube and lung isolation.

and coagulopathic patient. Hemorrhage is controlled, the thorax is packed, and resuscitation continues in the ICU. Following restoration of normal physiology, planned re-exploration and closure can be performed [13]. Proximal and distal vessel control is a fundamental tenant of vascular surgery; the previous section discussed the various operative approaches to accomplish this. With the expanding role of catheter-based therapy, a sophisticated option is proximal balloon occlusion. This is an excellent, though underutilized, technique to achieve inflow control without extensive dissection in a challenging anatomic location. Its role will expand as catheter-based therapies gain more popularity.

Although thoracic venous injuries may be repaired, it can be time consuming, often results in venous thrombosis and possible embolization. With the crucial exception of the superior and inferior vena cavae, which are repaired without lumen compromise, thoracic veins can be ligated with little clinical consequence. If ligation is performed, indwelling venous catheters must be removed prior to venous ligation.

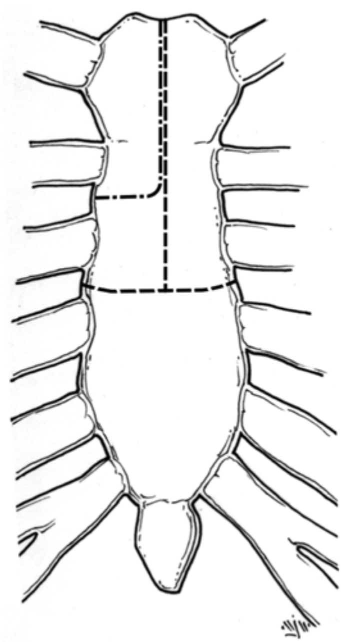

Fig. 18.7. Partial sternotomy. This is an attractive option in stable patients. Carrying the sternotomy distal to the angle of Louis generally provides excellent exposure to the superior mediastinum. Either a "T" or "J" lateral division of the sternum can be utilized. This incision is versatile as it can be extended to the neck and clavicle or continued as a full median sternotomy.

Facial or extremity edema is the sequela of venous ligation, which is managed by elevation and generally resolves within days.

With few exceptions arterial injuries should be repaired, with ligation only performed as life-saving measure for uncontrollable ensanguining hemorrhage. There are multiple options for arterial repair, and the trauma surgeon should be familiar with all of them. They include primary repair, patch angioplasty, graft interposition, and temporary shunting with delayed repair. Stab wounds can often be repaired primarily, with or without resection as indicated. Patch angioplasty can be accomplished with autologous vein or prosthetic material. Gunshot wounds result in significant tissue injury and generally necessitate resection and end-to-end interposition graft. Contrary to the use of bypass grafting for diffuse atherosclerotic disease, penetrating injuries are localized and amenable to graft interposition. Either autologous vein or prosthetic graft can be used. Size match and wound contamination will influence the choice of conduit. Vein is the preferred conduit in a grossly contaminated wound or if the graft traverses a joint.

The principles of damage control surgery have been successfully applied to vascular trauma [14]. Performing an arterial reconstruction in the face of profound acidosis, hypothermia, and coagulopathy may be ill advised. The alternative approach is placing a temporary vascular shunt, physiologic resuscitation in the intensive care unit, and a delayed definitive arterial reconstruction. Once physiologic depletion has been corrected, a planned vascular repair can be performed.

Preoperative planning, adherence to established principles, and a precisely performed technical repair are all crucial to a successful outcome. Patients should be widely prepped and draped, including the torso and extremities for vein harvesting. As discussed in the previous section, the choice of incision is extremely important. Vascular control is obtained directly or using proximal balloon occlusion. Once the injury is isolated, devitalized tissue is excised; this is particularly important when treating gunshot wounds. Visualizing normal intima is imperative; a repair to damaged intima will fail. Next, inflow and back-bleeding must be assessed, and, if inadequate, a thrombectomy should be performed. Since most individuals with penetrating trauma are young, inadequate inflow cannot be the result of atherosclerotic lesions, and a proximal thrombus must be sought. Back-bleeding may be more difficult to assess, and if poor a thrombectomy should be performed. If back-bleeding is still inadequate, an intraoperative angiogram will define the distal anatomy. Performing the angiogram at this stage will assist in planning the remainder of the operation. If the distal vessels are patent, poor retrograde flow is secondary to the lack of collateral vessels, and arterial reconstruction may proceed. If, however, the distal vessels are occluded, additional procedures, such as distal vessel exploration and thrombectomy, are warranted. Whichever technique is chosen for arterial repair, it is imperative that the anastomosis be tension free. At the conclusion of the arterial repair, vessel patency must be confirmed. While interrogation with a Doppler is often performed, the presence of a palpable distal pulse will confirm a patent vessel. An absent palpable pulse should prompt an intraoperative angiogram and, if abnormal, will allow for the rapid correction of any technical problem. It is often stated that following arterial reconstruction one should leave the operating room with "a pulse or a picture."

The role of anticoagulation in the management of vascular trauma is debated, particularly among those with head trauma or blunt mechanism with significant associated injuries. It is preferable to systemically anticoagulate prior to applying vascular clamps. If systemic anticoagulation is contraindicated, flushing the arterial tree with heparinized saline is an option. Systemic anticoagulation is not reversed. Similarly, the role of postoperative antiplatelet agents is not known. It is our practice, if there is no contraindication, to keep the patient on low-dose aspirin for 1 month postoperatively.

The role of endovascular treatment of thoracic vascular trauma is evolving rapidly. Although these techniques are more commonly used in the treatment of blunt injuries, which are discussed below, there is a limited but growing application to penetrating vascular trauma. Pseudoaneurysms, arterial-venous fistulae, occlusion, and transection, resulting from penetrating trauma, have all been successfully treated using endovascular techniques [15]. The advantages are obvious, definitive treatment without thoracotomy or sternotomy, thereby avoiding the associated operative complications. There is, however, attendant morbidity with endovascular therapy; the two most common are endoleaks and insertion site vascular complications. These will be discussed in more detail below. It can be anticipated that the role of endovascular therapies in the treatment of penetrating vascular injuries will expand as devices improve and more experience is gained using this modality.

Personal Tips for Specific Vascular Injuries

The intercostal arteries are commonly injured arteries with penetrating trauma. Surgery to control hemorrhage from intercostal injury is the most common indication for thoracotomy following penetrating injury. The intercostal vascular bundle runs on the inferior border of the rib. Thus, it may be hard to isolate and ligate them. Our preferred method to control these is placing a suture, usually 0 or #1 Vicryl suture, around the rib and reenter the chest at the top of the lower rib, similar to a pericostal suture for chest closure. When the suture is tied down, the intercostal artery and vein are cinched up against the rib and ligated. It is important to ligate both proximally and distally from the point of injury, as the distal may bleed from collaterals if not ligated. If this is difficult, exposure may be enhanced by simply opening the entrance wound and dissecting down onto the chest wall. The suture can be passed from the chest out into the wound and then back again into the chest with a greater degree of accuracy. If hemostasis is being attempted using a thoracoscopic approach, using a suture passer can be helpful to occlude the intercostal artery. We prefer using the orthopedic passer. Intercostal artery injuries located posteriorly may be exceedingly difficult to control. The rib space is narrow, and the entire area posteriorly is difficult to approach from an anterior exposure. In that case, temporizing and attempting angiographic embolization may be helpful. Finally, bleeding from an intercostal artery may stop when compressed following placement of a chest or sternal retractor. Removing the retractor and establishing exposure using hand held retractors is a very helpful technique, which allows visualization of the bleeding vessel.

Internal mammary arteries are also under systemic pressure and bleed accordingly. One of the most common reasons internal mammary arteries bleed is they are divided during a clamshell thoracotomy. As these patients are often in extremis, the internal mammary arteries may not bleed with arterial pressure. If resuscitation is successful, these arteries can bleed impressively as do the intercostals. Bleeding from the internal mammary may be minimized by placement of a sternal retractor. It is important to exam these with the retractor removed. As with the intercostals, treatment for a mammary artery is ligation.

Bleeding from the large mediastinal arteries can produce exsanguinating hemorrhage. Regardless of the exposure used, control can be difficult. Initial control with digital pressure can be very helpful until formal control can be obtained. A side biting vascular clamp may also be helpful, in temporarily controlling arterial hemorrhage until the vessels can be dissected free. The innominate and right subclavian arteries are best exposed through a sternotomy with clavicular extension if necessary. It is important to maintain flow via the right carotid artery, if at all possible, during dissection to avoid cerebral hypoperfusion. Injuries to the pulmonary artery and pulmonary vein are fortunately relatively rare, but the bleeding is impressive. Because the pulmonary circuit is a low pressure system, hemorrhage from the pulmonary artery acts more like bleeding from a major vein. There is limited muscle in the wall. Thus, neither of these vessels develop vasospasm. Several of the techniques mentioned in the vascular chapter can be helpful. In particular, injuries to the side of these vessels can often be controlled with intestinal Allis clamps. The clamps can be used to control hemorrhage from the injury without occluding the pulmonary artery or vein. The injury can then be repaired under the clamps. Inflow control for pulmonary artery or venous injuries may be expedited by opening the pericardium. Controlling the vessels within the pericardium allows the surgeon to gain inflow control without attempting to expose the area of injury.

Blunt Vascular Injury

One area which has seen a dramatic change in both diagnosis and management is blunt aortic injury (BAI). Historically this highly lethal injury was suspected by mechanism, such as a motor vehicle collision with rapid horizontal deceleration, and a wide mediastinum on plain chest radiograph, and the diagnosis confirmed by aortography. Except in special circumstances, such as associated severe head injury, the treatment was operative repair with cardiopulmonary support or without cardiopulmonary using the "clamp and sew" technique.

In the current era, CTA is the screening modality of choice, and a more selective management is warranted. Options include medical management without operative intervention, delayed intervention, and the use of thoracic endovascular aortic repair (TEVAR) and open repair. This shift in practice is dramatically demonstrated by two studies, a decade apart, from the American Association for the Surgery of Trauma (AAST). In the first study published in 1997, no patient had a TEVAR, 65 % had repair performed with cardiopulmonary support, and the remainder had the "clamp and sew" technique. Overall morality was 31 % with a paraplegia rate of 8.7 % [16]. The second AAST report in 2008 revealed a dramatic change in practice. Almost two-thirds of patients had TEVAR; the remainder were managed by open repair, and of those, 80 % were performed with cardiopulmonary bypass support. Mortality and paraplegia were 13 % and 1.6 %, respectively [17]. While these data are encouraging, long-term data on TEVAR are lacking. This is particularly pertinent in the trauma population, as many patients undergoing TEVAR are young and the long-term durability of the endograft is unknown.

The evaluation, management, and operative therapy for BAI will be thoroughly addressed in Chap. 19. In brief, the landmark study by Parmley defined the lethality of BAI [6]. Operative management with or without cardiopulmonary support was the accepted treatment. Subsequent studies describing initial medical management for blood pressure and heart rate control followed by delayed aortic repair showed improved outcomes [18]. This concept has expanded to include medical management alone for the management of minimal BAI [19–21]. Determining which injuries can be successful, medical management requires high-grade imaging and sound surgical judgment. Blunt aortic injury in the multiply injured patient presents a challenge as there may be competing priorities. Higher-resolution CT scans now detect small aortic injuries not previously detected with older technology. Grading systems have been developed which guide the clinician [19, 21, 22]. Medical management alone, medical management followed by delayed repair, and urgent or emergent intervention either open or TEVAR are all options. Endovascular repair with TEVAR is the intervention most often used, with open repair reserved for high-grade BAI [17, 18, 21]. The combination of hemodynamics, associated injuries, and CT imaging will help guide a sound clinical decision.

The main concern with medical management is the risk of aortic rupture. In one report, no mortality resulted from the aortic injury but rather was secondary to associated injuries [21]. Complications associated with open repair are those common to any operation. A dreaded complication specific to the procedure is paraplegia, which is decreased when cardiopulmonary bypass or left atrial to femoral bypass is employed. Complications related to TEVAR can be divided into those which are device related, such as endoleaks, and vascular complications related to catheter insertion [19, 21].

While there is a larger experience with endovascular techniques to treat BAI, the same modality has been applied to traumatic injuries to peripheral arteries. Some published reports compare results of endovascular to open treatment [23, 24]. Care must be taken when comparing these non-randomized reports, since there is a selection bias. Unstable patients are more likely to undergo open repair with catheter-based approach used in the stable patient. Alternatively, there are observational studies describing the use of endovascular techniques [15, 25]. The promising results with endovascular therapy and the increasing experienced gained in treating traumatic vascular injuries will lead to an expanded role for this modality.

Complications

Complications associated with the operative management of thoracic vascular trauma can be divided into those related to any operation and those specific to the individual procedure. Complications related to the former include bleeding, respiratory and renal failure, atelectasis, and urinary tract infection. Persistent chest tube drainage is an indication for re-exploration. Wound infections can be considered as a procedure-specific complication. Multiple sources of chest wall vasculature make thoracotomy infections infrequent and generally managed by local wound care. The management of sternal wound infections and sternal dehiscence depends on the clinical setting. Dehiscence without a sternal infection may not require operative repair unless symptoms persist. Superficial sternal infections, without dehiscence, can be managed by local wound care and antibiotics. Deep sternal infections present a more difficult problem. Reoperation, debridement of nonviable tissue including the sternum, culture-specific antibiotics, and wound care are appropriate. Vacuum-assisted wound care (VAC) has been used with excellent results, either as definitive therapy or as an intermediate step prior to muscle flap coverage [26]. The pectoralis is ideal if muscle flap coverage is needed [27].

Empyema, while infrequent, is a serious complication following thoracotomy. The diagnosis is suspected in the postoperative patient with fever, leukocytosis, a persistent opacity on chest radiograph, and difficulty weaning from the ventilator. Enhancing parietal pleura on chest CT is suggestive of an empyema. The diagnosis is confirmed by thoracentesis and cultures, which guide antibiotic therapy. Interventional catheter-based techniques or decortication with VATS may be useful for early stage empyema. The more advanced organized stages more often require thoracotomy and decortication [28]. Whichever technique is chosen, the principles of complete drainage, decortication, full lung expansion, and appropriate antibiotics are the principles to be followed.

Edema resulting from venous ligation is self-limiting and managed by elevation. Serious complications related to arterial repair include bleeding, which if severe demands re-exploration, and limb ischemia resulting from vessel thrombosis. Frequent vascular checks are essential, and any decrease in pulse should be investigated with an imaging CTA, arterial duplex, or angiography, particularly if a catheter-based therapy is contemplated. An absent pulse and a threatened limb require intervention including lytic therapy, catheter-based therapy, and, more frequently, exploration and revision. Infections involving the vessel conduit can result in life-threatening hemorrhage. Pseudoaneurysm formation and anastomotic dehiscence are the dreaded sequela of infection. Vein grafts are more resistant, but not immune, to infection. Thorough debridement of devitalized tissue, adequate hemostasis, and covering the graft with viable tissue will lessen the chance of infection. Arterial duplex surveillance of the graft will detect a pseudoaneurysm.

In addition to the complications associated with an invasive procedure, catheter-based therapies have specific complications. A comprehensive discussion is found in Chap. 19, with a more limited review here. Endovascular complications may occur during the procedure or post-procedure. Endoleaks and access complications are among the more common morbidities encountered. Endoleaks may be an early or late complication and are classified as Type 1, incomplete proximal or distal sealing of the graft; Type 2, flow from collateral vessels; Type 3, rupture of graft fabric or junctional separation; and Type 4, graft porosity. Access complications are commonly discovered intraoperatively or shortly thereafter and require an open operative repair [29]. Complications should decrease over time as devices become more sophisticated and clinicians gain more experience with this modality.

Conclusions

Trauma to thoracic vessels presents a formidable challenge. Life-threatening hemorrhage, the relative inaccessibility of the vessels, and difficulty obtaining adequate exposure culminate in a daunting clinical problem. The clinician is faced with several crucial decisions, which have a profound impact on the patient's outcome. First is determining hemodynamically instability and the presence of shock. While the presence of hypotension is an ominous finding, tissue hypoperfusion and shock may occur in its absence. In addition to initial vital signs, serum lactate and base deficit measurements are critically important. Hemodynamic instability or shock should prompt emergent exploration. Only those patients who are stable are suitable for advanced imaging. Once the determination is made for surgical exploration, the next important decision is the optimal incision ("the incision decision"). The surgeon must be familiar with all surgical approaches, their attendant advantages and disadvantages, and, given the clinical situation, choose the appropriate incision. Having obtained appropriate exposure and identifying the vascular trauma, the next decision is the management of the specific injury. Again the surgeon must understand the multiple options available and, in the context of the patient's overall clinical condition, determine which is best. In the patient in extremis, a damage control procedure may be optimal. Additionally, the surgeon must be familiar with endovascular techniques and their indications. Complications will not be infrequent among this patient population. Sound clinical judgment and adherence to fundamental surgical principles will improve survival and decrease morbidity.

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