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The Shock Trauma Manual of Operative Techniques

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Preface

Operative therapy for trauma is at the center of the care of a badly injured patient. Hemorrhage can stem from a number of body cavities, the chest, abdomen, retroperitoneum, muscle compartments, and the street. Consultative aid can be extremely helpful in caring for multiply injured patients. However, the initial resuscitation and lifesaving operative therapy is almost always within the purview of the general surgeon. This generally involves operating in the neck, chest, abdomen, retroperitoneum, and on the vasculature.

Operative therapy for trauma has become much less commonly needed. Nonoperative management of solid visceral injuries has become the norm, not the exception. Newer therapies for primary or adjunctive hemostasis such as catheter techniques have become very much more commonly used. Penetrating injury in some American cities has dropped considerably. Thus, a general surgery resident and/or faculty member may do a relatively small number of operations for trauma in a given period of time.

However, when it is necessary, there is no substitute. This book will attempt to provide a refresher for surgeons who may be called on to provide lifesaving care in the middle of the night. Our intention is that this book fits into a pocket of a white coat and will be an immediately available reference.

The Shock Trauma Center has been providing large-volume trauma care for over 50 years. Authors are current faculty at Shock Trauma who were primarily trained there and/or have been recruited from high-volume trauma centers. We have developed a very uniform practice. This will be depicted in this book. While there are many ways to approach any given problem, this book will illustrate our approach.

The History of Care

Operative exploration was the norm for many years. In fact, within the abdomen, it was thought that the only diagnostics necessary was to prove intra-abdominal injury existed. The dogma at the time said that all injuries required exploration, visualization, and then therapy depending on its appearance [1].

For many years, physical examination was the only diagnostic test available. While careful physical examination can be quite helpful, even in good hands, it was only approximately 85 % accurate [2]. Newer diagnostic tests emerged. In 1965, H. David Root described diagnostic peritoneal lavage [3]. Surgeons now had a test to augment physical findings. However, DPL, while missing very few injuries, was overly sensitive, and we soon realized that a number of injures with a small amount of blood in the abdomen did not require real surgical therapy.

In the early 1980s, CT scan emerged and revolutionized the care of injured patients. As CT improved, we realized that we could explore with a scan [4, 5]. Operative therapy was reserved for those with proven injury and/or those who presented in shock.

Finally, catheter therapy proved to be a valuable adjunct to the non-operative management, particularly of solid visceral injuries. Splenic artery embolization, first described in 1995, has been extremely useful in sparing patients the need for operation [6]. Catheter therapy for liver injuries can be primary hemostasis and is also quite helpful as an adjunct to operative therapy [7].

Operative Technique with Personal Tips

A systematic approach to the operative therapy of the patient with injuries is extremely important. While the need for this has decreased, nothing substitutes for it when it is necessary. No matter where one trains or practices, it is hard to experience the full gamut of injury, particularly serious injury over a short period of time. To date, we have very poor simulated models; thus, the only real training is clinical experience. The American College of Surgeons Committee on Trauma has several courses which can be quite helpful. The Advanced Trauma Operative Management course (ATOM) provides students with real-life scenarios requiring operative therapy [8]. ATOM requires a large animal model and is quite costly, thereby limiting its utility. Advanced Surgical Skills for Exposure

in Trauma (ASSET) is a cadaver-based course, which allows students to become facile with operative exposures over the entirety of the body. As four students share a cadaver, ASSET can be efficient. However, it is unclear how long the lessons learned in ASSET or ATOM remain in the front of the surgeon's minds. Finally, newer techniques such as Resuscitative Endovascular Balloon Occlusion of the Aorta (REBOA) provide new options to the surgeons. There are several courses that teach this technique. Both the ESTARS and BEST course run by the United States Military and the Shock Trauma Center are options for practitioners who wish to become facile with this technique [9, 10]. Early experience in both courses suggests that these are easily learned by surgeons who have some experience with guide wires and catheters.

Regardless of training, there is still need for a readily available reference to which surgeons can refer to at the time of need for operation. The reference should be portable and easy to understand. There should be sufficient number of illustrations, as these most likely will make reviewing procedures easier than simply reading text. Ideally, a surgical trainee or faculty member should be able to review procedures during down time between patient encounters. In addition, a surgeon should be able to rapidly review a particular facet of operative care on the way to the operating room.

The Shock Trauma Manual of Operative Techniques seeks to help fill the void that currently exists in training of surgeons. We recognize that no single book will be the answer. We hope this will provide some help in caring for injury around the world.

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Part I
Indication and Techniques for Trauma Exploration

1. Neck

Laura S. Buchanan, M.D.

Introduction of the Problem

Neck injury has the potential to involve critical vascular, respiratory, and digestive structures. More than 15,000 neck injuries were documented in the National Trauma Data Bank for 2013 with an overall mortality of 1.87 % [1]. However, mortality for more severe injury (AIS ≥3) is almost 20 % greater than any other body region [1]. Neck injuries are combined with head in Centers for Disease Control (CDC) reporting and cumulatively account for 17 % of injuries requiring hospitalization and 20 % of injuries treated in an emergency department [2].

History

Early management with expectant observation led to delayed diagnosis of injuries and high mortality. Mandatory explorations of traumatic neck wounds gained favor after World War II and resulted in decreased mortality from injury but were associated with significant rates of negative exploration with risk of surgical site morbidity. Improvement in imaging techniques and improved understanding of neck trauma have resulted in a gradual shift to selective exploration.

Treatment of neck injuries is best understood by dividing patients first by mechanism (blunt vs. penetrating) and by anatomic zones. Blunt injury most commonly results from motor vehicle collisions but may occur with strangulation, assault, and sport injuries. Seat belts and dashboards can result in injury to cerebral vessels or larynx. Cervical spine

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injury and spinal cord injury requiring stabilization are much more common in blunt neck trauma than in penetrating. Blunt trauma requires cervical immobilization until spine injury has been ruled out. Blunt cerebrovascular injury is rarely operative, while identified injury to aerodigestive structures typically require repair.

Penetrating neck injury was historically treated nonoperatively until shortly after World War II. Fogelman and Steward reported the first large civilian series on penetrating neck injury and advocated mandatory exploration citing a significant improvement in mortality (6 % vs. 35 % with expectant management) [3]. Violation of the platysma was used to determine potential for injury. During the remainder of the twentieth century, mandatory exploration was widely accepted for penetrating injury to Zone II, with a more selective approach to Zone I and Zone III injuries. Diagnostic modalities for Zones I and III included arteriogram for diagnosis of vascular injuries, laryngoscopy and bronchoscopy for airway injuries, and contrast esophagram and esophagoscopy for digestive injuries. This combination of testing is costly and low yield and has potential complications. Improvement in multidetector computed tomography (CT) allowed for more selective approach to operative and diagnostic procedures.

The transition from mandatory neck exploration to selective operation was studied prospectively by Inaba and colleagues [4]. Including 453 patients over 3 years, they identified 9 % with hard signs of injury mandating exploration. Forty-two percent had no signs of injury and were followed clinically and discharged with no missed injury. The remaining 49 % of patients underwent multidetector computed tomography, which had a sensitivity of 100 % and specificity of 97 % in detecting injuries [4], confirming that a selective approach to exploration in neck trauma is safe and appropriate.

The Eastern Association for the Surgery of Trauma (EAST) guidelines for clinical practice (2008) advise selective management is equally safe and effective to mandatory exploration despite a paucity of prospective trials [5]. The Western Trauma Association (WTA) algorithm for penetrating trauma (2013) also advocates a selective approach [6]. Patients with hard signs (Table 1.1) of vascular or aerodigestive tract injury should undergo airway stabilization and tamponade and proceed to operative exploration. Similarly, patients who are symptomatic with Zone II injuries should undergo early operative exploration. In the absence of the hard signs of major injury, all Zone I and III injuries and asymptomatic Zone II injuries should undergo diagnostic evaluation.

Table 1.1. Hard signs of neck injury as defined in the Western Trauma Association's algorithm [6].

Hard signs of neck injury
Airway compromise
Massive subcutaneous emphysema
Air bubbling through the wound
Expanding/pulsatile hematoma
Active bleeding
Shock
Neurologic deficit
Hematemesis

Surgical Technique

Wise operative planning for injury to the neck involves understanding of specific anatomic landmarks. The neck is divided into three zones. Zone I extends from the sternal notch to the cricoid cartilage and includes the thoracic outlet vasculature, proximal carotids, and vertebral arteries, as well as the trachea, esophagus, spinal cord, thoracic duct, and cervical nerve trunks. Zone II extends from the cricoid cartilage to the angle of the mandible. The carotid arteries, internal jugular vein, vagus nerve, and upper trachea, as well as the larynx, are included in Zone II. Zone III is superior to the angle of the mandible.

Proximal and distal vascular control in Zone II can be relatively easily accomplished via a standard neck incision. This makes injuries in Zone II the most surgically accessible. Distal control in Zone I injuries can be obtained in Zone II; however, proximal control requires a thoracic incision, either a sternotomy, thoracotomy, or peri-clavicular incision. Proximal control of Zone III injuries can be obtained in Zone II; however, distal control—particularly distal vascular control—involves controlling the vascular structures within the skull.

Certainly, patients who present in shock with Zone II injuries are best treated with diagnostic exploration. Even stable patients in Zone II can be treated with operative exploration, though most prefer imaging. Unstable patients with Zone I injuries also undergo operative exploration. The thoracic incision is determined by best guess. If the incision does not provide adequate exposure, a second incision and/or third incision can be made. Incisions can be extended with attempts to gain control. Given the invasive nature of thoracic exposure, stable patients with