Penetrating Groin Trauma

Matelin Crosen MD
Lehigh Valley Health Network, matelin.crosen@lvhn.org

Rovinder S. Sandhu MD
Lehigh Valley Health Network, Rovinder_S.Sandhu@lvhn.org

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Crosen M, Sandhu R.

Continuing Education Activity

Penetrating groin trauma is an infrequent yet complex injury that requires quick identification, evaluation, and treatment in the emergency department and trauma bay setting. Multiple organ systems can sustain an injury with a significant risk of mortality and acute and chronic morbidity. Prompt identification of injuries, implementation of temporizing care measures, and appropriate decision-making in both the stable and unstable patients are crucial for positive patient outcomes. This activity reviews the etiology and epidemiology of penetrating groin injuries, summarizes critical steps in the clinical and imaging evaluation of the traumatically injured patient, and presents options for definitive and damage-control management based upon patient clinical status. This activity also highlights the role of pre-hospital care/transport on clinical outcomes and presents opportunities for interprofessional intervention to decrease rates of injury from firearms.

Objectives:

- Identify the etiology of penetrating groin trauma.
- Review the evaluation of penetrating injuries to the groin in both the stable and unstable patient.
- Summarize and implement the appropriate temporizing and definitive operative and non-operative care for the management of penetrating groin trauma.
- Identify interprofessional opportunities to enhance prompt surgical evaluation, as well as opportunities for outreach and intervention to decrease the incidence of penetrating trauma.

Access free multiple choice questions on this topic.

Introduction

Penetrating injuries to the groin represent a challenging clinical scenario with the potential for injury to multiple vital structures and organ systems. Prompt evaluation and high clinical suspicion can improve outcomes following traumatic injury. Awareness of pathophysiology for various traumatic mechanisms will enable focused assessment and management of injuries.

Etiology

Penetrating trauma can occur as a result of intentional or accidental acts. While most penetrating injuries are due to firearms or stab wounds, additional mechanisms also exist; penetration of blunt objects (sticks, metal bars, etc.) have transpired following falls and high-speed motor vehicle accidents. While chest and abdominal trauma are more common, groin trauma must not be ignored or forgotten. Gastrointestinal and genitourinary organs are at risk of injury. Major vascular structures traverse the groin, and injuries can result in significant morbidity and mortality.

Epidemiology

Penetrating trauma represents both military and civilian incidents; however, the underlying mechanisms of each vary notably. Civilian penetrating trauma mostly consists of stab and low-velocity projectile wounds, whereas military trauma is often high-velocity or blast-associated. Consideration of the mechanism of injury and the associated forces guide decision making in the evaluation and management of penetrating wounds to the groin.

In the military setting, peripheral and vascular trauma has increased in prevalence with advances in body armor. As the vital structures of the head, torso, and abdomen are increasingly protected, extremity trauma with vascular involvement has become more common. Vascular injury rates have increased 5-fold since the World Wars and now represent 12% of battlefield wounds; 60% of vascular injuries involve major/proximal vessels. During the recent conflicts in Iraq and Afghanistan, blast/explosive injuries account for 73% of vascular injuries, with the rest secondary to gunshots.[1]

Penetrating trauma remains a considerable civilian threat in the United States, with over 435,000 patients admitted from 2007-2014; this does not include patients pronounced deceased before arrival at a trauma center. The primary mechanism of injury was split equally between gunshot wounds and stab wounds.[2] As noted above, civilian gunshot injuries are often from low-velocity projectiles (handguns). Civilian penetrating trauma victims are overwhelmingly young males[3]; accidental penetrating trauma involving children also represents a concerning number of injuries.

Notably, high profile civilian mass shootings have increased in incidence and severity in recent years. Perpetrators in these events tend to use high-velocity firearms, and comparisons have been drawn to wartime injuries. However, as compared to the combat injuries described above, there is a

difference in overall and fatal wounding patterns with more frequent head, torso, and abdominal wounds seen as a result of civilian mass shootings; most of these injuries are nonsurvivable (93%).[4] Nevertheless, the civilian trauma surgeon must be familiar with and prepared to treat high-velocity wounds to the low pelvis/groin and associated vascular trauma, which represent potentially intervenable injuries with the opportunity for survival.

Pathophysiology

Tissue effects of penetrating trauma vary greatly based upon the type and velocity of weapon/projectile. Stab-type trauma (knives, swords, etc.) lead to local tissue effects along the tract of penetration. High-velocity projectiles (bullets, shrapnel, etc.) result in wider tissue injury due to the effects of cavitation; in these injuries, the projectile itself causes tissue damage along the tract while energy transfer from deceleration leads to radial stretching (cavitation) and rapid collapse of tissue bordering the path of the projectile. Thus, while tissues or structures may not be directly transected as the projectile passes, significant injury can result from transferred ballistic forces. Delayed presentation of injury can take place, most notably in the form of pseudoaneurysms, arteriovenous fistulas, or peritonitis from spillage of GI contents or urine.

History and Physical

As with any patient presenting after traumatic injury, systematic evaluation using ATLS protocols must be initiated to optimize patient outcomes and survival.[5] The primary survey should commence with an assessment of the airway and breathing. Circulation should then undergo evaluation, given the potential for vascular injury with penetrating trauma to the groin, attention is necessary to both distal and proximal assessment of pulses. Significant hemorrhage, if present, needs to be controlled. Direct pressure is often successful as a temporizing measure to allow for completion of the trauma survey; common femoral arterial inflow can be occluded with distal aortic or proximal iliac artery pressure, though substantial pressure (over 120 pounds) must be applied.[6] Full exposure of the patient is imperative.

The clinician should perform a secondary evaluation. The abdominal exam can reveal evidence of peritonitis if an intraabdominal component of injury is present. A rectal exam must be included to evaluate for blood within the GI tract, which may indicate bowel injury. Blood at the urethral meatus should raise suspicion for injury along the genitourinary tract. Close inspection of the bilateral axilla, bilateral groins, and perineum is imperative to avoid missing a concurrent injury.

The examiner should obtain a thorough pulse exam of the affected as well as the non-affected extremities. Ankle-brachial index (ABI) is easily measurable by a skilled practitioner in the trauma bay, and values less than 0.90 warrant further imaging.[7] Consideration is necessary for the geriatric patient, who may have chronic arterial disease, which decreases the sensitivity and specificity of ABI measurements; comparison to the contralateral (uninjured) limb may be of utility in this scenario. Particular attention is warranted for “hard signs” of vascular injury, which include expanding hematoma, pulsatile bleeding, bruit, thrill, or pulse deficit.[8]

A detailed neurologic exam should be performed to evaluate for nerve injury/palsy. Nerve injury can occur from direct involvement/laceration/transection or stretch secondary to high-velocity ballistic injury. Motor and sensory function should be evaluated and documented; if the patient requires emergent operative intervention, documentation of a brief gross pre-operative neurologic exam is ideal if feasible.

Early in the clinical course of the patient, large-bore IV access should be obtained, and fluids administered as indicated. Full trauma lab panels are necessary, including complete blood count, comprehensive metabolic panel, lactic acid, and coagulation profiles. Blood products need to be readily available and administered in the setting of ongoing hemorrhage or evidence of hypovolemia (hypotension, tachycardia, etc.). Securement of the airway with endotracheal intubation can be considered for pain management and anticipated course if surgical intervention appears urgent or emergently indicated.

Evaluation

Early activation of the trauma system is imperative; in the optimal scenario, the trauma surgeon is present at the bedside when the patient arrives. The patient should be brought to the trauma/resuscitation bay if available. Depending on the staffing and procedures of the receiving hospital, the emergency department and/or trauma surgery team may perform the early evaluation and management of the patient.

The clinical stability of the patient determines the evaluation of the penetrating groin injury. Pelvic radiographs are obtainable in the trauma bay or emergency room; locations of external wounds should be labeled with radiopaque marker to allow for visualization on X-ray. Hemodynamically unstable patients should be taken directly to the operating room for operative evaluation and management of ongoing hemorrhage or concurrent traumatic injuries. Patients with hard signs of vascular injury (expanding hematoma, pulsatile bleeding, bruit, thrill, pulse discrepancy, or evidence of ischemia) should also receive urgent/emergent exploration and management. Eastern Association for the Surgery of Trauma guidelines suggests forgoing vascular imaging in the setting of hard signs of injury.[8]

The hemodynamically stable patient without hard signs of vascular injury should undergo a detailed vascular exam, and ABIs should be obtained. If the vascular exam is normal and ABIs are greater than 0.9, no further vascular imaging is required. Conversely, soft signs of vascular injury (nonexpanding hematoma, persistent non-pulsatile bleeding, report of prior pulsatile bleeding, neurologic deficit), or an ABI less than 0.9 warrant CT angiography or conventional arteriography.[9]

Additional imaging modalities should be considered based upon the location of the injury and the suspected trajectory. Contrast CT of the abdomen and pelvis is warranted to evaluate for intraabdominal injuries; addition of rectal contrast can increase detection of colonic or rectal injuries. Delayed CT sequences and CT cystogram/urogram are useful tools for evaluation of the genitourinary system.[10] Additional imaging is an option as indicated for concurrent traumatic injuries. These imaging modalities are also beneficial following emergent groin exploration once the patient has stabilized, particularly if laparotomy was not indicated as part of initial operative intervention.

Treatment / Management

Management decisions for vascular injuries of the groin will vary with clinical scenario, injured vessel, and patient stability. In hemodynamically stable patients, or patients responsive to resuscitative efforts following initial hemorrhage control, definitive repair may be necessary. Persistently hypotensive patients or patients with associated intrathoracic or intraabdominal trauma may benefit from damage-control of vascular injuries with a planned return to the operating room for definitive repair at a later time. Gastrointestinal or genitourinary injuries should be addressed to prevent ongoing abdominopelvic contamination.

Ultimately, operative intervention is required in an urgent to emergent fashion in any hemodynamically unstable patient or any patient with clinical findings of hard signs of vascular injury. Patients with imaging findings of vascular injury should undergo operative intervention for reperfusion within 6 hours,[8] as ischemic complications increase significantly after this time. Vascular surgeons should be involved if possible; the on-call trauma surgeon should be able to provide at minimum temporizing care if no vascular surgeon is immediately available.

For urgent/semi-elective cases in a stable patient with isolated vascular trauma, the lower abdomen, bilateral groins, and bilateral legs should get prepped into the field. For emergent cases, the patient should get prepped from the chest to the feet. Vascular instrumentation and suture should be immediately available or opened. Vascular shunts should be quickly available; in emergent settings, suction catheters, or drain tubing can suffice.[11] Consideration can be given to aortic occlusion balloon positioned in Zone 3 if hemorrhage control is unobtainable with direct pressure. Proximal and distal occlusion with foley balloon passed through the site of vessel injury is also an option to temporize hemorrhage while obtaining proximal and distal control.

In the hemodynamically unstable patient, particularly those with concomitant injuries requiring operative management, the decision to forgo immediate definitive repair in favor of damage control may be necessary. Contiguous orthopedic injuries may also require temporary control of hemorrhage with definitive repair after completing orthopedic fixation. In these situations, the clinician can place and secure intraluminal arterial shunts. Shunt placement requires heparinization; patency can persist for up to 72 hours, allowing for revascularization of the lower extremity. Arterial ligation can provide definitive control of hemorrhage; however, it dramatically increases the postoperative ischemic complications and risk of amputation; iliac and femoral artery ligation confer a 50 to 80% risk of ischemia requiring amputation.[12] Profunda artery ligation is less morbid and is an option if needed. Venous control is rapidly obtainable with vein ligation; however, this increases the risk of postoperative venous hypertension and edema.[11]

For the hemodynamically stable patient, and when feasible in the unstable patient, definitive repair should be attempted. Multiple strategies exist for arterial repair, depending on the degree and location of the injury. Small punctures and linear lacerations can undergo debridement and closure if care is taken to avoid narrowing the lumen. Larger punctures can be debrided and repaired with a vein, or less optimally bovine, patch to prevent stricture. Segmental loss of vessels less than 1 to 2 cm can have debridement to the healthy vessel, and primary anastomosis is a consideration if the ends easily approximate without tension. Long-segment loss of artery or ends that will not approximate without tension should be reconstructed with graft. Saphenous vein graft from the contralateral leg is preferred, particularly in contaminated wounds. PTFE merits consideration if the use of the saphenous vein is not feasible; adequate tissue coverage must be provided to limit the risk of graft infection. Regardless of the type of repair, several key steps must take place. Any damaged or devitalized vessel requires debridement as failure to do so increases the risk of pseudoaneurysm formation. Care must be taken to ensure no intimal flap is present to prevent dissection. Proximal and distal thrombectomy should also take place. Completion angiogram is a recommended modality for objective evaluation of distal perfusion. Data are lacking to support the use of endovascular techniques for repair.[8][11]

Venous control often precedes arterial repair in simultaneous injuries to improve visualization for arterial revascularization. Venous control may be in the form of proximal and distal ligation; this increases the risk of venous hypertension and edema postoperatively. A primary venous repair is an option if practical.

Patients with peritonitis or with imaging evidence of intraabdominal injury should have an exploratory laparotomy. Temporary hemorrhage control should be obtained with abdominal packing upon entry into the peritoneal cavity. Sequential removal of packs from the four abdominal quadrants allows for localization of vascular injuries, including injuries to the liver or spleen; definitive hemostasis should be obtained with repair, ligation, or resection. Attention should then turn to the gastrointestinal tract. The small bowel requires an inspection from the ligament of Treitz to the terminal ileum; any encountered injuries should undergo resection with the creation of primary anastomosis. In an unstable patient, damage control principles encourage limiting contamination with resection or various methods of ligation, including umbilical tape and leaving the bowel in discontinuity for planned second-look laparotomy. The colon requires inspection, and mobilization of the white line of Toldt may be required. Colonic injuries should be repaired primarily or resected; in a stable patient, there is no needed for fecal diversion with ostomy formation, and primary repair/anastomosis are possible in spite of fecal contamination.[13] Rectal injury management is similar to colon injuries with few caveats. Intraperitoneal rectal injuries can often be safely managed with primary repair or resection and anastomosis, while guidelines for extraperitoneal injuries recommend repair and proximal fecal diversion; presacral drainage and distal rectal washout are no longer recommendations.[14][15] In the setting of bladder injuries, clinicians should have a high clinical suspicion for concomitant rectal injury as previous literature has revealed rectal involvement associated with 41% of penetrating bladder injuries.[16]

Intraperitoneal bladder injuries, whether visualized in the operating room or on imaging, require operative repair to prevent intraperitoneal spillage of urine. Single or double layer suture repair of the bladder are both options; permanent suture within the bladder lumen should be avoided to prevent nidus for stone formation. Foley catheter should be placed for bladder decompression and left in situ for two weeks to allow for healing; no sequential imaging is necessary following primary intraperitoneal repair. Extraperitoneal bladder leaks are often manageable with foley catheter alone for 2 to 3 weeks; contrast cystogram should be obtained before removal of the foley catheter to ensure resolution of the leak. Persistent urine leaks lasting longer than four weeks in spite of decompression will require surgical repair.[17][18]

Urethral injuries are managed based upon location, tissue loss, and patient's sex; the majority of urethral injuries occur in male patients. Males with anterior urethral injuries can often undergo primary repair with spatulated urethral ends; if the tissue loss is too great (greater than 2 to 3 cm bulbar urethra, over 1.5 cm penile urethra) marsupialization of the urethra with delayed (over three months) graft/flap repair is recommended. Posterior urethral injuries should have management with endoscopic alignment and foley placement in the stable patient; foley should remain in situ for four weeks. If the endoscopic alignment fails or in the unstable patient, it requires placement of a suprapubic catheter should, and urethral repair should be delayed (with care taken to ensure repair less than two weeks after injury). Female urethra injuries are rare; most are primarily repairable.[18]

A perioperative dose of antibiotics is a requirement in the operative setting; however, the continuation of antibiotics in the postoperative setting is not indicated unless the patient develops evidence of septic complication.

Differential Diagnosis

Multiple organ systems can have involvement following a penetrating injury to the groin. A spectrum of arterial and/or venous injuries are possible, presenting acutely as life-threatening hemorrhage, expanding hematomas, or pulse deficits; conversely, injuries may be occult initially with subsequent development of pseudoaneurysms or traumatic arteriovenous fistulas. The most common injured vascular structures are the superficial and common femoral arteries, with iliac artery, iliac vein, femoral vein, profunda artery/vein, and great saphenous vein injuries possible. Neurologic injury may occur, including injuries to the femoral and sciatic nerves. Wounds to the proximal groin can result in small bowel or colon injuries, and clinical suspicion must remain high. Bladder or urethral injuries may be present. Orthopedic trauma such as pelvic or femoral fractures from the projectile impact may result.[19]

Prognosis

Injuries to the vasculature of the groin/inguinal region have high rates of associated morbidity and mortality. Of these injuries, external iliac vessel injuries have a significantly higher rate of complications than femoral injuries; these include higher mortality (41.4% external iliac vs. 6.6% femoral), permanent disability (13.8% vs. 0.9%), and any complication (48.3% vs. 17.9%). Rates of DVT (0 to 5%), SSIs (4 to 7%), and length of stay (6 to 9 days) were similar between external iliac and femoral vessel injury.[20]

Approximately 34% of patients with penetrating injury to the colon or rectum require ICU admission with a hospital length of stay 10 to 14 days. A 3% leak rate from the repair/anastomosis site and been documented in the literature. 67% of patients will experience a morbidity complication, including anastomotic leak, intraperitoneal sepsis, and wound complications. Mortality estimates are at 10%.[21]

Bladder injuries are mostly extraperitoneal (63%) and are associated with a mortality rate of 8%.[22] Mortality from urethral injuries is rare, but morbidities, including erectile dysfunction and urethral strictures, may occur.[23]

Complications

Prolonged ischemia and reperfusion place patients at risk for compartment syndrome of the lower extremities. Compartment syndrome is less common in proximal injuries as compared to femoropopliteal or distal injuries; however, they remain a clinical concern in any above-knee injuries requiring operative vascular intervention.[24] Prophylactic 4-compartment fasciotomies are a consideration; if fasciotomies get deferred, close post-operative monitoring of compartments is imperative as missed or delayed diagnosis of compartment syndrome can lead to the need for amputation.[8]

External iliac/femoral arterial injuries are associated with arterial thrombosis (1%), need for amputation (5 to 9%; up to 20% with associated femur fracture), and chronic neurologic sequelae. Iliac/femoral vein injuries are associated with DVT (22%), PE (2.5%), and chronic lower extremity edema/venous insufficiency. Pseudoaneurysms and traumatic arteriovenous fistulas may also result.[25][26]

Gastrointestinal complications include leaks from anastomosis or site of primary repair. Additional surgical intervention is requisite for intraabdominal sepsis from leaks or missed injuries. Contained leaks are manageable with drains placed by interventional radiology. Anastomotic strictures present a potential long-term complication following bowel resection. Wound infections and deep space infections can occur.

Persistent bladder leaks can occur after repair or attempts at nonoperative management of extraperitoneal injuries. The site of repair can present a nidus for stone formation if using a nonabsorbable suture. Urethral strictures requiring dilation or other intervention are possible if a urethral anastomosis is necessary. Erectile dysfunction may occur in patients following urethral trauma, particularly if there was surgical intervention.

Deterrence and Patient Education

Gun violence remains a significant issue in the United States, particularly among the youth. Gun crimes, homicides, and firearm-related suicides are markedly higher in the United States as compared to other developed nations.[27] Mental health crises certainly play a role and must be addressed. Increased access to behavioral health treatment has been found to modestly reduce firearm suicide rates, which represents an opportunity to intervene and prevent firearm-related deaths.[28] Additionally, legislation to keep firearms out of the hands of criminals should be pursued; this presents an opportunity for lobbying on behalf of clinicians. Safe storage and firearm handling practices have been shown to reduce the risk of accidental injury[29]; this likely represents the most direct opportunity for clinicians to intervene with patients during well-patient visits, with questions related to firearm ownership and counseling on the safe handling and storage of firearms to reduce injury risk.

Enhancing Healthcare Team Outcomes

Penetrating injuries to the groin represent a challenging scenario with the potential for injuries of multiple organ systems. Hemorrhage associated with vascular injury is the most rapid threat to life. Early control of bleeding on-scene can improve outcomes by allowing time for transport to a Trauma Center for definitive care. The American College of Surgeons “Stop the Bleed” campaign focuses on the training of laypersons and first responders in control of hemorrhage, with training in the proper techniques of direct pressure, hemostatic agents, and tourniquet use; this training has been shown to increase layperson confidence and willingness to intervene in bleeding control scenarios.[30]

Rapid presentation to an appropriate trauma center confers a survival advantage. In a comparison of prehospital transport via private vehicle vs. EMS in the urban setting, patients transported by a private vehicle following penetrating trauma had a lower risk of mortality than those transported by EMS[3]; this remained true when stratified for the severity of injury and location of the wound(s). While most would not advocate for private vehicle transport for patients following traumatic injury, the data suggests that a “scoop and run”-type EMS policy may be beneficial as the time to definitive care plays a significant role in outcomes following penetrating trauma.[31] Upon arrival to the hospital, an interprofessional care team involving emergency physicians, trauma surgeons, and, in select cases, vascular and urologic specialists play an integral role in the care of the penetrating trauma patient to optimize survival and outcomes.

Review Questions

- Access free multiple choice questions on this topic.
- Comment on this article.

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Publication Details

Author Information

Authors

Matelin Crosen[1]; Rovinder Sandhu[2].

Affiliations

[1] Lehigh Valley Health Network

[2] Lehigh Valley Health Network

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