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Adult Bladder Trauma Management

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ABSTRACT

Bladder injuries occur in up to 10% of abdominal trauma cases, contributing to significant morbidity and mortality (10–22%). These injuries may result from blunt or penetrating trauma, as well as iatrogenic damage during surgical procedures. Accurate diagnosis and timely intervention are crucial to minimizing complications.

Bladder injuries are classified into extraperitoneal (EP), intraperitoneal (IP), or combined types. Mechanisms of injury vary, with blunt trauma, predominantly from motor vehicle accidents, accounting for 60–85% of cases, and penetrating injuries, such as gunshot wounds, comprising 15–51%. Evaluation includes clinical assessment, cystography, and CT imaging, supplemented by cystoscopy for iatrogenic cases. Management strategies range from conservative catheterization to surgical repair, depending on injury type and severity. EP injuries, the most common type (63%), are frequently associated with pelvic fractures, whereas IP injuries (32%) typically result from blunt trauma to a distended bladder. Conservative management with catheter drainage suffices for most EP injuries; however, IP injuries necessitate surgical intervention to mitigate risks such as sepsis and peritonitis. Outcomes are influenced by concomitant injuries, which are often more critical than the bladder injury itself.

Advanced imaging modalities, particularly CT cystography, offer high sensitivity and specificity for bladder injury diagnosis. While conservative management is preferred for minor injuries, indications for surgical repair include significant extravasation, ongoing urinary leakage, or associated injuries. Multidisciplinary approaches are essential for comprehensive trauma care. Bladder injuries are rare but carry substantial risks if unrecognized or inadequately treated. Timely diagnosis, guided by clinical suspicion and imaging, coupled with appropriate management strategies, is essential to optimize outcomes and reduce complications.

KEYWORDS: Bladder injuries, management, trauma surgery

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INTRODUCTION

Bladder injuries occur in up to 10% of abdominal trauma cases and can lead to considerable morbidity and fatality rates (10-22%). Such injuries may arise from blunt or penetrating trauma, as well as iatrogenic damage during surgical procedures. Cystography may be conducted to ascertain the existence and severity of bladder injury, which will later inform the decision between conservative therapy and surgical surgery [1]. This review summarizes the causes, symptoms, evaluation, and treatment of bladder injuries.

CAUSES

The bladder is an extraperitoneal organ safeguarded by the pubic bone. In males, it is positioned superior and anterior to the prostate, whereas in females, it is located anterior to the uterus. The peritoneum, a membrane covering, is located superior and posterior to the bladder, defining the intraabdominal cavity. Bladder injuries can be categorized

into extraperitoneal (EP), intraperitoneal (IP), or a combination of both, comprising 63%, 32%, and 4% of cases, respectively. An additional, rare form of bladder injury is the interstitial subtype, characterized by an incomplete disruption of the bladder wall without urine extravasation. The ratios of EP and IP injuries may differ according to geographic location and injury mechanism. In a research conducted in South Africa, intraperitoneal injuries were more prevalent, accounting for 60% of bladder injuries, whereas extraperitoneal injuries constituted 22%. Penetrating injuries are more prevalent (65%) than blunt trauma (22%) at the respective trauma centers. Another institution assessed their cohort of gunshot wounds to the lower urinary tract and found that 72% of patients experienced bladder injury, while 80% had an associated gastrointestinal injury, further illustrating the susceptibility of penetrating injuries to IP injury [2,3].

Blunt trauma constitutes 60-85% of bladder injuries, and penetrating trauma comprises 15-51%. Blunt abdominal injuries predominantly arise from motor vehicle accidents, while penetrating injuries frequently come from stab or bullet wounds. Gunshot wounds (GSWs) account for the predominant proportion of penetrating bladder trauma in the United States, including 80% compared to 20% from knife wounds. GSWs are characterized as high-velocity injuries that can traverse an erratic trajectory, producing a blast effect that causes extensive damage to adjacent tissues. Stab wounds adhere to a more predictable trajectory confined to the direct route of the object [4].

Multiple mechanisms of blunt bladder injury have been suggested. A direct impact to the abdomen may result in a "burst" rupture of the dome, which is the bladder's most vulnerable area. An distended bladder is more prone to rupture when the dome protrudes into the abdominal cavity, removing the protective barrier provided by the bony pelvis and pelvic organs. This results in an intraperitoneal bladder damage and urine extravasation into the peritoneal cavity, posing a risk for peritonitis, chemical ileus, sepsis, and potentially fatal outcomes. While concomitant pelvic injuries are frequently observed in IP injury, up to 25% of cases do not exhibit such injuries.

Bladder injuries frequently occur alongside pelvic fractures in 85-100% of instances. These injuries can result in an extraperitoneal rupture, allowing urine to escape into the perivesicular area surrounding the bladder without entering the intraperitoneal cavity. Pelvic ring disruptions can generate shear forces that compromise the ligaments anchoring the bladder wall to the pelvic base, or induce counter-coup forces leading to a burst injury at a location contralateral to the pelvic fracture. In 65% of instances, bladder injuries occur contralateral to the fracture site. Furthermore, osseous fragments from a pelvic fracture may immediately sever the bladder's surface [5].

Bladder trauma is often accompanied by long bone fractures, central nervous system injuries, thoracic injuries, and other intra-abdominal injuries. The elevated mortality associated with bladder injuries is primarily due to these concomitant injuries rather than the bladder injury itself. Adjacent organs to the bladder are also susceptible to injury. Penetrating bladder damage may coexist with rectal injuries in as many as 38% of patients, potentially resulting in increased morbidity due to bowel content contamination and the risk of sepsis [6].

Isolated bladder injuries are uncommon, predominantly resulting from iatrogenic factors. Iatrogenic bladder injuries are most prevalent in gynecologic and urologic surgeries due to the anatomical proximity of pelvic organs, although they can also arise during general and orthopedic procedures. The procedures with the highest rates of bladder injury are vaginal hysterectomies (0.4-6.3%), urethral or retropubic slings (6-50%), and transurethral resection of the bladder (3.5-58%) [7].

The American Association of Surgery for Trauma (AAST) established the Organ Injury Scale to create a standardized terminology that enhances clinical decision-making and research. The classification ranges from Grade I, indicating modest anatomical disturbance, to Grade V, signifying deadly disruption. Bladder damage is classified from contusion or partial laceration (Grade I) to total laceration (Grades II-V). Grade I injuries, including contusions of the bladder wall and partial thickness lacerations, may result in self-limiting intramural hematoma formation. These mild injuries are the most prevalent, accounting for one-third of all bladder injury cases. Eleven EP injuries are classified as Grade II (<2 cm) or Grade III (≥2 cm). IP injuries are classified as Grade III (<2 cm) or Grade IV (≥2 cm). Bladder injuries may reach the bladder neck and affect the ureteral orifices or trigone (Grade V). Detecting these injuries is crucial, as an undiagnosed injury to the bladder neck may lead to urinary incontinence or necessitate a more intricate repair, such as ureteral reimplantation, in the context of an injury to the ureteral orifice [8].

CLINICAL MANIFESTATION

Timely identification of bladder trauma can avert serious complications from urinary leakage, such as sepsis, peritonitis, abscess, urinoma, fistulas, and electrolyte imbalances due to reabsorption. Morbidity and mortality rates from bladder injuries correlate with injury severity scores exceeding 15, systolic blood pressure below 90 mmHg, and concurrent pelvic fractures. Additionally, bladder injuries are linked to prolonged hospitalizations and pose a considerable risk of morbidity, potentially escalating healthcare costs.

BLADDER INJURY DESCRIPTION

GRADE	Injury	Description
I	Hematoma	Contusion, intramural hematoma
	Laceration	Partial thickness
II	Laceration	Extraperitoneal bladder wall laceration <2 cm
III	Laceration	Extraperitoneal ≥ 2 cm or intraperitoneal <2 cm bladder wall laceration
IV	Laceration	Intraperitoneal bladder wall laceration ≥ 2 cm
V	Laceration	Laceration extending into bladder neck or ureteral orifice (trigone)

Gross hematuria, observed in 67-95% of instances, is the primary symptom indicative of bladder trauma. Microscopic hematuria may occur in 5% of cases. Additional signs, including the injury mechanism, concurrent pelvic fractures, suprapubic tenderness, diminished urine output, voiding difficulties, elevated creatinine levels, abdominal hematomas, perineal and upper thigh edema, and shock, should heighten suspicion of bladder injury. In cases of penetrating trauma, particularly gunshot wounds, entrance and exit wounds in the lower abdomen, perineum, and buttocks should be identified and traced [10].

Iatrogenic bladder injuries during surgery may manifest as clear fluid or the visibility of the urethral catheter in the surgical field, blood or gas in the urine drainage bag, fatty tissue or bowel observed on cystography, diminished return of bladder irrigation fluid, and either an inability to distend the bladder or, conversely, abdominal distension. This necessitates urological consultation [11].

Trauma patients must be evaluated according to the Advanced Trauma Life Support protocol established by the American College of Surgeons. Patients exhibiting hemodynamic instability should forgo acute evaluation of bladder trauma and instead proceed directly to surgical exploration. Gross hematuria associated with a pelvic fracture necessitates cystography, given that bladder injury occurs in 29% of these instances. Gross hematuria denotes visible blood in the urinary tract, whereas microscopic hematuria is identifiable solely through urinalysis. Gross hematuria absent pelvic fracture and microscopic hematuria present with pelvic fractures are relative criteria for cystography in cases of clinical suspicion. Clinical suspicion may encompass the mechanism of injury, pubic symphysis diastasis, displacement of the obturator ring exceeding 1 cm, penetrating injuries with pelvic trajectories, inability to void, diminished urine output, elevated blood urea nitrogen or creatinine levels, abdominal distension, suprapubic pain, or urinary ascites observed on imaging. A limited percentage of patients with pelvic fractures (0.6-5%) exhibit microscopic hematuria; however, this condition is generally an unreliable indicator of bladder injury. In a study conducted by Brewer et al., among 214 patients who underwent cystography due to microscopic hematuria, none were diagnosed with bladder injury. Consequently, cystography solely based on the presence of a pelvic fracture or microscopic hematuria is not advised [12].

Although X-ray cystography has historically been employed to assess bladder injuries, most institutions are transitioning to Computed Tomography (CT) cystography because of its enhanced convenience and expedited processing time. CT cystography is especially advantageous when imaging of other abdominal organs is necessary, as it can identify multiple injuries, including the origin of hematuria. The European Association of Urology (EAU) advocates for the utilization of CT cystography in conjunction with other potential abdominal traumas, whereas the American Urological Association (AUA) guidelines do not explicitly compare the use of CT to X-ray [13].

In both CT and X-ray cystography, contrast is introduced into the bladder retrogradely through gravity filling via a catheter. The bladder is typically dilated with a minimum of 300 mL of contrast agent. X-ray cystography necessitates a minimum of a plain film, a complete filling film, and a post-drainage film. The post-drainage film is employed to detect a posterior bladder damage that may be obscured by a contrast-filled bladder. Oblique X-ray pictures can assist in identifying the site of a bladder injury. In contrast, the post-drainage film is unnecessary in CT cystography, as three-dimensional reconstruction facilitates comprehensive assessment of the bladder and identification of the laceration [13].

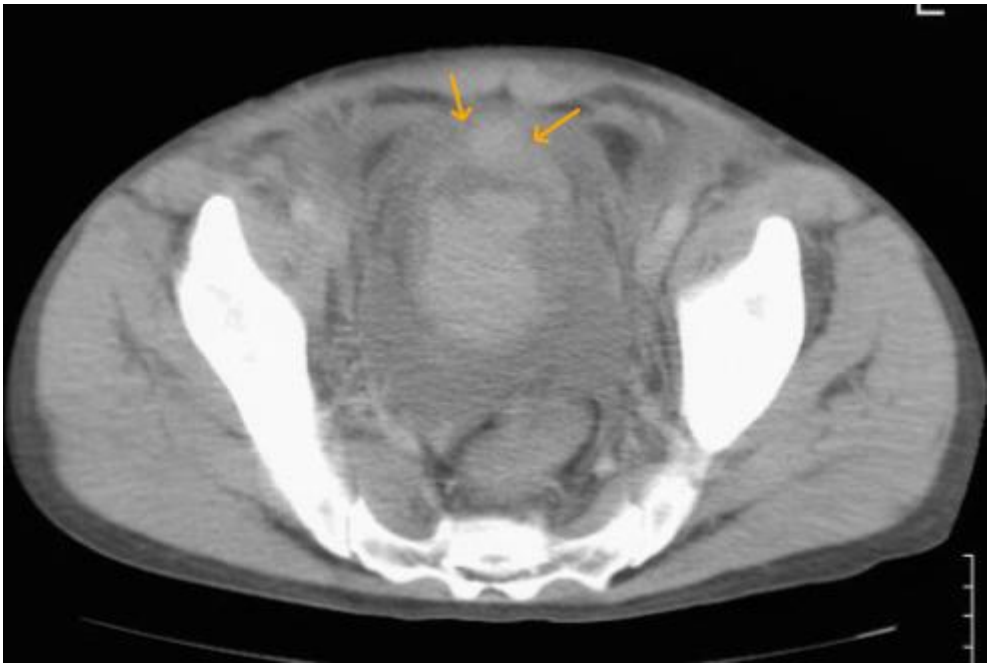

Figure 1. Bladder rupture CT

The presence of contrast material outside the bladder signifies bladder damage (Figure 1).

Surgical intervention for intraperitoneal bladder injuries is necessary due to the potential for sepsis, the larger size of these injuries, and the elevated risk of morbidity and mortality relative to extraperitoneal injuries. Consequently, intraperitoneal injuries necessitate surgical exploration, typically conducted via a lower midline or Pfannenstiel incision. The wound must be sutured in one or two layers using an absorbable running suture. Following the repair of the bladder injury, the closure can be evaluated by retrograde filling of the bladder via a urethral catheter. Additionally, the application of a chromatic agent, such as methylene blue, may assist in detecting leaks during bladder distension. An abdominal drain may be inserted to assess for post-operative urinary leakage. No definitive guidelines exist regarding the ideal duration for catheter placement post-bladder repair; however, a period of 7-14 days is frequently reported and utilized. The AUA guidelines advise against the use of suprapubic catheters after bladder repairs, as urethral catheters are adequate in most instances. Drainage utilizing urethral catheters has been linked to reduced hospital stays and diminished morbidity in comparison to combined drainage employing suprapubic and urethral catheters [14]. EP injuries are often treated conservatively, involving bladder drainage through catheterization, succeeded by a cystogram to verify the healing of the damage. In a study by Johnsen et al., cystogram revealed continued extravasation in at least 18% of patients with EP injuries managed with catheters, suggesting confirmatory cystography may still be of some utility. The majority of ruptures heal by three weeks; if the injury has not healed by four weeks, AUA guidelines recommend surgical repairs. The guidelines also recommend surgery for EP bladder injuries when there is persistent hematuria, associated pelvic organ injury, the presence of foreign bodies or projecting bones in the bladder, ongoing urinary leak, and penetrating trauma. Other indications may include concomitant vaginal or rectal lacerations, inadequate drainage via urethral catheters, bladder neck injuries, and internal fixation of pelvic fractures. Concurrent cystorrhaphy during surgical intervention for other abdominal injuries has also been shown to reduce urologic complications, time in intensive care, and overall hospital stay. Similarly, EAU guidelines recommend concomitant cystorrhaphy during laparotomy to decrease infective complications [15].

CONCLUSION

Although bladder injuries are rare, they pose a considerable risk of morbidity and fatality if not identified and addressed swiftly. Gross hematuria is a definitive indicator of bladder trauma. Additional indications and symptoms encompass microscopic hematuria, suprapubic pain, hematomas, and diminished urine production. CT and X-ray cystography provide equivalent efficacy in identifying the site and classification of bladder injury. The majority of bladder injuries can be treated conservatively with urethral catheter drainage; nevertheless, surgical intervention is necessary for intraperitoneal injuries and certain rare cases of extraperitoneal injuries. This research concentrated solely on bladder injuries; nevertheless, it is crucial to acknowledge that ureteral or urethral injuries may concurrently occur with bladder injuries. Consequently, the complete anatomy and scope of the genitourinary tract must be taken into account when formulating management strategies.

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