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Lower Genitourinary Injuries Following Traffic Accidents: Epidemiology, Clinical Characteristics and Outcomes

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What's known on the subject? and What does the study add?

This study investigates lower genitourinary injuries (LGUI), including trauma to the testicles, penis, bladder, urethra, scrotum, vagina, and vulva, resulting from road traffic accidents, using a large trauma registry covering 178,625 cases from 1996 to 2015. Among these, 591 patients (0.33%) presented with LGUI, with motorcyclists and cyclists being the most affected groups (53% and 26.4%, respectively), while 83.9% of these victims were male. The most common injuries involved the testicles (41%) and scrotum (20%). The study aimed to describe the incidence, clinical patterns, and predictive factors of these injuries to improve early detection and management. Using a novel statistical model (DataShared-SepLogit), the study also identified frequent injury associations: Such as testicular injuries with penile trauma among motorcyclists and cyclists and bladder injuries with pelvic fractures in pedestrians and motorists. Analysis of clinical records revealed that testicular injuries were mostly serious and required surgery. Blunt trauma often led to severe outcomes such as hematomas and albuginea ruptures, whereas open wounds, though generally deemed less severe, paradoxically had lower salvage rates after surgery, perhaps due to the nature of the intervention required. Urethral and bladder injuries were often associated with pelvic fractures and required long catheterization or surgery. The study highlights the importance of early identification of LGUI after road accidents and may improve trauma protocols by drawing attention to underdiagnosed injuries with potentially serious consequences.

Abstract

Objective: Traffic accidents are the most frequent cause of genitourinary injuries. There exists a paucity of data on lower genitourinary injuries (LGUI) after traffic accidents. The main objective of our study was to analyze the incidence and clinical patterns of LGUI in traffic accidents. The secondary objective was to determine the LGUI predictive factors, and the associations with lesions.

Materials and Methods: Patient cases were extracted from the trauma registry of the French department of Rhone from 1995 to 2015. We assessed the LGUI presented by each road user category. Injuries were coded with the abbreviated injury scale and the injury severity score. Multivariate prediction models and the DataShared-SepLogit method were used for data analysis.

Results: Of 178,625 victims, 591 (0.33%) presented with LGUI, 53% were motorcyclists, and 26.4% were cyclists. The most commonly injured organ was testicles (41%) followed by scrota (20%) and penises (15%). Among the 312 motorcyclists, testicular (60%) and scrotal (24%) injuries were the most frequent lesions. Among the 156 cyclists, penile injuries were the most frequent (27%). Among the 54 motorists, bladder (46%) and testicle (20%) injuries were the most frequent. For motorcyclists, motorists, and pedestrians, compared to women, a four, three, and two-fold risk of LGUI was observed for men, respectively. For cyclists, being a man was a protective factor. Testicular lesions were strongly associated with penile lesions for motorists and cyclists. Bladder injuries were strongly associated with pelvic fractures for pedestrians and motorists. Within the 78 testicular traumatisms with clinically available records, 69% (54) had an ultrasound examination and 12.5% (16) had an albuginea rupture. The salvage rates for patients who had surgery after blunt testicular trauma were 64% (7 albuginea repairs for 11 albuginea ruptures) and 33% after open wound trauma.

Conclusion: LGUI is an infrequent trauma after traffic accidents, with testicular injuries being the most commonly injured. Physicians must maintain a high awareness of external genitalia injuries in motorcyclists and cyclists.

Keywords: Functional urology, general urology, radiology

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Introduction

Blunt or penetrating trauma of the pelvis or external genitalia can cause significant damage to the lower genitourinary system. This includes bladder, urethra, penis, scrotum, or testicle (1). Although rarely lethal, failure to recognize these lesions at initial management can lead to significant morbidity and persistent genital and urinary dysfunction. Their detection and early management can help limit the occurrence of such complications (2).

Patients with severe trauma due to road traffic accidents and sudden deceleration traumas are particularly prone to urinary genital injuries (2,3). In 2017 in France, 3,600 deaths occurred because of road accidents. Among these deceased patients, 10% had genitourinary lesions (4).

In previous studies (5,6), between 1996 and 2013, a prevalence of 0.59% has been shown (963 out of 162,690) for urinary tract injuries after traffic accidents, including 41% of kidney trauma and 23% of testicular trauma. Most of the victims were motorcyclists.

Kidney trauma epidemiology has been described previously. Hotaling et al. (7) reported 9,002 kidney injuries (0.3%) among 3,247,955 trauma injuries from hospitals in the United States and Puerto Rico, and Bjurlin et al. (8) reported a rate of 0.8% kidney trauma among 466,028 motor vehicle collisions (9,10).

The etiology and clinical patterns of all-cause combined lower genitourinary injuries (LGUI) have also been described previously. Lee et al. (9) reported 74 testicular ruptures and 32 penile fractures among 156 patients with blunt trauma to the external genitalia.

Bjurlin et al. (10) reported 162 (0.57%) penetrating external genital traumas among 28,459 trauma patients in Chicago; gunshot wounds accounted for the most common mechanism of injury (93%) and included 63% of testicular injuries.

Only a few studies reported the specific epidemiology of LGUI following road traffic accidents. Bjurlin et al. (11) found that among 16,585 bicycle injuries, 2.16% of victims presented with LGUI. Kidneys were the predominant organ of injury (75%), followed by bladder and urethra (15%), and penis and scrotum (10%) in 1979. Similarly, in 1979, Hurt (12) described 117 motorcyclists (13%) out of 900 who sustained LGUI, with the majority of these injuries being minor in severity.

Most of the studies concerning LGUI caused by road accidents were retrospective epidemiologic analyses. To the best of our knowledge, no study has thoroughly investigated clinical patterns, management strategies, and clinical outcomes of patients with LGUI following road traffic accidents.

The main objective of our study was to define the incidence and clinical patterns of LGUI occurring after road traffic accidents.

The secondary objective was to determine the predictive factors and associations in lesions, to improve early detection and management of LGUI.

Materials and Methods

This study used recorded data from the official departmental Registry. Since 1996, this association has reported traffic accident cases to the National Institute of Science and Technology for Transport, Development and Networks. The registry covers the department and has been approved by health authorities (National Registry Committee and National Commission for Information Technology and Civil Liberties no: 999211, date: 09.09.2016).

The Registry collects the demographic characteristics of each road traffic casualty type of road user, the characteristics of the crash (time, location, and collision type) and a description of the bodily injuries sustained to help researchers better understand the mechanisms of injury in motor vehicle collisions.

The inclusion criteria were: Road traffic casualty involving at least one vehicle (motorized or not) from 1996 to 2015, occurring in the department, and requiring institutional health care activity. This included 245 health care structures cooperating, including prehospital primary care teams and forensic medicine institutes.

The different populations analyzed were motorists, motorcyclists, cyclists, pedestrians, van drivers, van passengers, bus passengers, and skateboard users.

We assessed different groups of LGUI: Testis, bladder, penis, perineum, scrotum, urethra, vagina, and vulva.

Cases of LGUI were identified using the abbreviated injury scale (AIS) 90 codes in the register, and the severity through injury severity score (ISS) score (1).

Initial medical history, physical examination, radiological exams, and management approach were retrospectively reviewed by utilizing the complete electronic medical records available from 2005 to 2015.

Statistical Analysis

Statistical analyses were performed using SAS (SAS 9.4, SAS Institute Inc., Cary, NC). A p-value ≤ 0.05 was used to indicate statistical significance. The DataShared-SepLogit method was used to estimate conditional associations between bodily injuries in the Registry. This method consists of multiple logistic regressions that include penalties which encourage structured sparsity. Ballout and Viallon (13) described the model's

superiority over other graphical models based on empirical comparisons using synthetic data. It uses well-known methods of binary graphical models, to show association structures among a set of injuries.

Results

A total of 178,625 victims were available for analysis from 1996 to 2015; 591 of whom presented with LGUI (0.33%). More than half (53%) of the victims were motorcyclists, 26.4% were on a bicycle, 9.1% were in a car, 9% were pedestrians, and 4% were involved in other vehicles such as trucks and buses. Overall, 34.0% (201/591) of victims were hospitalized.

The mean (standard deviation) age of victims with LGUI was 26.2 (16.6) years, and 83.9% were males (sex ratio 5.2/1, 496 men and 95 women).

The most commonly injured genitourinary organs were testicles (41%), scrotum (20%), penis (15%), bladder (11%), vagina (7%), urethra (5%), vulva (5%), and perineum (5%).

Among the LGUI victims, 54 (9%) were motorists, and 37% of them were hospitalized. Bladder (46%), testicles (20%), and scrotum (13%) were the most frequently injured organs in this group.

Among the 312 motorcyclist victims with LGUI, testicular (60%) and scrotal (24%) injuries were the most frequent. Additionally, 43% of the victims were hospitalized.

There were 156 cyclists with LGUI for whom penile injuries (27%) were the most frequent.

Among the 42 pedestrians with LGUI, bladder (38%) and perineum (19%) injuries were the most frequent. 52% of pedestrian victims were hospitalized (Table 1).

We found that the mean AIS was 2 and the mean ISS was 13. More than 80% of LGUI were associated with low and moderate ISS; 13% of cases had an ISS of 25 or higher, and the mortality rate was 7% (Table 2).

We found a strong interaction between road user type and age on the presence of LGUI. Therefore, we presented one multivariate model per road user type, using the same factors in each model (Table 3).

Compared to women, the risk of presenting with LGUI in men was 4 times higher for motorcyclists, 3 times higher for motorists, and twice as high for pedestrians ($p<0.05$). Conversely, being a man was a protective factor when considering cyclists [odds ratio (OR) 0.71, 95% confidence interval (CI) (0.50, 0.99)]. In this same group, the risk of LGUI was 3-fold for cyclists aged 15 years or younger compared to those aged 26 to 35 years old [OR 3.34; 95% CI (1.83; 6.11)].

Considering motorists, the odds of presenting with LGUI were 3 times higher in victims between 66 and 75 years old compared to those aged 26 to 35 years [OR 3.5, 95% CI (1.2: 9.8)].

In the case of motorcyclists, crashes on rural roads led to a higher risk of LGUI than crashes on city streets [OR 1.53; 95% CI (1.10, 2.11)].

Injury Associations

The analysis of the distribution of the bodily injuries of the 178,625 victims by the DataShared-SepLogit method, permitted the definition of profiles of injury associations.

The DataShared-SepLogit method is a statistical tool used to study the linking of different factors across several groups of patients. It works in two steps: SepLogit breaks down complex relationships between binary outcomes (yes/no events, such as the presence or absence of an injury) into a series of simple

Table 1. Hospitalization rate and type/frequency of LGUI (skateboard and rollerskate users are not represented for more clarity, <5% of victims)

	Motorists n=54 (9%)		Motorcyclists n=312 (53%)		Cyclists n=156 (26%)		Pedestrians n=42 (7%)		Total
	n	%	n	%	n	%	n	%	
Hospitalization	20	37	135	43	24	15	22	52	201
Penis	2	4	38	12	42	27	4	10	86
Perineum	3	6	8	3	9	6	8	19	28
Scrotum	7	13	75	24	32	21	3	7	117
Testicles	11	20	188	60	36	23	4	10	239
Urethra	6	11	9	3	6	4	6	14	27
Vagina	1	2	5	2	25	16	6	14	37
Vulva	1	2	4	1	20	13	0	0	21
Bladder	25	46	19	6	1	1	16	38	61

LGUI : Lower genitourinary injuries

Table 2. Global injury severity according to maximum AIS and the ISS					
MAIS	**n**	**%**	**ISS**	**n**	**%**
MAIS=1	324	55	1-'8	408	69%
MAIS=2	93	16	9-'15	69	11.7%
MAIS=3	86	15	16-24	36	6.1%
MAIS=4	42	7	>24	78	13.2%
MAIS=5	6	1	Total	591	100%
Death	40	7			
Total	591	100			
AIS: Abbreviated injury scale, ISS: Injury severity score					

logistic regressions. Data-Shared Lasso then compares results across groups, identifying which associations are common to all groups and which are specific to one group. By combining these two ideas, this approach allows researchers to analyze several subgroups at once, highlight both shared and unique patterns, and reduce the risk of missing important signals.

To represent those associations, we used a graphical model. When there was a dependence/association between two injured organs (OR >1, $p<0.05$), we represented it by an edge (line between two organs). If, and only if, the two corresponding organs were independent given the other organ, they were not linked by an edge on the graphic model (Figure 1).

Using this method, we found that testicular lesions were strongly associated with penile lesions for motorists, cyclomotorists, and cyclists. We found that for pedestrians and motorists, bladder injuries were associated with pelvic fractures.

Medical and Radiological Records Analysis

Data from medical and radiological records were electronically registered from 2005, allowing the collection of complete data for 341 patients with LGUI between 2005 and 2015. The data from the more recent accidents were not fully available.

The medical and radiological records of 78 testicular injuries were available for analysis (Table 4).

The mean vehicle speed at the moment of the crash, as reported by patients, was 64.7 (30-110) km/h. The mean hospital length of stay was 11.6 days (range 1-72). Scrotal trauma occurred on the right side in 42% of cases, on the left side in 31%, and was bilateral in 19% of cases (missing data: 8%). Scrotal hematoma and/or hematocele were clinically found in 55% of the cases, and scrotal swelling was found in 76% of the cases.

Of the 78 testicular injuries, 31% were open wounds. In comparison with blunt trauma, we found that open testicular trauma had less hematoma at clinical examination (42% vs. 80%). We found that they also had fewer intratesticular hematomas (25% vs. 79%) and albuginea ruptures (25% vs. 73%) at ultrasound (US) examination.

67% of the patients had a testicular US examination, 12% had a computed tomography (CT) scan, and 23% had no imaging.

The salvage rate for patients who had surgery after blunt or penetrating trauma was 67% (7 albuginea repairs and 4 orchiectomies for 11 albuginea ruptures) and 100% for those who underwent conservative management. The salvage rate for patients who had surgery after open wounded trauma was 33% (1 albuginea repair and 2 orchiectomies for 3 albuginea ruptures). From 11 operative records, a mean length of 2.3 cm for the rupture of tunica albuginea was found.

Thirty-seven patients (47%) were seen at a first follow-up consultation with a mean delay of 1.48 months (0.25-7 months). Sixteen patients (21%) were seen at a second follow-up consultation with a mean delay of 3.9 months after initial treatment.

The records of 15 penile traumas were available, four of them being bruises, eight open wounds, and three fractures. The open wounds were all superficial, with no complications found during the follow-up consultation for the 6 patients who attended. For the 3 penile fractures, no cracking sound or typical eggplant presentation was reported, and one was associated with an open wound. One penile US was performed; showing an albuginea tear at the middle third of the cavernous corpus. During initial management, two penile fractures were complicated by penile curvatures and pain during sexual intercourse at the follow-up consultation, at 5 weeks. One patient underwent surgical management and presented with penile curvature and erectile dysfunction at the follow-up consultation (at 6 weeks).

Fifteen urethral injuries had clinical and radiological records available (Figure 2).

Blood at the meatus was found in 86.7% of cases; 80% of patients had a urinary diversion by suprapubic catheter; and 80% of patients had an associated pelvic fracture (12/15).

A total of 8 cases of anterior urethral injuries were found: 4 complete disruptions (grade 4), 1 partial disruption (grade 3), 1 contusion (grade 2), and 2 unspecified cases. The severity reports of 2 urethral injuries were unavailable. The mean length of catheterization was 77.5 days.

Table 3. Risk factors for LGUI, OR estimated from a multivariate logistic regression

		Motorist				Motorcyclist				Cyclist				Pedestrian			
Factors		**OR**	**95% CI**		**p-value**	**OR**	**95% CI**		**p-value**	**OR**	**95% CI**		**p-value**	**OR**	**95% CI**		**p-value**
					p<0.001				p<0.0001				p<0.05				p<0.05
Sex	Male	3.35	1.75	6.40		4.44	2.43	8.10		0.71	0.50	0.99		2.06	1.07	3.97	
	Female	1				1				1				1			
					p<0.05								p<0.0001				
	0-15	2.32	0.88	6.111						3.34	1.83	6.11					
	16-25	0.73	0.36	1.5						1.23	0.61	2.478					
	26-35	1				1				1				1			
Age	36-45	0.50	0.17	1.525						0.96	0.40	2.28					
	46-55	0.74	0.24	2.252						0.84	0.31	2.229					
	56-65	1,06	0.30	3.71						0.65	0.18	2.3					
	66-75	3.472	1.225	9.838						0.43	0.06	3.32					
	+76	2.236	0.99	10.023						-							
Road network									p<0.01								p<0.01
	City street					1.00				1.00				1.00			
	Highway					1.30	0.72	2.33						4.66	1.10	19.68	
	Rural road					1.53	1.10	2.11						4.75	1.67	13.55	
	Other					0.72	0.2	1.00						0.69	0.27	1.77	
Time of accident					p<0.01												
	0 to 3:00 am	3.639	1.282	10.333													
	4:00 to 7:00 am	2.535	0.934	6.88													
	8:00 to 11:00 am	1.03	0.357	2.976													
	midnight to 3:00 pm	1.376	0.531	3.569													
	4:00 to 7:00 pm	1				1				1				1			
	8:00 to 11:00 pm	3.311	1.359	8.067													
	Unknown	0.432	0.114	1.0637													
Antagonist									p<0.0001				p<0.05				
	Motorist					1				1				1			
	None					0.199	0.143	0.28		2.194	1.174	4.099					
	Van/bus					0.813	0.381	1.74		6.788	1.867	24.68					
	Fixed obstacle					0.754	0.5	1.14		2.632	1.189	5.828					
	Other					0.375	0.209	0.67		1.49	0.596	3.723					

CI: Confidence interval, OR: Odds ratio, LGUI: Lower genitourinary injuries

Among the 4 cases of posterior urethral injuries, 3 of these were complete ruptures, associated with bladder neck injury (grade 5), and were linked to pelvic fractures and intra-abdominal injuries. The mean length of catheterization was 71.3 days. The average delay in retrograde urethrography control was not available.

Among the 17 bladder lesions with clinically and radiologically available records, 15 had a CT cystography, 6 hematomas and 9 perforations were found. 82% of the patients (n=14) had simultaneous pelvic fracture, and 71% (n=12) had an associated intra-abdominal lesion.

Table 4. Management of the 78 testicular traumatisms							
		Testicular injuries (n=78)					
		Surgical management 35% (n=27)					Conservative management 65% (n=51)
Clinical presentation	Pain	100% (27)					100% (51)
	Scrotum swelling	74% (20)					75% (38)
	Hematoma	63% (17)					51% (26)
	Perineum extension of the hematoma	7% (2)					4% (2)
	Spermatic cord infiltration	19% (5)					2% (1)
	Testicular dislocation	7% (2)					2% (1)
Ultrasound (US) findings	Intra-testicular hematoma	**67% (18)** 66% (12)					**71% (36)** 36% (13)
	Peri-testicular hematoma	78% (14)					36% (13)
	Scrotal hematoma	17% (3)					19% (7)
	Parenchyma heterogeneity	72% (13)					44% (16)
	Albuginea rupture	72% (13)					8% (3)
	Doppler mode irregularity	56% (10)					11% (4)
Surgical findings	Albuginea rupture	51% (14)					
	Extra testicular hematoma	51% (14)					
	Intra testicular hematoma	37% (10)					
	Epididymis lesion	11% (3)					
	Spermatic cord lesion	22% (6)					
Surgical procedure			Orchiectomy (n=6)	Albuginea repair (n=7)	Hematoma draining (n=4)	Others (n=10)	
Short term follow-up			n=4	n=7	n=3	n=5	n=18
	Pain		0	43% (3)	0	20% (1)	22% (4)
	Hematoma		0	29% (2)	0	0	6% (1)
	Incomplete wound healing		25% (1)	29% (2)	66% (2)	40% (2)	0
US follow-up			n=0	n=6	n=2	n=0	n=5
	Atrophic testis		0	83% (5)	50% (1)	0	20% (1)
	Hematoma		0	17% (1)	0	0	40% (2)
Middle term follow-up			n=4	n=6	n=3	n=1	n=2
	Pain		0	33% (2)	0	0	50% (1)
	Atrophic testis		0	50% (3)	0	0	50% (1)
	Erectile dysfunction		25% (1)	17% (1)	33% (1)	100% (1)	0
	Infertility		25% (1)	0	0	0	0

The intraperitoneal ruptures represented 56% (5/9) of the perforations and were all managed surgically, with a mean length of postoperative catheterization of 10 days. Most of the perforations were located at the dome (60%). The extraperitoneal ruptures were all treated conservatively. No fistula was found during the cystography controls, and the mean length of catheterization was 6.3 days.

Discussion

To our knowledge, this is the largest report in the literature on LGUI following traffic accidents.

This is the only study on LGUI after traffic accidents, and it provides a detailed understanding of the presentation, management, and outcomes of these infrequent injuries.

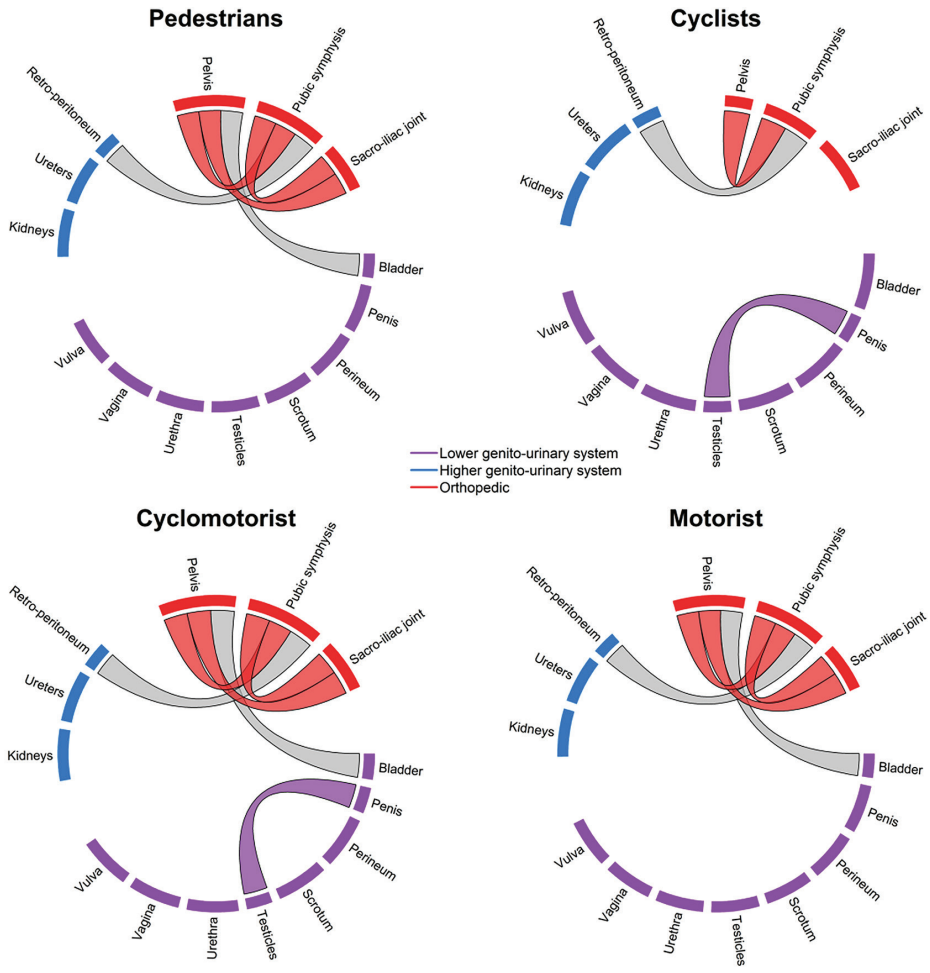

Figure 1. Injuries association by road user: application of the DataShared-SepLogit approach on the Rhone registry data. An association between two injured organ (odds ratio >1 and p<0.05) is represented by an edge (line between two organs). Grey color is for injuries associations between two different categories

This study may impact the daily management of LGUI after traffic accidents, given the higher morbidity compared to all causes of trauma combined. It may also change emergency clinical examination practices, considering the strong association between testicular and penile injuries in motorcyclists and cyclists.

We found a low rate of motorists (9%), compared with our previous study (22%) (4). This can be explained by the protection offered by the driver's compartment, which may limit LGUI (14).

More than 75% of LGUI victims were motorcyclists or cyclists, and 83% were men. This male predominance was also reported by Wessells et al. (6) and Hotaling et al. (7). This may be explained by a higher prevalence of at-risk road behaviors, such as speeding or alcohol abuse (15).

Conversely, for cyclists, being male was a protective factor. This can be explained by the fact that 72% of the vulva and vagina injuries in our study were recorded among bicycle users. Straddle-related injuries are well-known non-obstetric vulvovaginal injuries (16).

The finding that cyclists under the age of 15 years were at higher risk of presenting with LGUI, corroborates the finding of Tasian et al. (17) that children were nearly 10 times more likely to have a GUI after a bicycle accident compared to adults.

Injury Associations

Associations between urologic and orthopedic injuries have been described before. Symphyseal diastasis associated with bladder injuries has been well described by Aihara et al. (18) and Deibert and Spencer (19).

In this study, the large number of patients, the quality of the data collected in the registry, and the use of the DataShared-SepLogit approach, allowed new associations of injuries to be described. The most notable association found was the strong positive relationship between testicular and penile injuries in motorcyclists and cyclists.

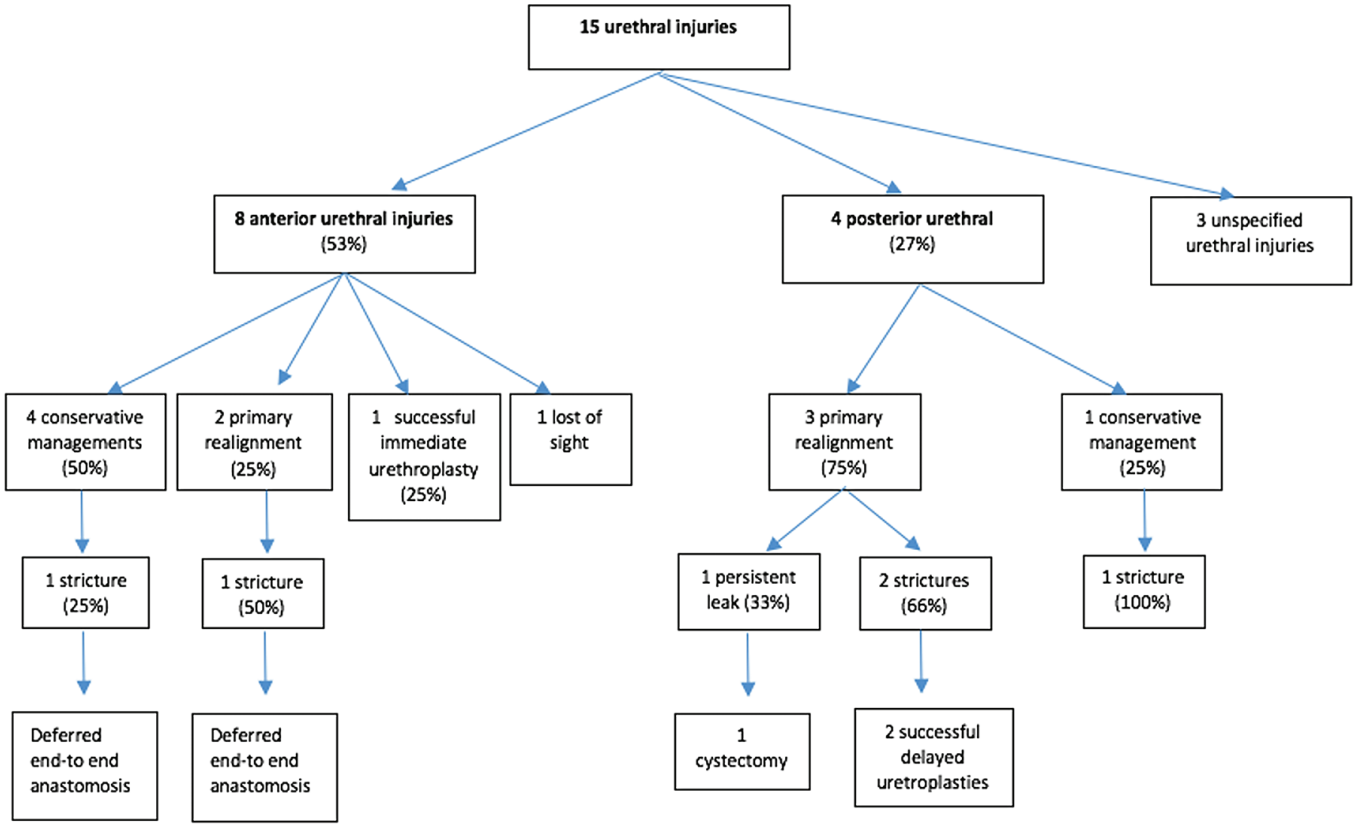

Figure 2. Management of the 15 urethral injuries

With this statistical tool, we can summarize the injury tables of road accident victims. We can also report injury associations based on age, user type, or antagonist use. Such a detailed description of injury associations could be useful for diagnosis and avoiding misdiagnoses, which can lead to severe morbidity.

Urethra

Rare in the trauma population, urethral injuries account for approximately 4% of GU trauma (2,20) and have the potential to incur substantial long-term morbidity, including intractable stricture disease and incontinence (2,21).

Our findings corroborate that approximately 65% of urethral injuries are complete disruptions, with the remaining 35% resulting in partial tears (22).

Meanwhile, posterior urethral injuries are reported to be four times more common than anterior ones in various studies (21). Conversely, in our study, most of the injuries were anterior injuries. This may be explained by the mechanism of trauma (straddle injuries or fuel tank injuries).

Eighty percent (12/15) of our patients with urethral injuries with available medical records had associated pelvic fractures. The management of pelvic fracture urethral injuries (PFUI) is a hotly debated and controversial topic because, currently, there is no level 1 evidence (23). The American Urological Association Guidelines leave it open to interpretation whether suprapubic tube (SPT) placement, with delayed repair or primary realignment (PER), is superior for PFUI (24).

In the only level 2 study to date, Hadjizacharia et al. (25) showed that PER resulted in a significantly shorter time to spontaneous voiding and a decreased risk of urethral stricture (14% in the PER group vs. 100% in the SPT group).

In our study, the stricture rate after PER of posterior urethral injury was higher than in the Hadjizacharia et al. (25) study (75% vs. 14%). The difference may be explained by the intensity and kinetic energy of the trauma.

Hypotheses were developed by Koraitim (26) suggesting that the posterior urethra may be initially stretched, and then partially or completely disrupted at the bulbomembranous junction, depending on the magnitude of trauma. These hypotheses were recently confirmed by computer-generated models for traffic accident modeling based on human imaging, which provided insight into the mechanics of posterior urethral injury (27,28).

Penis

Penile trauma is less common than testicular trauma but still comprises 10% to 16% of GUI according to several single-institution series (29). Most penile injuries in our studies were superficial open wounds treated non-surgically with excellent results. This confirms the findings of other large-scale studies. Krishna Reddy et al. (30), Phonsombat et al. (29), and Bjurlin et al. (10) also found that nonoperative management can be performed in well-selected patients with penile injuries superficial to Buck's fascia.

Bladder

Data from a 20-year prospectively maintained database (31) recently reported that road accidents are the most common cause of blunt bladder rupture (50.5%). Concomitant pelvic fractures are reported in approximately 70% (ranging from 35% to 87%) of bladder ruptures (31,19). Johnsen et al. (32) reported that the association with a PF resulted in both increased complications and increased hospital length of stay: 7.1 days vs. 2.8 days in the intensive care unit ($p<0.01$) and 13.5 days vs. 7.7 days in the hospital overall ($p=0.01$). The presence of pelvic fractures following blunt trauma serves as a marker of significant injury from high-energy force.

Extraperitoneal bladder ruptures, as seen in the present study, occur almost universally in the presence of pelvic fractures and are usually the result of shearing forces or laceration by bony spicules.

Intraperitoneal bladder ruptures, on the other hand, are most often due to blunt trauma to a distended bladder. Passengers wearing a seat belt without a shoulder attachment can sustain bladder injury from such a mechanism when the belt forcefully compresses the lower abdomen (33), resulting in elevated bladder pressures and, in most cases, a perforation through the dome of the bladder (34,35).

Testicular

While our blunt trauma salvage rate was low (64%), up to 82-86% of ruptured testicles after blunt trauma can be salvaged according to Buckley and McAninch (36), Altarac (37), and Lee (9) studies.

In the current literature, the salvage rate for open wounds ranges from 35-65% (28). In this study, we report a 33% salvage rate, which is higher than findings from studies on self-inflicted orchiectomies, which are less often salvageable.

Clinical examination of patients with polytrauma is often limited because of pain and coexisting life-threatening injuries, which may lead to the misdiagnosis of severe injuries, particularly testicular fractures. These misdiagnoses have been shown to increase orchiectomy rates (39).

Moreover, this difference in salvage rates can be explained by the high kinetic energy of the impact and the presence of a fuel tank.

Study Limitations

However, this study has several limitations. The primary limitation is the potential under diagnosis of penile and urethral injuries in the setting of polytrauma, where life-threatening conditions often take precedence. Urethral trauma may remain unrecognized in the absence of hallmark signs, such as acute urinary retention or urethrorrhagia, and injuries to the corpora cavernosa, particularly following blunt trauma, may similarly be overlooked. Such underdiagnosis is likely to result in mediumand long-term urogenital complications (as urethral stricture, penile curvature, and erectile dysfunction) which could not be assessed in the present study, as patients were not systematically referred for urological evaluation in these scenarios.

Conclusion

LGUI is an infrequent trauma after a traffic accident, with the testicles being the most commonly injured. Physicians must maintain a high awareness of testicular and penile injuries in motorcyclists and cyclists.

Ethics

Ethics Committee Approval: The registry covers the department and has been approved by health authorities (National Registry Committee and National Commission for Information Technology and Civil Liberties no 999211, date: 09.09.2016).

Informed Consent: Retrospective study.

Footnotes

Authorship Contributions

Surgical and Medical Practices: N.K., Concept: A.N., N.K., Design: N.B., A.N., N.K., Data Collection or Processing: N.B., A.N., N.K., Analysis or Interpretation: P.N., N.B., N.K., Literature Search: N.K., Writing: P.N., N.K.

Conflict of Interest: No conflict of interest was declared by the authors.

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References

1. Baker SP, O'Neill B, Haddon W Jr, Long WB. The injury severity score: a method for describing patients with multiple injuries and evaluating emergency care. J Trauma. 1974;14:187-196. [Crossref]

2. Bariol SV, Stewart GD, Smith RD, McKeown DW, Tolley DA. An analysis of urinary tract trauma in Scotland: imnpact on management and resource needs. Surgeon. 2005;3:27-30. [Crossref]

3. Paparel P, N'Diaye A, Laumon B, Caillot JL, Perrin P, Ruffion A. The epidemiology of trauma of the genitourinary system after traffic accidents: analysis of a register of over 43,000 victims. BJU Int. 2006;97:338-341. [Crossref]

4. Terrier JE, Paparel P, Gadegbeku B, Ruffion A, Jenkins LC, N'Diaye A. Genitourinary injuries after traffic accidents: analysis of a registry of 162,690 victims. J Trauma Acute Care Surg. 2017;82:1087-1093. [Crossref]

5. 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;67:1033-1039. [Crossref]

6. Wessells H, Suh D, Porter JR, Rivara F, MacKenzie EJ, Jurkovich GJ, Nathens AB. Renal injury and operative management in the United States: results of a population-based study. J Trauma. 2003;54:423-430. [Crossref]

7. Hotaling JM, Wang J, Sorensen MD, Rivara FP, Gore JL, Jurkovich J, McClung CD, Wessells H, Voelzke BB. A national study of trauma level designation and renal trauma outcomes. J Urol. 2012;187:536-541. [Crossref]

8. Bjurlin MA, Fantus RJ, Fantus RJ, Mellett MM, Villines D. The impact of seat belts and airbags on high grade renal injuries and nephrectomy rate in motor vehicle collisions. J Urol. 2014;192:1131-1136. [Crossref]

9. Lee SH, Bak CW, Choi MH, Lee HS, Lee MS, Yoon SJ. Trauma to male genital organs: a 10-year review of 156 patients, including 118 treated by surgery. BJU Int. 2008;101:211-215. [Crossref]

10. Bjurlin MA, Kim DY, Zhao LC, Palmer CJ, Cohn MR, Vidal PP, Bokhari F, Hollowell CM. Clinical characteristics and surgical outcomes of penetrating external genital injuries. J Trauma Acute Care Surg. 2013;74:839-844. [Crossref]

11. Bjurlin MA, Zhao LC, Goble SM, Hollowell CM. Bicycle-related genitourinary injuries. Urology. 2011;78:1187-1190. [Crossref]

12. Hurt HHJ. Status report of accident investigation data, « motorcycle accident cause factors and identification of countermeasures ». Janv 1979 [cité 17 oct 2018]; Disponible sur: https://trid.trb.org/view/88795 [Crossref]

13. Ballout N, Viallon V. Structure estimation of binary graphical models on stratified data: application to the description of injury tables for victims of road accidents. Stat Med. 2019;38:2680-2703. [Crossref]

14. Meredith L, Baldock M, Fitzharris M, Duflou J, Dal Nevo R, Griffiths M, Brown J. Motorcycle fuel tanks and pelvic fractures: a motorcycle fuel tank syndrome. Traffic Inj Prev. 2016;17:644-649. [Crossref]

15. Holmes J, Angus C, Buykx P, Ally A, Stone T, Meier P, Brennan A. Mortality and morbidity risks from alcohol consumption in the UK: analyses using the sheffield alcohol policy model (v.2.7) to inform the UK chief medical officers' review of the UK lower risk drinking guidelines. Final report: 74. ScHARR, University of Sheffield. [Crossref]

16. Habek D, Kulas T. Nonobstetrics vulvovaginal injuries: mechanism and outcome. Arch Gynecol Obstet. 2007;275:93-97. [Crossref]

17. Tasian GE, Appa AA, Bagga HS, Blaschko S, McCulloch CE, McAninch JW, Breyer BN. Bicycle-related genitourinary injuries in the USA from 2002-2010. Inj Prev. 2014;20:350-353. [Crossref]

18. Aihara R, Blansfield JS, Millham FH, LaMorte WW, Hirsch EF. Fracture locations influence the likelihood of rectal and lower urinary tract injuries in patients sustaining pelvic fractures. J Trauma. 2002;52:205-208; discussion 208-209. [Crossref]

19. Deibert CM, Spencer BA. The association between operative repair of bladder injury and improved survival: results from the National Trauma Data Bank. J Urol. 2011;186:151-155. Erratum in: J Urol. 2012;187:1938. [Crossref]

20. Najibi S, Tannast M, Latini JM. Civilian gunshot wounds to the genitourinary tract: incidence, anatomic distribution, associated injuries, and outcomes. Urology. 2010;76:977-981; discussion 981. [Crossref]

21. Mundy AR. Pelvic fracture injuries of the posterior urethra. World J Urol. 1999;17:90-95. [Crossref]

22. Webster GD, Mathes GL, Selli C. Prostatomembranous urethral injuries: a review of the literature and a rational approach to their management. J Urol. 1983;130:898-902. [Crossref]

23. Dixon AN, Webb JC, Wenzel JL, Wolf JS Jr, Osterberg EC. Current management of pelvic fracture urethral injuries: to realign or not? Transl Androl Urol. 2018;7:593-602. [Crossref]

24. Morey AF, Brandes S, Dugi DD 3rd, Armstrong JH, Breyer BN, Broghammer JA, Erickson BA, Holzbeierlein J, Hudak SJ, Pruitt JH, Reston JT, Santucci RA, Smith TG 3rd, Wessells H; American Urological Assocation. Urotrauma: AUA guideline. J Urol. 2014;192:327-335. [Crossref]

25. Hadjizacharia P, Inaba K, Teixeira PG, Kokorowski P, Demetriades D, Best C. Evaluation of immediate endoscopic realignment as a treatment modality for traumatic urethral injuries. J Trauma. 2008;64:1443-1449; discussion 1449-1450. [Crossref]

26. Koraitim MM. Pelvic fracture urethral injuries: the unresolved controversy. J Urol. 1999;161:1433-1441. [Crossref]

27. Bréaud J, Montoro J, Lecompte JF, Valla JS, Loeffler J, Baqué P, Brunet C, Thollon L. Posterior urethral injuries associated with motorcycle accidents and pelvic trauma in adolescents: analysis of urethral lesions occurring prior to a bony fracture using a computerized finite-element model. J Pediatr Urol. 2013;9:62-70. [Crossref]

28. Andrich DE, Mundy AR. The nature of urethral injury in cases of pelvic fracture urethral trauma. J Urol. 2001;165:1492-1495. [Crossref]

29. Phonsombat S, Master VA, McAninch JW. Penetrating external genital trauma: a 30-year single institution experience. J Urol. 2008;180:192-195; discussion 195-196. [Crossref]

30. Krishna Reddy SV, Shaik AB, Sreenivas K. Penile injuries: a 10-year experience. Can Urol Assoc J. 2014;8:E626-E631. [Crossref]

31. 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;31:913-917. [Crossref]

32. Johnsen NV, Dmochowski RR, Mock S, Reynolds WS, Milam DF, Kaufman MR. Primary endoscopic realignment of urethral disruption injuries--a double-edged sword? J Urol. 2015;194:1022-1026. [Crossref]

33. Stoddart A. Intraperitoneal bladder rupture and the wearing of rear seat-belts--a case report. Arch Emerg Med. 1993;10:229-231. [Crossref]

34. Gomez RG, Ceballos L, Coburn M, Corriere JN Jr, Dixon CM, Lobel B, McAninch J. Consensus statement on bladder injuries. BJU Int. 2004;94:27-32. [Crossref]

35. Brandes S, Borrelli J Jr. Pelvic fracture and associated urologic injuries. World J Surg. 2001;25:1578-1587. [Crossref]

36. Buckley JC, McAninch JW. Use of ultrasonography for the diagnosis of testicular injuries in blunt scrotal trauma. J Urol. 2006;175:175-178. [Crossref]

37. Altarac S. Management of 53 cases of testicular trauma. Eur Urol. 1994;25:119-123. [Crossref]

38. Cass AS, Luxenberg M. Testicular injuries. Urology. 1991;37:528-530. [Crossref]

39. Happian-Smith J, Chinn BP. Simulation of airbag restraint systems in forward impacts of motorcycles, International Congress and Exposition, Detroit (SAE 9000752), 1990. [Crossref]