Curr Trauma Rep (2017) 3:265–270
DOI 10.1007/s40719-017-0107-x

The Role of Surgery in the Management of Complex Extraperitoneal Bladder Injury

Jacob W. Lucas[1] · **Andrew Chen**[1] · **Jay Simhan**[1,2,3]

Published online: 8 September 2017

Abstract
Purpose of Review This review focuses on the evolving role of surgical management for complex extraperitoneal bladder injuries.
Recent Findings Despite recommendations from both the AUA and EAU advocating bladder drainage for the treatment of most extraperitoneal bladder injuries, there appears to be an increasing role for early operative intervention in select cases of extraperitoneal bladder injury. Although there is a paucity of contemporary data regarding surgical outcomes, both simple and complex extraperitoneal bladder injuries are wrought with short- and long-term sequelae that may warrant early closure.
Summary Catheter drainage of bladder injuries is most appropriate for carefully selected, simple extraperitoneal bladder injuries. Bladder injuries, however, with complex parameters including those with intravesical bony fragments, concomitant internal pelvic fixation, involvement of bladder neck, rectum, and/or vagina, or those undergoing exploratory laparotomy for non-GU injuries, can benefit from early cystorraphy to avoid deleterious short- and long-term complications.

Keywords Trauma · Extraperitoneal · Bladder injury · Surgery

This article is part of the Topical Collection on *Urologic Trauma*

✉ Jay Simhan
jsimhan@gmail.com

[1] Department of Urology, Einstein Healthcare Network/Fox Chase Cancer Center, Philadelphia, PA, USA

[2] Urologic Trauma, Reconstruction and Prosthetics, Einstein Healthcare Network, Philadelphia, PA, USA

[3] Temple Health and the Fox Chase Cancer Center, 1200 Tabor Road, Moss/3 Sley, Philadelphia, PA 19141, USA

Introduction

Genitourinary (GU) tract injury comprises a small but significant cohort of patients with traumatic injuries. As such, nearly 10% of patients presenting with trauma will have GU tract involvement, with 80–90% of these patients having comorbid non-urologic injuries [1, 2]. Despite the bony pelvis conferring some degree of protection, the bladder is still susceptible to a variety of injuries and represents the third most commonly injured GU organ. Blunt mechanisms, namely motor vehicle collision (MVC; 50.5%), pedestrian versus automobile accidents (29.1%), and falls (14.5%), account for a large proportion (67–86%) of bladder trauma, with the remaining injuries attributable to penetrating mechanisms [1, 3]. Classically, bladder trauma is classified as either intraperitoneal, extraperitoneal, or a combined intra- and extraperitoneal, with reported incidences of 55, 38, and 5–8%, respectively [4].

Per current American Urological Association (AUA) and European Association of Urology (EAU) guidelines, intraperitoneal bladder trauma necessitates surgical repair [5, 6]. Traditionally, extraperitoneal bladder injuries (EBI) were managed with prolonged catheter drainage. Recently, management strategies have evolved to include a growing role for the surgical repair complex EBI. In this review, we aim to describe current management strategies for EBI with a focus on the importance of prompt surgical repair of complex EBI.

Extraperitoneal Bladder Injury

Current Epidemiology and Diagnosis

Extraperitoneal bladder injury in the traumatic setting is most frequently caused by a traumatic disruption of the pelvic ring. Pelvic fracture is present in upwards of 90% of those with blunt bladder injuries, although only 3–8% of pelvic fractures present with bladder injury [7, 8]. Avey and colleagues were able to demonstrate that displaced obturator ring fractures greater than 1 cm and a pubic symphysis diastasis greater than 1 cm were independent predictors of bladder rupture, with relative risks (RR) of 3 and 7.6, respectively [8]. In addition to blunt trauma, extraperitoneal bladder injuries are also frequently the result of iatrogenic injury, commonly secondary to gynecologic, general surgical, and urologic procedures [4, 9]. Much of the data regarding iatrogenic extraperitoneal bladder injury has been extrapolated from the complications of transurethral resection of bladder tumors, where contrast extravasation may be seen in up to 58% of patients [10]. An overwhelming majority of cases of extraperitoneal injury secondary to transurethral resection can be managed non-operatively with prolonged catheter drainage alone with favorable success [11, 12].

Prior to the diagnosis and characterization of any bladder injury, practitioners must first suspect an injury based on mechanism of injury and patient symptomatology. Bladder trauma typically presents with varying degrees of hematuria, with gross hematuria found in 93–100% of cases [13, 14]. Other symptoms may include pelvic pain, bruising, dysuria, abdominal distension, scrotal swelling/hematoma, and/or lower abdominal pain among others [15]. When bladder injury is suspected, cystography is the gold standard imaging modality that not only characterizes the presence of a bladder injury but also distinguishes between extraperitoneal and/or intraperitoneal injury. As such, an absolute indication for cystography remains pelvic fracture with gross hematuria while relative indications include gross hematuria without pelvic fracture, pelvic fracture with microscopic hematuria, or simply a high index of suspicion based on mechanism [5, 6, 16, 17].

Currently, CT cystogram is the gold standard imaging choice for characterization of any bladder injury, but likely remains underutilized [18] (Fig. 1A). Although sensitivity and specificity are similar between plain-film cystography and CT, axial imaging confers the advantage of finding concomitant, non-GU injuries—and this is extremely important for the polytrauma patient [19]. Importantly, retrograde cystography must be performed with adequate bladder distension (> 300 mL) and with post-drainage films or one runs the risk of missing injuries [20].

Contemporary Management of Extraperitoneal Bladder Injury

For EBI, management is predicated on the complexity of the injury. Although historic management strategies revolved around prolonged catheter drainage alone, contemporary reports have reshaped the treatment of EBI to include a role for surgery. After diagnosis of EBI, it is necessary to then categorize the injury as simple or complex, which will then direct the most appropriate treatment strategy. Criteria defining complex EBI are listed in Fig. 2.

For patients with simple extraperitoneal ruptures, current AUA and EAU guidelines recommend prolonged bladder drainage for a period of around 3 weeks with success rates ranging between 74 and 85% [4, 21•, 22]. Repeat cystography is then recommended at an interval of 7–10 days following the index injury to confirm healing, with high rates of resolution [23] (Fig. 1B). It is important to note, however, that while most EBI can resolve with catheter drainage, this is not without risk as notable complications can be noted with this strategy. In one of the first reports with larger sample size assessing morbidity following non-operative treatment of EBI, Kotkin and Koch reported a 10-year experience treating a total of 29 patients solely with catheter drainage, of which 26% (7/27) experienced significant complications, including fistula formation, delayed healing, and infection, among others [21•]. Similar findings were also demonstrated in an earlier series by Cass and Luxenberg who reported both early and late complications of bladder drainage alone in a historic retrospective series of 105 patients with EBI, of whom 34 were treated conservatively [24].

In the past decade, there has been an increasing trend towards operative repair of EBI, especially in the setting of exploratory laparotomy for non-GU injuries and/or internal fixation of pelvic fractures [3]. Wirth and colleagues published a contemporary series of 22 patients with EBI, of which 55% (12/22) underwent primary closure of the bladder during non-GU surgery for fear of infection and pelvic hematoma; the remaining patients underwent a trial of conservative management with catheter drainage [25]. There was no difference in complications between the two groups, although the study was not large enough to detect statistical significance. This report demonstrated the feasibility of early operative repair for polytrauma patients with EBI.

More recently, Johnsen et al. described a series of 56 patients who underwent catheter drainage versus 24 who underwent early cystorraphy as a secondary procedure following concomitant non-GU injuries [26••]. In this series, early

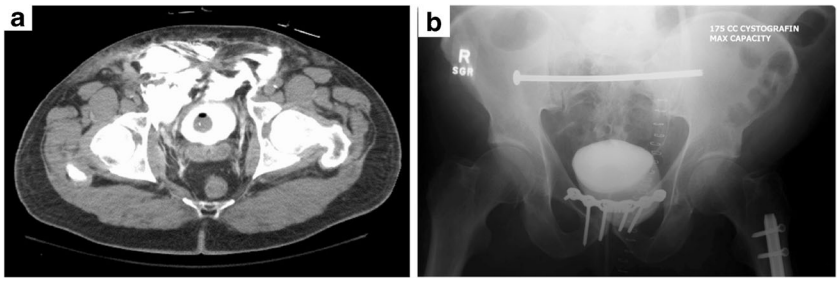

Fig. 1 **a** CT cystogram demonstrating an extraperitoneal bladder injury in the setting of pelvic fracture. Contrast can be seen tracking anteriorly in the bony pelvis. This finding is in contrast to intraperitoneal injuries that will demonstrate contrast within the peritoneal cavity outlining loops of bowel. **b** Plain-film cystogram following successful pelvic fixation and surgical repair of extraperitoneal bladder injury. It is of vital importance to fill the bladder to capacity to ensure highest sensitivity in detecting injury/persistent leak

repair of EBI resulted in fewer urologic complications and decreased ICU and hospital stay, as well as an earlier time to negative cystography. Importantly, however, this study had been met with some valid criticisms regarding patient selection for conservative management as evidenced by the high rate of fistula formation (6/56) in the catheter drainage group, as well as the conclusions regarding ICU and hospital stay since these are unlikely to be affected by bladder injury management [27]. In a follow-up series, the authors further characterized the rare finding of fistula formation in the non-operative group following extraperitoneal injury and contended that surgical management should play an increasing role in the management of EBI [28•]. Although such investigations might be limited by its retrospective, single-institutional nature, these reports provide valuable insight into the management of EBI and argue towards surgical management of complex EBI.

Pelvic fractures in the setting of bladder injury represent another complex scenario which necessitates immediate cystorraphy for several reasons: (1) bony fragments within the bladder preclude spontaneous closure with catheter drainage and (2) open-reduction and internal fixation (ORIF) of fractures is often required, and persistent urine leak represents

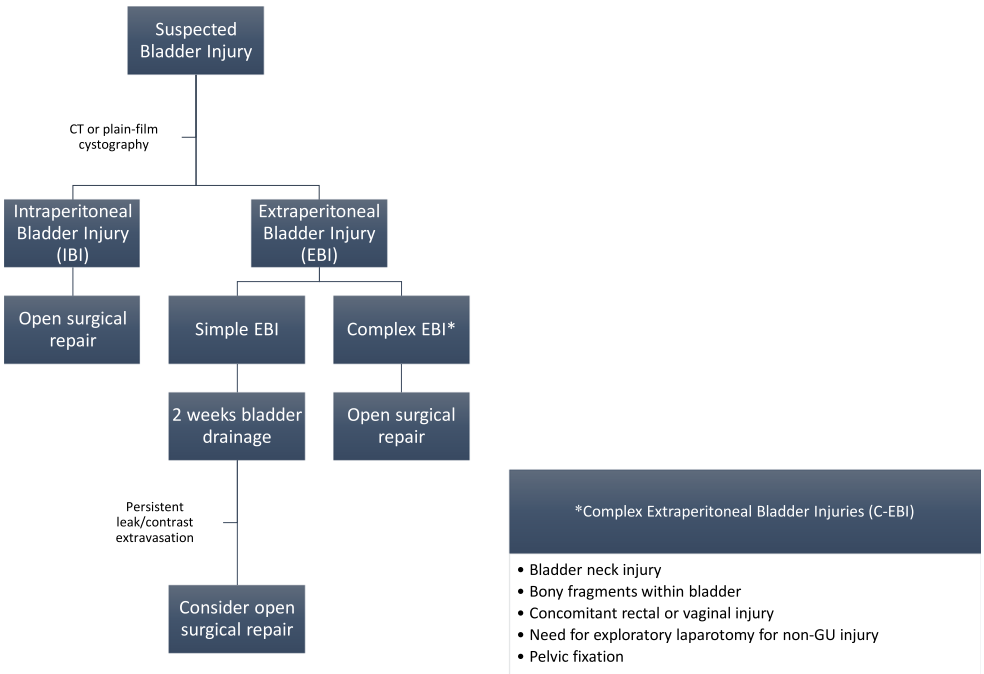

Fig. 2 This is our preferred management algorithm for extraperitoneal bladder injury. Our criteria for complex extraperitoneal injury are delineated as well

a potential source of infection of orthopedic hardware. Indeed, multi-disciplinary recommendations from Grady Hospital in Atlanta, GA, echo the above sentiment [29].

Concomitant rectal and vaginal injuries remain an indication for the surgical management of EBI, although these recommendations are derived from observations made through small case series. Elliott and McAninch reported two incidences of EBI resulting from gunshot wounds and motor vehicle collisions, respectively, that were complicated by rectal and vaginal lacerations managed without formal cystorraphy [30•]. Both patients subsequently developed vesicocutaneous fistulae that required multiple invasive and non-invasive procedures. Additionally, in another series of 20 females with external genital injuries from a variety of mechanisms, four patients presented with bladder injuries that were all subsequently repaired with early cystorraphy, although long-term outcomes were not reported [31]. This series did, however, highlight that delayed intervention on concomitant bladder injuries could potentially delay healing and even propagate pelvic/perineal abscess formation, urinoma, infection, and hematoma.

Injuries to the bladder neck represent an indication for early operative management of EBI, as significant sequelae are associated with non-operative measures. As a result of the injury, patients managed with concomitant bladder neck injury are less likely to achieve complete continence and often require complex reconstructive procedures such as future artificial urinary sphincter insertion and/or appendicovesicostomy performance [32•]. However, it should be noted that despite early intervention, patient morbidity following repair might also remain significant. In one such characteristic series, Black and associates presented a cohort of 25 female patients with both pelvic fracture and bladder neck injury [33]. Despite early primary repair in 21/25 patients, complications included vesicovaginal fistula (VVF; 16%), urinary incontinence (55%), and moderate-severe lower urinary tract symptoms (LUTS; 43%). Nonetheless, despite the high incidence of postoperative complications requiring further reconstruction, it is overall felt that delayed repair or non-operative management results in non-healing injuries and worse longer-term outcomes. As a result, early and immediate repair of concomitant bladder neck injury remains the recommendation of the AUA and EAU.

Our Technique of Cystorraphy for Extraperitoneal Bladder Injury

Surgical closure of bladder injury (cystorraphy) has been well documented through a variety of surgical techniques reported in the literature [4, 6, 32•, 34–36]. Our technique is to perform a low, vertical midline incision for repair of any bladder injury. We then incise the rectus fascia and dissect away from the underlying rectus muscle to gain access to the bladder. Exposure can be improved with the aid of a Balfour or Bookwalter retractor. At our institution, we prefer a transvesical approach to repair via a bivalving vertical cystotomy which allows full inspection of the bladder including the ureteral orifice. Often in the trauma setting, it might be uncertain as to if there is concomitant ureteral trauma, and we ordinarily use the opportunity of our exposure to verify good efflux of urine from both ureteral orifices at the bladder trigone. Importantly, if the cystotomy extends too close to the bladder neck, we routinely place a 2–0 absorbable suture transversely to prevent tearing of the bladder neck. We have often maintained a Foley catheter that a circulating RN can readily flush in order with up to 200 cm^3 of saline or water in order for us to inspect any injuries. We then perform formal closure of the bladder in at least two layers with absorbable suture. We also access the Foley catheter following completion of the repair in order to re-interrogate and test the viability of our bladder closure. For complex repairs that involve a large suture line on the bladder (>5 cm), we generally elect to leave a JP drain overlying the repair, although if the repair is watertight, we tend to leave a Foley alone. If the insult is a combined intra- and extraperitoneal injury, we do not hesitate to cover our suture line with any available omentum encountered during the abdominal exploration in the trauma setting. We do not recommend concomitant suprapubic tube placement with Foley placement during surgical management of EBI, as complication rates have not been demonstrated to be lower with multiple drainage tubes [5, 37–40].

Current/Ongoing Areas of Interest

Although there is a paucity of contemporary reports with large sample sizes and minimal confounding bias, many of the current treatment strategies regarding extraperitoneal injuries are derived from expert clinical opinion and through extrapolation from smaller case series and single-institutional reports. Importantly, a current large-scale multi-institutional AAST effort led by Myers and associates at the University of Utah aims to determine whether operative repair of EBI is associated with decreased leak rate and improved outcomes [41•]. Additionally, the investigators are assessing whether risk stratification of EBI can predict the patients that are more likely to benefit from early repair. This investigation is currently underway and will likely have outcomes suitable for reporting by early 2018. It is likely many of the current management recommendations will be further clarified with this important work.

Conclusions

The dogma that extraperitoneal bladder injuries simply require catheter drainage may be outdated as contemporary reports suggest worse outcomes with conservative management of

certain types of complex EBI. Although there are several recent studies advocating for early cystorraphy, long-term data regarding the surgical management of these injuries is needed. Nevertheless, considering the numerous complications associated with complex EBI managed with catheter drainage alone, it is imperative to consider the role of early operative intervention in select patients. Current large multi-institutional assessments are necessary to characterize and further define best-practice management of surgical repair compared with conservative treatments alone.

Compliance with Ethical Standards

Conflict of Interest The authors declare no conflicts of interest relevant to this manuscript.

Human and Animal Rights and Informed Consent This article does not contain any studies with human or animal subjects performed by any of the authors.

References

Papers of particular interest, published recently, have been highlighted as:
- • Of importance
- •• Of major importance

1. McGeady JB, Breyer BN. Current epidemiology of genitourinary trauma. Urol Clin North Am. 2013;40(3):323–34.
2. Shewakramani S, Reed KC. Genitourinary trauma. Emerg Med Clin North Am. 2011;29(3):501–18.
3. Pereira BM, de Campos CC, Calderan TR, Reis LO, Fraga GP. Bladder injuries after external trauma: 20 years experience report in a population-based cross-sectional view. World J Urol. 2013;31(4):913–7.
4. Gomez RG, Ceballos L, Coburn M, Corriere JN Jr, Dixon CM, Lobel B, et al. Consensus statement on bladder injuries. BJU Int. 2004;94(1):27–32.
5. Morey AF, Brandes S, Dugi DD 3rd, Armstrong JH, Breyer BN, Broghammer JA, et al. Urotrauma: AUA guideline. J Urol. 2014;192(2):327–35.
6. Lynch TH, Martinez-Pineiro L, Plas E, Serafetinides E, Turkeri L, Santucci RA, et al. EAU guidelines on urological trauma. Eur Urol. 2005;47(1):1–15.
7. Bjurlin MA, Fantus RJ, Mellett MM, Goble SM. Genitourinary injuries in pelvic fracture morbidity and mortality using the National Trauma Data Bank. J Trauma. 2009;67(5):1033–9.
8. Avey G, Blackmore CC, Wessells H, Wright JL, Talner LB. Radiographic and clinical predictors of bladder rupture in blunt trauma patients with pelvic fracture. Acad Radiol. 2006;13(5):573–9.
9. Cordon BH, Fracchia JA, Armenakas NA. Iatrogenic nonendoscopic bladder injuries over 24 years: 127 cases at a single institution. Urology. 2014;84(1):222–6.
10. Balbay MD, Cimentepe E, Unsal A, Bayrak O, Koc A, Akbulut Z. The actual incidence of bladder perforation following transurethral bladder surgery. J Urol. 2005;174(6):2260–2. discussion 2–3
11. Collado A, Chechile GE, Salvador J, Vicente J. Early complications of endoscopic treatment for superficial bladder tumors. J Urol. 2000;164(5):1529–32.
12. Traxer O, Pasqui F, Gattegno B, Pearle MS. Technique and complications of transurethral surgery for bladder tumours. BJU Int. 2004;94(4):492–6.
13. Brewer ME, Wilmoth RJ, Enderson BL, Daley BJ. Prospective comparison of microscopic and gross hematuria as predictors of bladder injury in blunt trauma. Urology. 2007;69(6):1086–9.
14. Hsieh CH, Chen RJ, Fang JF, Lin BC, Hsu YP, Kao JL, et al. Diagnosis and management of bladder injury by trauma surgeons. Am J Surg. 2002;184(2):143–7.
15. Tonkin JB, Tisdale BE, Jordan GH. Assessment and initial management of urologic trauma. Med Clin North Am. 2011;95(1):245–51.
16. Morey AF, Iverson AJ, Swan A, Harmon WJ, Spore SS, Bhayani S, et al. Bladder rupture after blunt trauma: guidelines for diagnostic imaging. J Trauma. 2001;51(4):683–6.
17. Deck AJ, Shaves S, Talner L, Porter JR. Current experience with computed tomographic cystography and blunt trauma. World J Surg. 2001;25(12):1592–6.
18. Myers JB, Taylor MB, Brant WO, Lowrance W, Wallis MC, Presson AP, et al. Process improvement in trauma: traumatic bladder injuries and compliance with recommended imaging evaluation. J Trauma Acute Care Surg. 2013;74(1):264–9.
19. Quagliano PV, Delair SM, Malhotra AK. Diagnosis of blunt bladder injury: a prospective comparative study of computed tomography cystography and conventional retrograde cystography. J Trauma. 2006;61(2):410–21. discussion 21–2
20. Lawson CM, Daley BJ, Ormsby CB, Enderson B. Missed injuries in the era of the trauma scan. J Trauma. 2011;70(2):452–6. discussion 6–8
21.• Kotkin L, Koch MO. Morbidity associated with nonoperative management of extraperitoneal bladder injuries. J Trauma. 1995;38(6):895–8. **A report highlighting complications with Foley catheter drainage.**
22. Corriere JN Jr, Sandler CM. Management of extraperitoneal bladder rupture. Urol Clin North Am. 1989;16(2):275–7.
23. Inaba K, Okoye OT, Browder T, Best C, Branco BC, Teixeira PG, et al. Prospective evaluation of the utility of routine postoperative cystogram after traumatic bladder injury. J Trauma Acute Care Surg. 2013;75(6):1019–23.
24. Cass AS, Luxenberg M. Management of extraperitoneal ruptures of bladder caused by external trauma. Urology. 1989;33(3):179–83.
25. Wirth GJ, Peter R, Poletti PA, Iselin CE. Advances in the management of blunt traumatic bladder rupture: experience with 36 cases. BJU Int. 2010;106(9):1344–9.
26.•• Johnsen NV, Young JB, Reynolds WS, Kaufman MR, Milam DF, Guillamondegui OD, et al. Evaluating the role of operative repair of extraperitoneal bladder rupture following blunt pelvic trauma. J Urol. 2016;195(3):661–5. **A retrospective study comparing outcomes of early cystorraphy versus catheter drainage.**
27. Hampson L, Hagedorn J, Voelzke BB. Re: evaluating the role of operative repair of extraperitoneal bladder rupture following blunt pelvic trauma: N. V. Johnsen, J. B. Young, W. S. Reynolds, M. R. Kaufman, D. F. Milam, O. D. Guillamondegui and R. R. Dmochowski J Urol 2016;195:661-665. J Urol. 2016;196(3):963–5.
28.• Johnsen NV, Sosland R, Kaufman MR, Guillamondegui OD, Dmochowski RR. Urinary-cutaneous fistulae following conservative management of extraperitoneal bladder ruptures. Urology. 2017 Jul 6. pii: S0090-4295(17)30703-3. https://doi.org/10.1016/j.urology.2017.06.034. **A retrospective study characterizing the rarely seen urinary-cutaneous fistulae in patients with EBI managed by catheter drainage.**
29. Figler BD, Hoffler CE, Reisman W, Carney KJ, Moore T, Feliciano D, et al. Multi-disciplinary update on pelvic fracture associated bladder and urethral injuries. Injury. 2012;43(8):1242–9.

30.• Elliott SP, McAninch JW. Extraperitoneal bladder trauma: delayed surgical management can lead to prolonged convalescence. J Trauma. 2009;66(1):274–5. **A series of two cases of EBI with delayed management and their resultant complications.**

31. Goldman HB, Idom CB Jr, Dmochowski RR. Traumatic injuries of the female external genitalia and their association with urological injuries. J Urol. 1998;159(3):956–9.

32.• Mundy AR, Andrich DE. Pelvic fracture-related injuries of the bladder neck and prostate: their nature, cause and management. BJU Int. 2010;105(9):1302–8. **This study highlights the severity of bladder neck injuries and the major reconstructive techniques required to repair them.**

33. Black PC, Miller EA, Porter JR, Wessells H. Urethral and bladder neck injury associated with pelvic fracture in 25 female patients. J Urol. 2006;175(6):2140–4. discussion 4

34. Wohlrab KJ, Sung VW, Rardin CR. Management of laparoscopic bladder injuries. J Minim Invasive Gynecol. 2011;18(1):4–8.

35. Kim FJ, Chammas MF Jr, Gewehr EV, Campagna A, Moore EE. Laparoscopic management of intraperitoneal bladder rupture secondary to blunt abdominal trauma using intracorporeal single layer suturing technique. J Trauma. 2008;65(1):234–6.

36. Kapoor R. Two-layer laparoscopic repair of intraperitoneal bladder rupture in blunt abdominal trauma: a case report with literature review. Surg Laparosc Endosc Percutan Tech. 2012;22(4):e204–5.

37. Parry NG, Rozycki GS, Feliciano DV, Tremblay LN, Cava RA, Voeltz Z, et al. Traumatic rupture of the urinary bladder: is the suprapubic tube necessary? J Trauma. 2003;54(3):431–6.

38. Volpe MA, Pachter EM, Scalea TM, Macchia RJ, Mydlo JH. Is there a difference in outcome when treating traumatic intraperitoneal bladder rupture with or without a suprapubic tube? J Urol. 1999;161(4):1103–5.

39. Alli MO, Singh B, Moodley J, Shaik AS. Prospective evaluation of combined suprapubic and urethral catheterization to urethral drainage alone for intraperitoneal bladder injuries. J Trauma. 2003;55(6):1152–4.

40. Margolin DJ, Gonzalez RP. Retrospective analysis of traumatic bladder injury: does suprapubic catheterization alter outcome of healing? Am Surg. 2004;70(12):1057–60.

41.•• Myers JB, Nirula R. A multi-center study of renal and bladder trauma [cited 2017]. Available from: http://www.aast.org/research/multiinstitutionalstudies.aspx. Accessed 15 Aug 2017. **An ongoing large, multi-institutional study attempting to identify outcomes for operative repair of EBI and predictors of need for early cystorraphy.**