Role of Ultrasonography in the Management of Vesical Injuries

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Abstract

Introduction: Traumatic bladder ruptures are most frequently seen in poly-trauma patients with blunt injuries. Complications from isolated bladder injuries are uncommon, unless delayed diagnosis. The gold-standard diagnostic radiological studies are ascending cystography and CT cystography respectively.

Objectives: To assess and compare the role of focused assessment sonography of trauma (FAST) with the gold standard radiological modalities in the diagnosis of vesical injury.

Methods: Clinical evaluation, laboratory assessment and radiological examination including FAST, ascending urethrogram and CT cystogram were done in the polytraumatized patients with suspected vesical injury admitted through the department of emergency medicine and trauma, Tanta University hospital.

Results: 28 patients were finally diagnosed with urinary bladder injury. This injury was seen mainly following road traffic accidents (RTA) in 64% of the cases, with male to female ratio 4:1. The most common associated injury was fracture pelvic bone in 64% and rib fractures in 29% of the cases. FAST examination was positive in 18 patients with sensitivity of 75% with negative predictive value of 85.3% and equivocal result in 12.5%. Conventional retrograde cystogram with oblique and post-deflation films had an overall sensitivity 90%. CT cystogram was positive for vesical injury in all cases 100%. Conservative treatment was followed in 60.7% with daily ultrasonographic examination to follow up the decrease in the perivesical extravasation. Open surgical repair was adopted only for the complicated vesical injury in 39.3%. Cases with vesical injury alone diagnosed intraoperatively were the cause for open repair in 14.3% of the total cases.

Conclusion: FAST examination in emergency room (ER) is an important, safe and quick bedside test for polytraumatized patients. It is helpful to diagnose intraperitoneal free

fluid and intraabdominal solid organ injury with sensitivity of 75% in diagnosis of urinary bladder injury and daily follow up with conservative treatment, with no need for dye instillation or injection or patient transfer to the radiology unit.

Keywords: Bladder , Trauma, Ultrasonography

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1. Introduction

Urinary bladder injury has three main causes which are traumatic, iatrogenic and spontaneous vesical rupture.[1]The most common cause of traumatic bladder injury is blunt trauma in 80-90%. Spontaneous rupture mostly occurs in cases having previous bladder problems such as history of bladder augmentation, intermittent catheterization and bladder dysfunction.[2] For a long time, conventional cystogram has been the standard study for assessment and evaluation of patients with suspected urinary bladder injury, but CT cystography is now the gold standard radiological study to diagnose and grade patients with urinary bladder injury following blunt or penetrating abdominal trauma.[3] FAST is done in emergency room by emergency physician and one of the main sites to be assessed during FAST is the urinary bladder. The main advantages of ultrasonography are that it is quick, bedside, has minimal cost, no need for intravenous contrast and no ionizing radiation which makes it totally safe during pregnancy.[4] Surgical interference is indicated in patients with penetrating trauma and complicated cases with intraperitoneal or extraperitoneal vesical injury. Most of patients with extraperitoneal bladder rupture are treated conservatively with urethral catheter drainage as long as urine clears of blood, catheter functioning well and no complications appear. In the presence of concomitant infection or progressive increase in the size of urinoma, ultrasound or CT guided drainage is indicated.[5]

2. Subjects and Methods:

Our study included patients with suspected urinary bladder injury admitted to Tanta University Emergency Hospital from October 1st 2018 till October 31st 2020, after approval of our Ethics Committee Board and getting informed written consent from the patients. All patients were submitted to detailed history taking and full examination according to ATLS protocol (Primary and Secondary survey). Laboratory investigations done were CBC, coagulation profile, serum creatinine, blood urea, BUN and complete urine analysis. Ultrasongraphic imaging by curvilinear probe of Philips Affiniti 50G machine for FAST examination was done. In order to improve the test sensitivity in vesical injury detection, the test was done initially then repeated within an hour to assess any increase in intravesical urine volume with IV fluid resuscitation. Supra-pubic area ultrasonographic assessment is implemented (Coronal and saggital views) in order to visualize the bladder contour and perivesical collections. Any decrease in intravesical volume associated with increase in the perivesical collection suggests bladder injury rather than pelvic hematoma. Detection of intraperitoneal free fluid and rigidity suggested intraperitoneal bladder tear as one of the causes for this intraperitoneal fluid. Also, ascending urethrocystogram with increase in the amount of dye instilled, oblique view and after deflation film was done in the radiology department to identify urethral, vesical and bony pelvis injuries. Patients were submitted to CT cystography in the presence of any signs of urinary bladder injury using the contrast material instillated into the bladder. In cases with inability to bypass the urethral catheter, CT urography was done, taking the vesical

phase of the study (descending CT cystography). These data were compared with the results of FAST examination.

3. Results:

This study included 28 patients with different types of urinary bladder injuries out of 63 patients suspected to have traumatic bladder injury. It was found that the incidence of urinary bladder trauma in the polytraumatized patients is the highest in the age group 21-30 years old (35.7%) followed by the age group 31-40 (32.2%), while the least affected group was between 11-20 years in 21.4% and cases older than 40 years in 10.7%. Males were highly affected in 23/28 patients (82.1%) than females in 5 patients (17.9%). The most common cause for the bladder injury was RTA in 18 cases (64.3%), falling from height in 4 cases (14.2%), 2 cases (7.1%) after a direct blow and iatrogenic injury in 4 cases during obstetric and gynecological operations, all were identified and managed concomitantly. Extraperitoneal vesical injury was seen in 22 patients (78.6%), intraperitoneal injury in 4 cases (14.2%), combined injury in one patient and one patient with vesical contusion. The most common associated injury with bladder rupture was fracture pubic bone in 18/28 cases (64.3%), followed by fracture bone of the femur in 6/28 cases (21.4%), spleenic injury in 4 patients (14.3%), brain injury in 3 cases (10.7%) and hepatic injury in 2 cases (7.1%). Posterior urethral injury was seen in 3/28 cases (10.7%), all were associated with extraperitoneal bladder rupture. The results of the FAST ultrasound examination of the urinary bladder in the ER room according to the protocol of examination in 24 patients had shown a positive study of vesical injury, shown in fig (1), with non intact detrusor wall, asymmetrical contour with free fluid surrounding the bladder or freely mobile hyper echoic intravesical mass (blood clot) in 18/24 (75%) patients (including the pregnant female). The study was negative in three patients (12.5%) and equivocal i.e. suggestive but not conclusive in three patients (12.5%), Table (1).

Therefore the ultrasonographic examination was sensitive in the diagnosis of 75% of the cases and could not diagnose vesical injury for sure in 25% of the cases, with negative predictive value 85.3%. Half of these cases showed equivocal results when the bladder was empty on initial and second assessment with no definite perivesical collection. Some of these cases had also marked abdominal gaseous distension.

The ultrasonographic examination showed specificity of 67.3% during the study and regarding the positive predictive value it was 51.4%.

Retrograde urethrocystogram initially had sensitivity in 75% similar to FAST examination, but after instillation of 100 ml. more of the dye with films in the oblique and after deflation film of the bladder, the sensitivity improved up to 80%, 85% and 90% respectively. However with this radiologic study we were unable to identify simple from complex bladder injury with extrapelvic dye extravasation. During ascending urethrocystogram the dye could not pass up into the bladder in three cases due to complete posterior urethral injury with periurethral and perineal extravasation.

Four of the six false negative cases with FAST examination were diagnosed by ascending cystography, while the other two patients were diagnosed on CT cystography, Table (2). Also the patient diagnosed with the ultrasonographic examination as bladder contusion was also confirmed by CT cystography.

CT cystography study has diagnosed bladder injury in all 24/24 cases 100%. CT cystography showed perivesical intrapelvic extravasation i.e. simple extraperitoneal bladder injury in 18 cases (75%), while in three cases (12.5%) the extravasation was perivesical and outside the pelvis i.e. complex extravasation into the scrotum, pericolic, anterior abdominal wall and gluteal area, Fig. 2. While combined vesical injury and bladder contusion were seen each in one patient.

A total of seventeen patients (60.7%) in our series were managed conservatively. Conservative management included urethral catheter drainage and follow up for 7-10 days. The amount of extravasated urine was followed by ultrasonographic examination daily to assure gradual decrease in size. After one week, clinical and laboratory changes had been subsided with no more tenderness or extravasated fluid.

Only 11/28 patients (39.3%) were submitted to open surgical repair including the iatrogenic injury cases.

Open exploration was done for five females and six males, three of them had associating posterior urethral injury that mandated exploration, repair and realignment and one female only following road traffic accident with vesicouterine tract, Fig 3.

Vesical injury alone was the cause for open repair in 4/11 patients (36.4%) of the opened cases and this constitutes 4/28 patients (14.3%) of the total patients with vesical injury. Associated other injuries were the indication for open surgical repair and bladder repair was done concomitantly in 7/11 patients (63.6%).

Table (1) Results of FAST examination in 24 patients

Result of examination	Number	Percentage
Sure signs of diagnosis	**18**	**75%**
Signs are not sure diagnostic - **Negative study result: 3 cases (12.5%)** - **Equivocal study result: 3 cases (12.5%)**	**6**	**25%**

Table (2) Comparison between FAST, Retrograde cystogram and CT cystogram in 24 patients with vesical injury.

	Ultrasonography 24 patients		Retrograde cystogram 20 patients		CT cystogram 24 patients	
	Number of patients	Percentage	Number of patients	Percentage	Number of patients	Percentage
Sensitivity	18	75%	18	90%	24	100%
False negative	6	25%	2	10%	0	0%
Number of patients	24*		20**		24*	

* 4 patients diagnosed in Operating Room (OR).

** 4 patients diagnosed in OR + 3 patients with posterior urethral injury + 1 patient presented with CT cystogram done before arrival to Tanta University Hospital.

Figure 1: Ultrasound examination to the urinary bladder with non intact bladder wall with intravesical blood clots and perivesical collection.

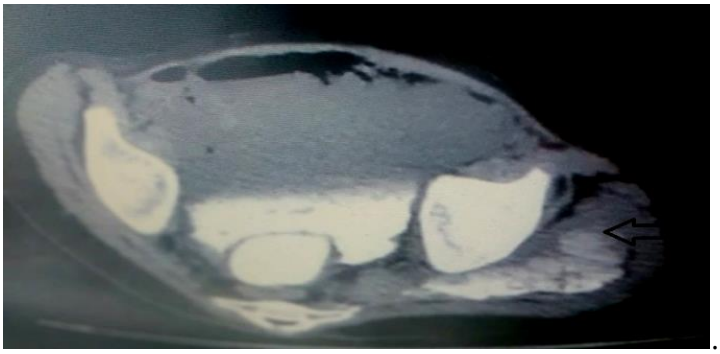

Figure 2: CT cystogram for a male patient after RTA showing complex vesical injury. The dye is extending outside the pelvis into the left gluteal area

Figure 3: CT cystogram for a 35 years old, female patient after RTA showing vesicouterine tract. Patient was managed operatively with primary repair to the tract.

4. Discussion

Genitourinary injuries are presented in almost 10% of the polytrauma patients in emergency room.[6] On the other hand in an epidemiological study of 57,367 trauma patients over 1 year, 0.5% had genitourinary injuries and urinary bladder injury constituted only 3% with a mean age of 25 years.[7]

Most of the cases in this series were males in 82.1 % and 10.7% only were above age of 40 years and no one was seen below 10 years concluding that bladder injury is usually the problem of young adults.

In our study, because all patients (100%) had microscopic and or macroscopic hematuria with suprapubic pain and inability to void spontaneously in the emergency room, it was concluded that hematuria is a stigmata of bladder injury but its degree is not correlated to the degree and type of vesical injury, even with intraperitoneal type of bladder rupture.

The degree of hematuria and its relation to the extent of bladder injury had been always controversial. Therefore some authors recommend radilogical evaluation to vesical injury, regardless the degree of hematuria, in all patients with pelvic bone injury. [8] On the other hand, other authors had suggested that in absence of gross hematuria or other clinical sign of lower urinary tract injury in patients with pelvic bone fracture, retrograde cystogram was mostly unnecessary. [9]

In our series road traffic accidents was the cause for vesical injury in about two thirds of the cases with fracture in the pelvic bone in 64.3%. However the site of the vesical injury was not correlated to the site and even the side of the bone fracture as previously observed by other authors. [10]

Also iatrogenic injury can follow pelvic operations whether open, endoscopic or laparoscopic procedures, but most of these cases occur during cesarean section and cesarean hysterectomy as reported in 14.3% of the cases in this series and other previous studies. [10,11]

Fracture of the pubic rami was the most common type of pelvic fracture as seen in fifteen patients (53.6%) with bladder rupture being unilateral in ten cases (35.7%) and bilateral in five cases (17.9%).

Also many authors e.g. Cass (1988) had observed (83.3%) pelvic bone fractures in 534 patients with bladder rupture with non significant relation between the type of pelvic fracture and type of bladder rupture. On the other hand when fracture of the pelvic bone is the main index lesion, the incidence of vesical injury was not very common as seen in (20%) only. [12,13]

Extraperitoneal bladder injury was seen in 78.6%, compared to intraperitoneal bladder injury in 14.3% with insignificant correlation between the mode of trauma and the type of bladder injury which is more related to the degree of bladder distension at the time of trauma, an observation that has been previously observed. [14]

Other intra abdominal injuries associated with vesical injury in our study were usually the cause of subsequent hemodynamic instability after admission. Therefore, if the patient became hemodynamically unstable, causes other than bladder injury should be carefully considered. A similar observation since long time had been reported by Cass in 1989. [15,16]

The final diagnosis of vesical injury depends on radiological data that has been changed over years as intravenous urography done in the radiology department has insensitive results and high rate of false negative findings due to inadequate filling of the bladder with the diluted contrast material.

Urinary bladder assessment during FAST examination have recently been used widely with better sensitivity and specificity, due to the wide usage of more advanced machines and learning curve of emergency physicians. In this series, the test was done as a bedside, quick and safe test with no need to transfer the patient to the radiology unit with a sensitivity of 75%.

Ultrasonographic assessment by emergency physician was evaluated in 2011 by Wu et al, with reasonable degree of diagnostic accuracy in a short time. [4]

Also, Tayal et al on evaluating the accuracy of the ultrasound in pelvic fracture patients had found that ultrasound had a sensitivity of 80.8% with a negative predictive value of 91.4%. [17] This is similar to the data reported in this work.

On the other hand, Bain et al, had recorded ultrasound sensitivity of 44%, this difference could be contributed to lower sample size in addition to the well known fact on ultrasound study as an operator dependent test. [18]

Initial conventional retrograde cystography could detect bladder injury with sensitivity of 75% and after instillation of more dye inside the bladder the sensitivity increased to

80%. After obtaining an oblique film and taking X ray film after deflation of the urinary bladder an increase in the sensitivity of this study into 85% and 90% respectively and reducing the false negative results into 10% of the cases diagnosed by the CT cystography examination.

False negative cystographic findings with conventional retrograde cystogram was reported previously in 10% and 13% of the cases with vesical injury by Sandler et al in 1986 and Cass in 1989. [15,19] This was due to inadequate vesical filling and lack of oblique and post drainage film. Also, this was seen in cases with small perforation preventing extravasation of the contrast outside the bladder unless the intravesical pressure is raised by more dye instillation i.e. natural protective mechanism, or due to plugging of this small tear by omental piece or intestinal loop. [14,20]

On the other hand, CT cystography had diagnosed vesical rupture in 24 patients (100%) after excluding the four patients diagnosed on the operative table due to iatrogenic injury. This had been done without intravesical instillation of a radio-opaque material or taking films in certain position which is in some situations impossible.

Therefore, the sensitivity of the FAST, retrograde cystogram and CT cystogram to detect simple extraperitoneal bladder injury was 75%, 90% and 100% respectively. However, the CT cystogram had diagnosed 3 cases with complex vesical injury that could not be diagnosed on FAST or retrograde study. The dye was seen outside the pelvis in the scrotum and retroperitoneal space around the psoas muscle.

CT cystography as a gold standard radiological study to diagnose bladder rupture had been also reported by many other authors and to increase the sensitivity of that test, the Foley's catheter has to be clamped during the study to improve distension of the bladder. [21, 3, 15, 22 & 23]

Treatment depends mainly on the degree of injury, mode of trauma and association with other concomitant injury that mandate either conservative or operative treatment with repair and closure of the vesical injury. [5]

Conservative treatment was reported in 1974 for 8 patients [24], 1976 for 12 patients[25], 1982 for 2 females [26] and in 1986 for 14 patients [27]. Therefore conservative treatment is indicated when no other causes for open surgery is present, especially in patients with small tears and urinoma and it is not related to the size of rupture or the size of extravasation which is related to the amount and rate of instilled contrast material during retrograde cystogram. [6]

The results in our study following conservative treatment in (60.7%) with daily follow up ultrasonographic examination supported these data with no morbidity or mortality even in the patient with intraperitoneal bladder injury.

Open exploration and repair to the vesical injury was done in 39.3% of the total cases. It was followed for 6 males

(21.4%) and 5 females (17.9%), four of them were iatrogenic diagnosed and managed on table.

Therefore, the principle in the management of bladder rupture following this protocol has been changed recently in contrast to the old reports by Cass and Ireland that stressed on operative treatment for all cases with urinary bladder rupture. [28, 29]

5. Conclusion:

Ultrasonography has a valuable role as a bedside screening tool in early diagnosis of vesical injury, followed by CT cystography in vitally stable patients as a gold standard diagnostic tool. It is very helpful in early diagnosis of vesical and other abdominal and pelvic organs injury with its consequence on improving post-traumatic morbidity and mortality. Conservative treatment guided by daily ultrasonographic examination is the standard line of management for uncomplicated urinary bladder injury even in some selected cases with intraperitoneal injury. In the emergency departments more trainings on a bigger number of patients on the FAST examination is crucial as a quick, non invasive and bedside test to minimize morbidity and the need for unnecessary exploration to vesical injury.

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Statement of Ethics:

All data gathered and procedures performed in our study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Written informed consent was obtained from the patients or their parents or their legal guardians for publication of the details of their medical case and any accompanying images. Approval from the Ethics Committee of Tanta Faculty of Medicine has been obtained with reference no. 32646/10/18.

Conflict of interests

The authors declare that they have no conflicts of interest to disclose.

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Authors contributions

Sherif S Elabd: Data gathering, statistics and manuscript writing.

Esraa H Nassar: Data gathering and statistics.

Roeya M Aboelnasr: Data gathering and statistics.

Abdelnaser K Elgamasy: Design of the work and sharing in patients management.

Mohamed G Soliman: Sharing in patients management and statistics.

Mohamed A Elheniedy: Design of the work and Revision

Data availability statement:

All data generated or analysed during this study are included in this article. Further enquiries can be directed to the corresponding author due to legal and ethical issues.

References

1. Walters MD and Weber AM. Anatomy of the lower urinary tract, rectum and pelvic floor. In: Walters MD and Karram MM eds. Urogynecology and Pelvic Reconstructive Surgery. 2nd ed. St. Louis, Mo: Mosby; 2000: 3-13.
2. Gomez R, Ceballos L, Coburn M, Corriere JR, Dixon C, Lobel B, et al. Consensus statement on bladder injuries. BJU 2004 Jul; 91(1): 27-32 .
3. Tonkin JB, Tisdale BE and Jordan GH. Assessment and initial management of urologic trauma. Med Clin North Am. 2011 Jan; 95: 245–51.
4. Wu TS, Pearson TC, Meiners S and Daugharthy J. Bedside ultrasound diagnosis of a traumatic bladder rupture. J Emerg Med. 2011 Nov; 41(5): 520-3.
5. Mahat Y, Leong JY and Chung PH. A contemporary review of adult bladder trauma. J Inj Violence Res. 2019 Jul; 11(2): 101-106.
6. Corriere JN and Sandler CM. Bladder rupture from external trauma: diagnosis and management. World J Urol 1999 Apr; 17: 84–89.
7. Salimi J, Nikoobakt MR and Zareei MR. Epidemiologic study of 284 patients with genitourinary trauma in three trauma centers in Tehran. Urol J 2004 Jun; 1(2): 117-20 .
8. Pokorny M, Pontes JE and Pierce JM. Urological injuries associated with pelvic trauma. J Urol 1979 Apr; 121(4): 455-7.
9. Fallon B, Wendet JC and Hawtrey CE. Urological injury and assessment in patients with fractured pelvis. J Urol 1984 Apr; 131(4): 712-4.
10. Johnsen N, Dmochowski R, Young J and Guillamondegue O. Epidemiology of Blunt Lower Urinary Tract Trauma with and without Pelvic Fracture.Urology. 2017 Apr; 102: 234-239.
11. Dobrowolski ZF, Lipczynski W, Drewniak T, Jakubik P and Kusionowicz O. External and iatrogenic trauma of the urinary bladder: a survey in Poland. BJU Int. 2002 May; 89(7): 755-6.
12. Cass AS. Genitourinary trauma. In: National Library of Medicine Current Catalog. Boston, PA. Blackwell scientific publications, 1988; 141 .
13. Cass AS, Behrens F, Comfort T and Matsuura J. Bladder problems in pelvic fractures treated with external fixator and direct urethral drainage. J Trauma 1983 Jan; 23(1): 50-3.

14. Husman DJ. Diagnostic techniques in suspected bladder rupture. In McAninch JW eds. Traumatic and reconstructive urology. McAninch JW et al ed. Philadelphia, USA, PA: WB Saunder, 1996, chap 18; 261-8.
15. Cass AS. Diagnostic studies in bladder rupture. Urol Clin North Am. 1989 May; 16(2): 267-73.
16. Cass AS and Luxenberg M. Features of 164 bladder ruptures. J Urol. 1987 Oct; 138(4): 743-5.
17. Tayal VS, Nielsen A, Jones AE, Thomason M, Kellam J and Norton H. Accuracy of Trauma Ultrasound in Major Pelvic Injury. J Trauma. 2006 Dec; 61(6): 1453-7.
18. Bain K, Kassapidis V, Meytes V and Glinik G. FAST examination diagnosing bladder rupture following blunt pelvic trauma. BMJ case reports 2018 Mar; 2018:bcr2017223933.
19. Sandler CM, Hall JT, Rodriquez MB and Corriere JR. Bladder injury in blunt pelvic trauma. Radiology 1986 Mar; 158(3): 633-8.
20. Sagalowsky AI and Peters PC. Genitourinary trauma. In: Campell's Urology. 7th ed, vol 6. Philadelphia, Pa: W.B Saunders, 1998; 3104-8.
21. Goldstein AS, Sclafani SJ, Kupferstein NH, Bass I, Lewis T, Panetta T, et al. The diagnostic superiority of computerized tomography. J Trauma. 1985 Oct; 25(10): 938-46.
22. Kane NM, Francis IR and Ellis JH. The value of CT in the detection of bladder and posteriorurethral injuries. Am J Roentgenol. 1989 Dec; 153(6): 1243-6.
23. Lowe FC, Fishman EK and Oesteroling JE. Computed tomography in diagnosis of bladder rupture. Urology 1989 Apr; 33(4): 341-3 .
24. Mulkey AP and Witherington R. Conservative management of vesical rupture. Urology. 1974 Oct; 4(4): 426-30.
25. Brosman SA and Paul JG. Trauma of the bladder. Surg Gynecol Obstet. 1976 Oct; 143(4): 605-608.
26. McConnell JD, Wilkerson MD and Peters PC. Rupture of the bladder. Urol Clin North Am. 1982 Jun; 9(2): 293-6.
27. Corriere JN and Sandler CM. Management of the ruptured bladder: seven years of experience with 111 cases. J Trauma. 1986 Sep; 26(9): 830-3.
28. Yeung LL, McDonald AA, Como JJ, et al. Management of blunt force bladder injuries: A practice management guideline from the Eastern Association for the Surgery of Trauma. J Trauma Acute Care Surg. 2019 Feb; 86(2): 326-336.
29. Cass AS and Ireland GW. Bladder trauma associated with pelvic fractures in severely injured patients. J Trauma. 1973 Mar; 13(3): 205-12

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