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Urethral injury in major trauma

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ABSTRACT

Urethral injury in major trauma is infrequent, with complex problems of diagnosis and treatment. The aims of this study are to determine the incidence and epidemiological factors relating to urethral injury in major trauma, as well as determine if any additional prognostic factors are evident within this cohort of patients. A retrospective review of patients sustaining urethral injury following major trauma was made over a 6-year period, from 2010 to 2015. Quantitative analysis was made using the national trauma registry for England and Wales, the Trauma Audit and Research Network (TARN) database, identifying all patients with injury codes for urethral injury. 165 patients with urethral injuries were identified, over 90% were male, most commonly injured during road traffic accidents and with an associated overall mortality of 12%. Urethral injury in association with pelvic fracture occurred in 136 patients (82%), representing 0.6% of all pelvic fractures, and was associated with double the rate of mortality. Urethral injury was associated with unstable pelvic fractures (LC2, LC3, APC3, VS, CM) but not with a specific pelvic fracture type. This study confirms the rare incidence of this injury in major trauma at 1 per 2 million population per year.

Introduction

Urethral injury in major trauma is infrequent, with complex problems of diagnosis and treatment, especially during the cacophony of polytrauma patient management. Traumatic urethral injuries can result in a poor quality of life and carry substantial morbidity including stricture, repeated lower urinary tract infections, bleeding, recurrent pyelonephritis, peri-urethral abscesses and fistulas, incontinence, erectile dysfunction, and infertility [1].

Anatomical variation between the genders leaves the male urethra at greater susceptibility for injury. However, female urethral injury is a marker of trauma severity and poor prognosis [2]. In males and depending upon the magnitude of trauma, the membranous urethra is first stretched and then partially or completely ruptured at the bulbomembranous junction. Complete disruption of the urethra occurs in two-thirds of injuries, with partial tears according for the remaining third [3]. Injuries to the prostatic urethra and bladder neck tend to occur only in children. Injury to the female urethra usually is a partial tear of the anterior wall, but rarely a complete disruption of the proximal or distal urethra may occur [4,5].

The association of pelvic trauma and concomitant urethral injury is well recognised, most frequently with higher grade fracture patterns [6]. The risk of urethral injury in pelvic fracture is influenced by the number of broken pubic rami, as well as injury of the sacroiliac joint. Each millimetre of symphysis pubis diastasis or infero-medial pubic rami fracture displacement has been demonstrated to be associated with an approximate 10% increased risk of urethral injury [7].

The suspicion of urethral injury increases with the following clinical features: blood at the urethral meatus; difficulty/inability to void; palpable bladder distension; butterfly pattern perineal bruising; high-riding or impalpable prostate; displaced pubic rami fracture; pelvic haematoma [8]. The first three clinical features form the classic triad for urethral injury but are not present in all cases and the absence of these signs should not provide diagnostic reassurance.

Complications of delayed or missed diagnosis include death, urethral stricture, impotence, and incontinence. Specialist opinions regarding management differ as to whether immediate suprapubic cystostomy followed by secondary reconstruction is preferable to immediate direct urethral realignment although the consensus in the UK is to perform secondary reconstruction [9].

The aims of this study are to define the incidence and epidemiological factors relating to urethral injury in major trauma for England & Wales, as well as determine any

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additional prognostic factors evident within this cohort of patients.

Methods

A retrospective review of patients sustaining urethral injury in major trauma was made over a 6-year period, from January 1st 2010 to December 31st 2015. Quantitative analysis was made using the national trauma registry for England and Wales, the Trauma Audit and Research Network (TARN) database, identifying all patients with injury codes for urethral injury. TARN collates data submitted from the network of Major Trauma Centres (MTC) and Trauma Units (TU), registering patients meeting TARN eligibility criteria. Eligibility criteria include: trauma patients; hospital admission > 3 days or critical care admission or specialist trauma care transfer; in-hospital mortality; isolated injury classification (in accordance with TARN injury exclusion criteria).

Data collected comprised of patient demographic information, Injury Severity Score (ISS), Abbreviated Injury Scale (AIS) scores, mechanism of injury and clinical outcomes. Urethral injury cohort was extracted as defined by relevant diagnostic codes, listed in Appendix A, according to the Association for the Advancement of Automotive Medicine (AAAM) AIS 2005 dictionary.

Comparison of injury characteristics and clinical outcomes were made between pelvic fracture patients with and without urethral injury. Pelvic fracture cohort was also extracted as defined by relevant diagnostic codes, listed in Appendix A, as well as the reconfiguration from the pelvic AIS to match Young & Burgess classification [10,11] and then grouped by stability: stable (antero-posterior compression type 1), partially unstable (antero-posterior compression type 2, lateral compression type 1) & unstable (antero-posterior compression type 3, lateral compression type 2 & 3, vertical shear, combined mechanism).

Statistical evaluation for comparison were performed using chi-square test with $p < 0.05$ regarded as statistically significant. Analyses were performed in SPSS v 13.0.

TARN has HRA Section 251 approval to conduct research on this anonymised data set.

Results

During the studied period, over 200,000 patients were entered into the TARN database, including 21,394 pelvic fracture patients. 165 patients with urethral injury were identified over the 6-year period analysed. The vast majority of injuries are as a result of blunt mechanisms (see Table 1), in particular road traffic collision (RTC) and falls. 92% were male. No paediatric patients with urethral injury were identified.

Urethral injury was associated with an overall mortality of 12%. Associated with urethral injury in major trauma were other injuries; intra-abdominal visceral (27%), genital (20%), rectal (5%).

Without pelvic fracture

Only 29 patients sustained urethral injury without associated pelvic fractures (see Table 1). A small number of these (20%) were due to penetrating trauma. Urethral injury without pelvic fracture had a lower injury severity score (ISS) and associated mortality rate of 10%.

With pelvic fractures

136 major trauma patients had urethral injuries that were associated with pelvic fractures, over 80% of the total cohort (Table 2). Only 0.07% of female pelvic fracture patients have urethral injury, against the 1% of male pelvic fracture patients.

When comparison is made to the overall pelvic fracture cohort (21,394), patients with urethral injury are seen to be younger, with a higher incidence in males, more common in penetrating trauma and following road traffic collisions. Median ISS was also seen to be higher (28 vs. 8).

Blood loss > 20% circulating volume was seen in 43% of pelvic fractures with associated urethral injury. Open fractures were found in 5% of pelvic fractures with associated urethral injury.

Mortality rates were significantly higher in patients with urethral injuries (12% vs. 6%) [p-value <0.01]. Female mortality following pelvic fracture with associated urethral injury was double the rate of male mortality from the same injury pattern (15% vs. 7%).

Within the overall pelvic fracture cohort, excluding urethral trauma, associated injury rates were: rectal (0.2%), vascular (0.5%), genital (1%), other intra-abdominal (5.7%). Pelvic fracture type, when described according to Young & Burgess classification, demonstrates urethral injury rates increases with fracture configuration severity (see Table 3).

Mortality of pelvic fracture types was analysed and demonstrated a significant increase in only the unstable group, as defined

Table 1
Urethral Injuries. *Median (IQR). †30 day mortality.

Urethral Injuries		All (%)	Without Pelvic Fracture (%)	With Pelvic Fracture (%)	p-value
Total		165	29	136	
Age*		38 (25.4 - 50.8)	38.5 (24.5 - 45.8)	37.8 (25.4 – 50.8)	0.77
Gender					
	Male	152 (92)	24 (83)	128 (94)	<0.01
	Female	13 (8)	5 (17)	8 (6)	
Mechanism of Injury					
	RTC	97 (60)	9 (31)	88 (65)	<0.01
	Fall > 2m	11 (7)	0 (0)	11 (8)	
	Fall < 2m	10 (6)	8 (28)	2 (1)	
	Shooting/Stabbing	4 (2)	4 (14)	0 (0)	
	Blow(s)	3 (2)	1 (3)	2 (1)	
	Other	40 (24)	7 (24)	33 (24)	
Injury type					
	Blunt	155 (94)	24 (83)	131 (96)	0.02
	Penetrating	10 (6)	5 (17)	5 (4)	
Injury Severity					
	ISS*	29 (20 - 43)	9 (4 - 25)	28 (20 – 43)	<0.01
Survival†					
	Alive	145 (88)	26 (90)	119 (87.5)	0.99
	Dead	20 (12)	3 (10)	17 (12.5)	

Table 2
Pelvic Fractures with & without Urethral Injury. * Median (IQR). † 30 day mortality.

Pelvic Fractures		Without Urethral Injury (%)	With Urethral Injury (%)	p-value
Total		21258	136	
Gender				
	Male	10520 (49.5)	128 (94)	<0.01
	Female	10738 (50.5)	8 (6)	
Age				
	Median Age*	51.5 (37.7 – 81.8)	37.8 (25.4 – 50.8)	<0.01
Mechanism of Injury				
	RTC	7455 (35.1)	88 (65)	<0.01
	Fall >2m	3660 (17.2)	11 (8)	
	Fall <2m	9463 (44.5)	2 (1)	
	Shooting / Stabbing	52 (0.2)	0 (0)	
	Blow	168 (0.8)	2 (1)	
	Other	460 (2.2)	33 (24)	
Injury type				
	Blunt	21137 (99.4)	131 (96)	<0.01
	Penetrating	121 (0.6)	5 (4)	
Injury Severity				
	ISS*	8 (4 – 20)	28 (20 – 43)	<0.01
Survival †				
	Alive	19900 (93.6)	119 (87.5)	<0.01
	Dead	1358 (6.4)	17 (12.5)	

Table 3
Urethral Injury by Pelvic Fracture Type. (*Urethral Cohort n = 135, due to data unavailable).

Pelvic Fracture Types	Pelvic	Urethral*	p-value
Stable (AP1)	15,856 (99.8%)	26 (0.2%)	
Partially Unstable (LC1, APC2)	4538 (98.5%)	71 (1.5%)	
Unstable (LC2, LC3, APC3, VS,CM)	864 (95.8%)	38 (4.2%)	<0.01

by pelvic fracture classification (LC2, LC3, APC3, VS, CM), when there is associated urethral injury (24% vs. 12%) [p-value < 0.01].

In addition to the national registry evaluation, summary of the published literature, in direct reference to the incidence of urethral injury in major trauma, is shown in Table 4. Overall, only 1640 cases of such an injury pattern were identified and therefore this study represents a valuable and significant contribution to the limited epidemiological evidence.

The adult population over this period was 46 million for England and Wales [50]. This injury is rare with an average of 28 cases per year, giving a population incidence of 0.61 cases per million population per year.

Discussion

Our study demonstrates the first national incidence and outcome data for England & Wales for urethral injury in major trauma patients and supports the published literature regarding urethral injury associated with pelvic fractures.

Dalal described the patterns of organ injury following pelvic fracture, in accordance with the authoring group's classification system [51]. Although a comprehensive review, the presented data in graph form is difficult to interpret for the observed rates of urethral injury. The pattern of increased rates of urethral injury with higher pelvic trauma severity is replicated, but the expected rates could not be reliably established in order to inform and provide a comparison against this data set.

Bjurlin demonstrated, in a registry study based on the United States National Trauma Data Bank (NTDB), a rate of urethral injury following pelvic fracture for male patients of 1.5% and for female patients of 0.15% [22]. Our study has comparable rates, with the frequency of urethral injury following pelvic fracture being in males, 1.2% and in females, 0.1%. Data to the NTDB is submitted voluntarily and with very few mandatory data fields, some of which are non-standardised definitions and of variable quality control.

Therefore, using the demonstrated population incidence for urethral injury in major trauma, each Major Trauma Centre will only receive 1 or 2 cases each year. This emphasises the need for strict diagnostic vigilance, as well as the necessary aim for specialist centres to undertake secondary urethral reconstruction. Developing expertise in primary urethral reconstruction or repair in each Major Trauma Centre may not be feasible with such low volumes of injury.

Registry level data can therefore be limited in the depth of clinical information. Yet, case ascertainment for the TARN registry is extremely high, with high levels of data standardisation and good quality control. Therefore, a greater precision of reliability may be applied to the presented information. However, certain limitations must be recognised for this study is based upon TARN inclusion criteria, where cases of traumatic death occurring in the pre-hospital setting are excluded, as are patients sustaining isolated pubic rami fractures.

While the incidence of genitourinary injuries has been shown to be similar for each of the three common types of pelvic fractures, certain subtypes are known to place the genitourinary system at greater risk of injury, in particular straddle fractures. However, from a clinical perspective, the stability characteristic of a pelvic fracture is a more useful in determining the likelihood of urethral injury. As demonstrated by the incidence when pelvic fractures are categorised in this manner, stable, partially unstable or unstable, the associated incidence rises as the stability declines. Previously published works have demonstrated the use of ICD-9 and AIS codes have been successfully evaluated pelvic fractures [52,53]. While the precise nature of the pelvic fractures, in relation to exact fracture patterns or fracture displacements, was not available, by using the aforementioned coding systems, the categories of Young & Burgess pelvic fracture types were determined.

Along with severity of pelvic fracture, independent predictors of mortality for all pelvic fractures included age 65 years or older, female gender, first SBP in ED < 90 mm Hg, a GCS total <8, and an ISS > 25 [54]. While the presence of a urethral injury does not independently predict mortality, it should alert the trauma team to the severity of trauma sustained by the patient and diligence applied to identifying all concomitant injuries.

Polytrauma patients or those sustaining major trauma with pelvic fractures, should raise the clinical index of suspicion for not

Table 4
Systematic Literature Review for Case Numbers of Urethral Injury in Major Trauma.

Author	Year	Origin	Primary Research	Urethral Injury	Associated Pelvic Fractures Cohort	Notes
Osterberg et al. [12]	2017	USA	Yes	3	–	Bicyclists
Johnsen et al. [13]	2017	USA	Yes	71	5518	
Pereira et al. [14]	2017	Brazil	Yes	2	66	
Hegele et al. [15]	2016	Germany	Yes	254	90000	Registry
Ngaroua et al. [16]	2014	Cameroon	Yes	4	19	
Pejčić et al. [17]	2013	Serbia	Yes	24	376	
Odzébé et al. [18]	2013	Congo	Yes	16	193	
Firoozabadi et al. [19]	2011	Iran	Yes	21	–	Disaster
Lückhoff et al. [20]	2011	Australia	Yes	29	998	
Salako et al. [21]	2010	Nigeria	Yes	53	–	
Bjurlin et al. [22]	2009	USA	Yes	355	31380	Registry
Kunkle et al. [23]	2008	USA	Yes	12	–	
Paparel et al. [24]	2006	France	Yes	6	–	Estimated
Bariol et al. [25]	2005	UK	Yes	16	–	
Aihara et al. [26]	2002	USA	Yes	7	372	
Eke et al. [27]	2001	Nigeria	Yes	30	–	
Siegmeth et al. [28]	2000	Germany	Yes	7	–	
Venn et al. [29]	1999	UK	Yes	12	–	Female
Koraitim et al. [30]	1996	Egypt	Yes	100	–	
Lowe et al. [31]	1988	USA	Yes	21	405	
Lascombes et al. [32]	1988	France	Yes	64	–	
Krieger et al. [33]	1984	USA	Yes	14	–	
Janak et al. [34]	2017	USA	Yes	125	341	Military
Nnamani et al. [35]	2016	USA	Yes	124	–	Military
Banti et al. [36]	2016	USA	Yes	36	–	Military
Ramasamy et al. [37]	2012	UK	Yes	11	–	Military
Serkin et al. [38]	2010	USA	Yes	7	–	Military
Trachta et al. [39]	2016	Czech	Yes	13	–	Paediatric
Tarman et al. [40]	2002	USA	Yes	28	811	Paediatric
Bjurlin et al. [41]	2013	USA	Yes	21	–	Penetrating
Simhan et al. [42]	2012	USA	Yes	10	–	Penetrating
Phonsombat et al [43]	2008	USA	Yes	110	–	Penetrating
Al-Azzawi et al. [44]	2014	Egypt	Yes	21	–	War
Hudolin et al. [45]	2003	Bosnia-Herzegovina	Yes	9	–	War
Patel et al. [46]	2017	USA	No	158	–	Female
Barrett et al. [47]	2014	USA	No	464	–	Meta-analysis
Fok et al. [48]	2013	USA	No	150	–	Female
Gansslen et al. [49]	2012	Germany	No	11-12%	–	Paediatric

only urogenital, but also intra-abdominal or pelvic visceral injury. The British Orthopaedic Association (BOA), in collaboration with the British Association of Urological Surgeons (BAUS), have recently published an audit standard for trauma (BOAST) outlining the management for urogenital injuries associated with pelvic fractures [9] (BOA 2016). This consensus document provides audit standards for the early management of these rare and complex injuries. The recommendation from BAUS was to avoid primary urethral reconstructive surgery in adult males (the vast majority of patients) and the experts suggested that early restoration of the bone anatomy of the pelvis helped to (indirectly) realign the urethra and made secondary reconstructive surgery easier. The current national database study confirms the very low incidence of this injury, making it difficult to design randomised controlled studies and confirming the need to concentrate expertise in urethral reconstructive surgery in a small number of regional centres which can audit the results and provide the full spectrum of surgical, medical and psychosexual treatment.

Conclusion

Urethral injury in major trauma is rare, occurring in only 165 patients over 6 years, with a population incidence in England & Wales of 1 case per 2 million population per year. Over 80% are associated with pelvic fractures and present in 0.6% of all pelvic fractures. Greater than 90% of urethral injuries are to the male urethra. The recent establishment of national trauma audit standards for the management and treatment of traumatic urogenital injuries aims to highlight this injury pattern, reduce variation in care and improve clinical outcomes.

Table 5
Urethral Injury Scale [55].

Grade*	Injury type	Description of injury	ICD-9	AIS-90
I	Contusion	Blood at urethral meatus; urethrography normal	867.0 / 867.1	2
II	Stretch injury	Elongation of urethra without extravasation on urethrography	867.0 / 867.1	2
III	Partial disruption	Extravasation of urethrography contrast at injury site with visualisation in the bladder	867.0 / 867.1	2
IV	Complete disruption	Extravasation of urethrography contrast at injury site without visualization in the bladder; <2 cm of urethra separation	867.0 / 867.1	3
V	Complete disruption	Complete transaction with $\geq$2 cm urethral separation, or extension into the prostate or vagina	867.0 / 867.1	4

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Appendix A.

Urethral Injury Code Listings: 5450##.#.
Urethral Injury Severity described in Table 5 [55].
Pelvic Fracture Code Listings: 856###.#.

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