RESEARCH ARTICLE

New Onset Urological Complication in Pelvic Fractures: Predictors of Bladder Injury, Urethral Injury, Urinary Retention and Urinary Incontinence Following Pelvic Fractures

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Abstract

Objectives: This study aims to identify the incidence of urological complications named bladder injury, urethral injury, urinary retention, and urinary incontinence following pelvic fractures and e xamine age, sex, fracture type, and mechanism of injury as possible predictors.

Methods: A retrospective cohort study was conducted at two general hospitals, including patients with pelvic ring fractures between January 2021 and March 2024. Data were gathered using the patients' files.

Results: A total of 45 patients were included. 2 (4.4%) had urethral injury, 4 (8.9%) had bladder injury, 6 (13.3%) had urinary incontinence, and 2 (4.4%) had urinary retention. Neither age nor sex showed a statistically significant difference. Anteroposterior compression type III (APC III) injuries were disproportionately associated with urological complications, namely one urethral injury, three bladder injuries, and two urinary retention cases. Patients with APC III injuries had an increased probability of sustaining bladder injuries (OR- 15, p = 0.057). In terms of mechanisms of injury, road traffic accidents, falls from height, injuries with heavy objects, and falls from stairs were the most common, accounting for 51% of the cases. However, a fall from stairs was identified as the only mechanism of injury (MOI) that showed a lower odds of urethral injury, which is statistically significant; however, due to the rarity of complications as well as small sample size, the odds ratio calculations are known to be dubious with a resultant high variance and wide confidence interval, therefore further studies are required to confirm findings.

Conclusion: This study shows a significant association between APC III pelvic fractures and bladder injuries and urinary retention. The results show that the type of fracture and its mechanism of injury play a more significant role in predicting urogenital complications, compared to factors like age and gender. Early diagnostic interventions and management strategies based on these factors are essential for improving patient outcomes. Although the study provides valuable insights, further research with a larger sample size is needed to develop predictive models for more effective management.

Level of evidence: III

Keywords: Bladder injury, Pelvic fracture, Urinary incontinence, Urethral injury, Urinary retention

Introduction

Pelvic fractures are relatively uncommon, accounting for 3-9% of all types of fractures.[1] However, they are associated with a high mortality rate of 10.5.2 This is usually due to significant blood loss or disruption of the genitourinary and gastrointestinal systems.[2,3]

The structural and functional complications of the urogenital system result from the close anatomical relationships among the bony pelvis, the neurovascular structures, and the pelvic organs.[4] Urogenital complications post pelvic ring injuries vary and include: sexual dysfunction, urinary retention, urinary incontinence, bladder injury, and urethral injury.[5,6] They occur at different rates, and they are associated with the

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severity of the injury. A comprehensive review of literature showed that female sexual dysfunction following pelvic fracture occurred at a rate varying between 25% and 62%.[7] Another study highlighted that male urinary function is highly associated with the severity of pelvic injury and the type of pelvic fracture. In contrast, female urinary function was affected by the severity of urinary tract injury.[6]

Urogenital complications post pelvic fractures can negatively affect patients' general health. For example, urinary incontinence and sexual dysfunction, combined with pelvic fracture, are associated with poor quality of life and psychological outcomes, including depression and anxiety.[8-11] These complications are also associated with a higher risk of mortality, as patients with pelvic ring fracture combined with urogenital complications are at higher risk of mortality compared to patients with pelvic ring fracture without urogenital complications (14% and 8%, respectively).[12]

Recognizing age, gender, high-risk mechanisms, and pelvic fracture patterns may allow for early identification of patients with urogenital injury and improve patient outcomes.[13,14] This study aims to identify the frequency of urogenital complications named bladder injury, urethral injury, urinary incontinence, and urinary retention following pelvic ring fractures and examine the patient's age, sex, fracture type, and mechanism of injury as possible predictors, to achieve effective management and early intervention, which are crucial in mitigating those dysfunctions and improving patients' overall health.

Materials and Methods

A total of 59 patients with pelvic fractures were identified using the database and files from two general hospitals between January 2021 and March 2024. Inclusion criteria included: Blunt trauma, Pelvic ring fractures. Exclusion criteria included: penetrating Trauma, isolated acetabular fractures, history of urological malformations, and pelvic bone pathology. Fourteen patients with isolated acetabular fractures were excluded, leaving 45 patients included in the study.

Data were obtained on variables including age, gender, Mechanism of injury, and urological complications. Each fracture was classified according to the Young-Burgess classification using computed tomography (CT) images and video clips.

A comprehensive analysis of the study data involved both descriptive and inferential statistical approaches. Descriptively, frequencies and percentages were computed for demographic characteristics, complications, and other categorical variables. The distribution of continuous variables was assessed for normality using the Shapiro-Wilk test. Logistic regression was used to find the predictors of all four complications. Results were presented as odds ratios (ORs) with 95% confidence intervals (CIs). The significance threshold was set at a p-value of 0.05 or less, accompanied by a 95% Confidence Interval. Bar charts, both simple and multiple, were used for data visualization. All statistical analyses were executed using SPSS Software, specifically version 27.0.1, developed by IBM.

Results

This study involved 45 patients, among whom the majority (78%) were male with a median age of 38, and an interquartile range (IQR) of 28 to 47 [Table 1].

With regards to complications, two (4.4%) of the patients experienced urethral injury, four (8.9%) had bladder injury, six (13%) suffered from urinary incontinence, and two (4.4%) experienced urinary retention. All cases of urethral injury, urinary incontinence, and urinary retention occurred exclusively in male patients, with 0% of these complications reported in women. In contrast, bladder injury had a slightly more diverse gender distribution, with 75% of the cases occurring in males, with only one case occurring in a female patient. The median ages of patients with specific complications varied, with those experiencing bladder injuries and urinary incontinence being slightly older: 41 years (IQR 34 to 50.5) and 44 years (IQR 33 to 46), respectively. In terms of the mechanism of injury (MOI), road traffic accidents were the most common, accounting for 51% of the cases. All urethral injuries (two of two) and the majority of urinary incontinence cases four (67%) were related to road traffic accidents. Fall from height was the next most common MOI (42% of cases), with a notable association with bladder injury (25%) and urinary incontinence (33%). When classified using the Young-Burgess classification system, APC III injuries were particularly associated with complications, with one (50% of) urethral injury, three (75%) of bladder injuries, and two (100%) of urinary retention cases occurring in patients with this classification. Lateral compression type I (LC I) was the most common classification overall (49%), but was less frequently associated with complications, except for urinary incontinence (50% of cases in this group).

Logistic regression analysis of bladder injury, urethral injury, urinary incontinence, and urinary retention are displayed in Tables 2-5, respectively. Age and Gender were not significant predictors of any of the aforementioned complications studied. Among the mechanisms of injury (MOI), road traffic accidents showed a higher likelihood of bladder injury (with fall from height used as the reference category) with an OR of 5.910 (95% CI: 1.759–19.854) and a P-value of 0.544 [Table 2]. However, the association did not reach statistical significance.

Regarding the Young-Burgess classification (with anteroposterior compression type II (APC II) as the reference), patients with APC III injuries had increased odds of sustaining bladder injuries, with an OR of 15 (95% CI: 3.7–59) and a P-value of 0.057. Other classifications, such as LC I and LC II, were not significant predictors, with P-values of 0.864 and 0.947, and ORs of 0.302 (95% CI: 0.085–1.070) and 0.179 (95% CI: 0.033–0.979), respectively. LC III showed a P-value of .075 and an OR of 2.97 (95% CI: 0.897–9.897).

Among the mechanisms of injury (MOI), a fall from stairs was identified as a significantly less dangerous mechanism with a P-value of .047, and OR of 0.179 (95% CI: 0.033–0.979), However, road traffic accidents and trauma with a heavy object were not statistically significant, with P-values of .486 and .463, and ORs of 1.349 (95% CI: 0.581–3.134) and 0.644 (95% CI: 0.199–2.084), respectively [Table 3].

Table 1. Descriptive statistics of patients and complications

		Total (n=45)	Urethral injury 2(4.4%)	Bladder injury 4(8.9%)	Urinary incontinence 6(13.3%)	Urinary retention 2(4.4%)
		Count (%)	Count (%)	Count (%)	Count (%)	Count (%)
Gender	F	10(22.2%)	0(0.0%)	1(25.0%)	0(0.0%)	0(0.0%)
	M	35(77.8%)	2(100.0%)	3(75.0%)	6(100.0%)	2(100.0%)
Age		38(47-28)	36.50(46-27)	40.50(50.50-34)	43.50(46-33)	45(63-27)
MOI	Fall from height	19(42.2%)	0(0.0%)	1(25.0%)	2(33.3%)	0(0.0%)
	Fall from stairs	1(2.2%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
	Road traffic accident	23(51.1%)	2(100%)	2(50.0%)	4(66.6%)	1(50.0%)
	Trauma with a heavy object	2(4.4%)	0(0.0%)	1(25.0%)	0(0.0%)	1(50.0%)
Young-Burgess classification	APC I	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
	APC II	2(4.4%)	0(0.0%)	0(0.0%)	1(16.7%)	0(0.0%)
	APC III	8(17.8%)	1(50.0%)	3(75.0%)	2(33.3%)	2(100.0%)
	LC I	22(48.9%)	1(50.0%)	0(0.0%)	3(50.0%)	0(0.0%)
	LC II	9(20.0%)	0(0.0%)	0(0.0%)	0(0.0%)	0(0.0%)
	LC III	4(8.9%)	0(0.0%)	1(25.0%)	0(0.0%)	0(0.0%)

Table 2. Predictors of Bladder Injury

	OR	95% C.I.for OR		*P-value*
		Lower	Upper	
Age	1.004	.947	1.064	.895
Gender (Male / Female)	.844	.078	9.125	.889
MOI				
Fall from height*	-	-	-	-
Fall from stairs**$^{\Delta}$	N/A	N/A	N/A	N/A
Road traffic accident	5.910	1.759	19.854	.544
Trauma with a heavy object**$^{\Delta}$	1.761	.373	8.315	.475

Table 2. continued

Young-Burgess classification				
APC II*	-	-	-	-
APC III	14.649	3.659	58.654	.057
LC I	.302	.085	1.070	.864
LC II	.179	.033	.979	.947
LC III	2.979	.897	9.897	.075

*Reference category
**Odds ratio calculation and confidence interval are invalid due to 0 cell count.
ΔSub-categories utilized extremely low sample size (< 2), resulting in high variance and wide CI

Table 3. Predictors of urethral injury

	OR	95% C.I.for OR		*P-value*
		Lower	Upper	
Age	.980	.888	1.082	.693
Gender (Male/Female)	1.122	.338	3.730	.851
MOI				
Fall from height*	-	-	-	-
Fall from stairs**Δ	.179	.033	.979	.047
Road traffic accident	1.349	.581	3.134	.486
Trauma with a heavy object**Δ	.644	.199	2.084	.463
Young-Burgess classification				
APC II*	-	-	-	-
APC III	1.532	.390	6.023	.542
LC I	1.081	.329	3.550	.898
LC II	.982	.955	1.010	.211
LC III	.759	.237	2.427	.642

*Reference category
**Odds ratio calculation and confidence interval are invalid due to 0 cell count
ΔSub-categories utilized extremely low sample size (< 2), resulting in high variance and wide CI

For the Young-Burgess classification, none of the injury types were significant predictors of urethral injury. APC III had a P-value of .542 and an OR of 1.532 (95% CI: 0.390–6.023), while LC I and LC II had P-values of .898 and .211, with ORs of 1.081 (95% CI: 0.329–3.550) and 0.982 (95% CI: 0.955–1.010), respectively. LC III also did not show significance, with a p-value of .642 and an OR of 0.759 (95% CI: 0.237–2.427). In terms of the predictors of urinary incontinence in terms of mechanisms of injury, road traffic accidents had an OR of 2.118 (95% CI: 0.342–13.099) and a P-value of .420, indicating no significant relationship with urinary incontinence [Table 4].

Table 4. Predictors of Urinary Incontinence

	OR	95% C.I.for OR		*P-value*
		Lower	Upper	
Age	1.410	.653	3.047	.382
Gender (Male/Female)	1.003	.954	1.054	.919
MOI				
Fall from height*	-	-	-	-
Fall from stairs**Δ	N/A	N/A	N/A	N/A
Road traffic accident	2.118	.342	13.099	.420
Trauma with a heavy object**Δ	N/A	N/A	N/A	N/A
Young-Burgess classification				
APC II	-	-	-	-
APC III	.333	.014	8.182	.501
LC I	1.550	.649	3.700	.232
LC II	1.659	.735	3.746	.394
LC III	.759	.237	2.427	.949

*Reference category
**Odds ratio calculation and confidence interval are invalid due to 0 cell count
ΔSub-categories utilized extremely low sample size (< 2), resulting in high variance and wide CI

For the Young-Burgess classification, none of the injury types were significant predictors of urinary incontinence. APC III had a P-value of .501 and an OR of 0.333 (95% CI: 0.014–8.182), indicating no significant association. LC I and LC II classifications also did not show significant results, with P-values of .232 and .394, and ORs of 1.550 (95% CI: 0.649–3.700) and 1.659 (95% CI: 0.735–3.746), respectively. LC-III had a p-value of .949 and an OR of 0.759 (95% CI: 0.237–2.427), again showing no significant association in the logistic regression. Among the predictors of urinary retention, no mechanism of injury was a significant predictor. Road traffic accidents showed a P-value of .489 and an OR of 1.107 (95% CI: 0.829–1.479) [Table 5].

Table 5. Predictors of urinary retention

	OR	95% C.I.for OR		*P-value*
		Lower	Upper	
Age	1.013	.939	1.092	.747
Gender (Male/Female)	.589	3.103	1.352	.456
MOI				
Fall from height*	-	-	-	-
Fall from stairs**Δ	N/A	N/A	N/A	N/A

Table 5. Continued

Road traffic accident	1.107	.829	1.479	.489
Trauma with a heavy object**Δ	N/A	N/A	N/A	N/A
Young-Burgess classification				
APC II*	-	-	-	-
APC III	1.166	.439	3.096	.758
LC I	.990	.959	1.021	.505
LC II	.992	.961	1.023	.596
LC III	.958	.940	.976	.254

*Reference category
**Odds ratio calculation and confidence interval are invalid due to 0 cell count.
ΔSub-categories utilized extremely low sample size (< 2), resulting in high variance and wide CI

In terms of the Young-Burgess classification, none of the injury types were significant predictors. APC III had a P-value of .758 and an OR of 1.166 (95% CI: 0.439–3.096). LC I and LC II classifications had p-values of .505 and .596, respectively, and ORs of 0.990 (95% CI: 0.959–1.021) and 0.992 (95% CI: 0.961–1.023), respectively. LC III had a P-value of .254 and an OR of 0.958 (95% CI: 0.940–0.976).

Figures 1-3 show types of urological complications, the mechanism of action involved in each complication, and the number of each urological complication according to Young Burgess classification, respectively [Figure 1-3].

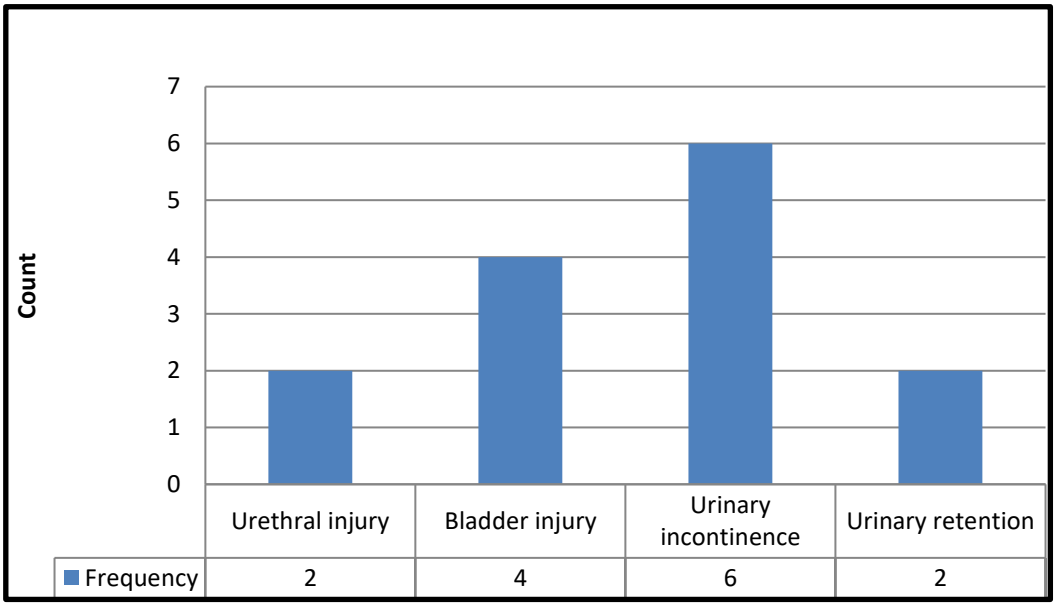

Figure 1. Types of complications

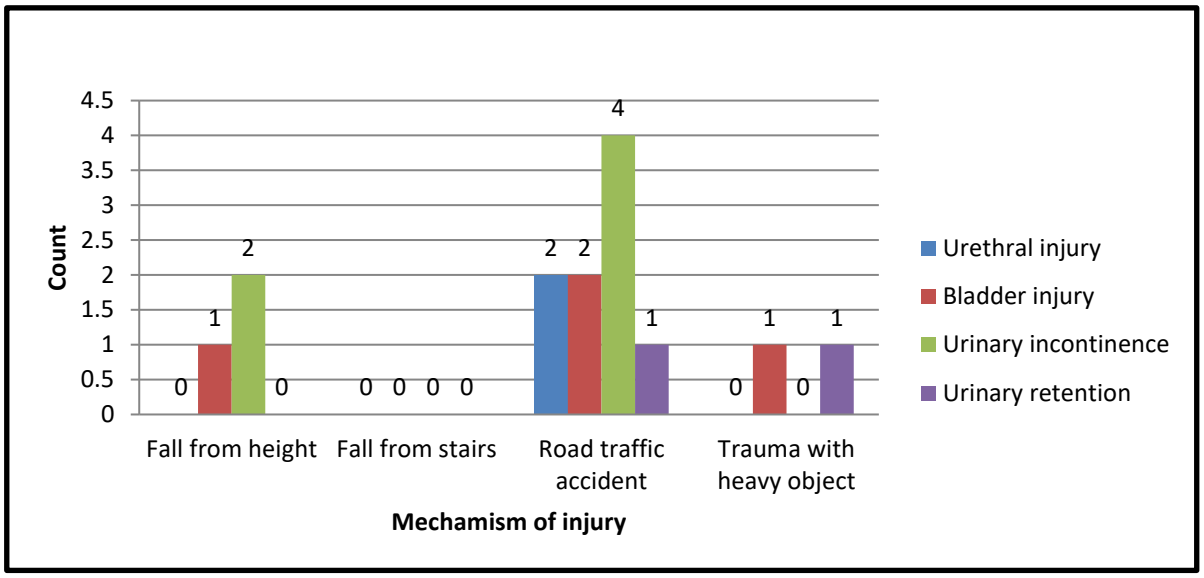

Figure 2. MOI for each complication

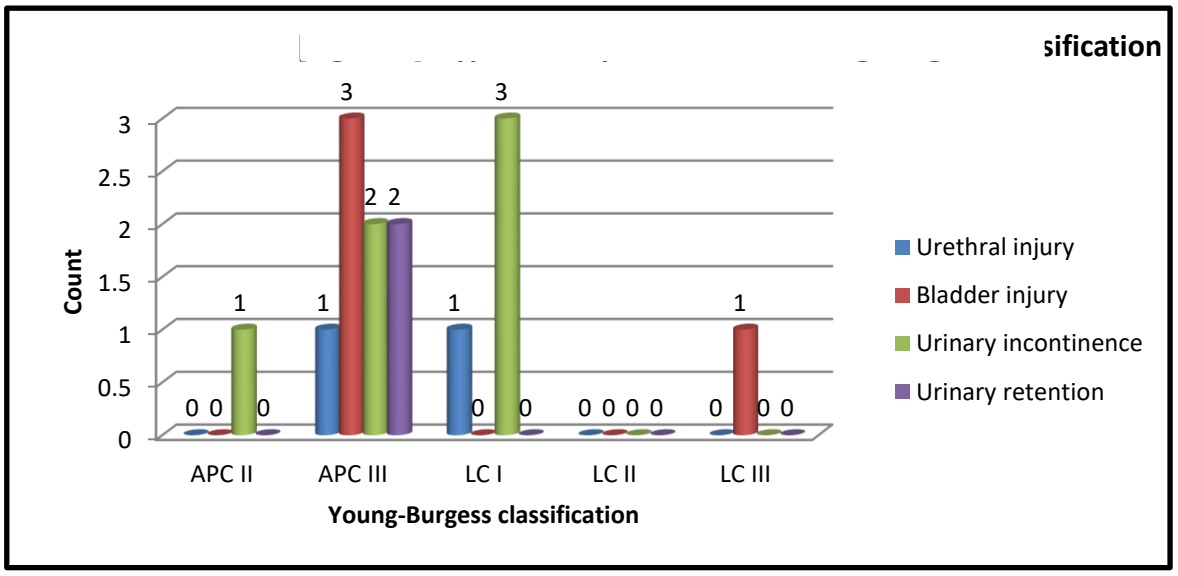

Figure 3. Type of complication with Young-Burgess classification

DISCUSSION:

The present study aimed to investigate the incidence and potential predictors of urogenital complications associated with pelvic fractures. In this study of patients post-pelvic fractures, we found that urogenital complications can present variably, with urinary incontinence being the most commonly reported (13.3%), followed by bladder injuries (8.9%), urethral injuries (4.4%), and urinary retention (4.4%). The study shows that predictors such as age and gender are not significantly associated with these complications. However, specific types of fractures, such as APC III, in particular, show a significant association with certain complications, including bladder injury (75%) and urinary retention (100%). Moreover, specific mechanisms of injury, such as falls from stairs, were significantly linked to less urethral injury (OR of 0.179 (95% CI: 0.033–0.979)).

The findings of this study demonstrate that while pelvic fractures can lead to a range of urological complications, the type of fracture and the mechanism of injury are the primary determinants of the risk and severity of these complications, rather than demographic characteristics such as age and sex. The link between APC III fractures and urogenital complications suggests that the severity of these fractures may lead to significant urological complications by causing greater disruption to the pelvic anatomy, inflicting more extensive damage to urogenital structures. These findings align with the Young-Burgess classification system, which ranks APC III as the most severe type of fracture, often associated with extensive damage to adjacent structures such as the bladder and urethra.[15] This explains the higher incidence of complications, with bladder injuries occurring in 75% and urinary retention in 100% of patients with APC III fractures.

Additionally, the mechanism of injury plays a significant role in the type of urethral injury sustained. Our study demonstrated a significant association between decreased odds of urethral injury and falls from stairs as the mechanism of injury (P-value = 0.047, OR = 0.179). This finding suggests that the specific forces involved in this mechanism of injury may target specific regions of the pelvis, leading to distinct patterns of damage that are less likely to result in urethral injury.

Our findings align with prior research indicating that severe pelvic fractures, such as APC III, are associated with a higher incidence of urogenital injuries. The significant anatomical disruption caused by these complex fractures increases the likelihood of urogenital involvement.[4,16] Additionally, studies have shown that fractures affecting both the anterior and posterior pelvic rings, as seen in APC III fractures, are considered more unstable and present a higher risk for injuries to the bladder and urethra.[17] This instability may contribute to the greater frequency of urogenital complications observed in patients with these severe fracture types.

Our study did not identify significant associations between demographic variables, such as age and gender, and the risk of urogenital complications, even though some literature suggests these factors may play a role in influencing the likelihood of such injuries.[7,13] Instead, our findings emphasize that the mechanism of injury significantly influences the risk of urogenital injuries. This observation underscores the importance of a thorough assessment of the type and severity of trauma to accurately predict the likelihood of urogenital complications. Recognizing fracture type and mechanism of injury as significant predictors of urogenital complications has crucial clinical implications. For example, closely monitoring patients with APC III fractures for signs of bladder injuries and urinary retention is highly advantageous, given that these complications are more prevalent in such cases.[7,16,17] Similarly, identifying injury mechanisms that may be potential causes of urethral injuries can facilitate early recognition and prompt intervention, potentially preventing long-term urological dysfunction.[3,13] Our study has identified that pelvic fractures resulting from falls from stairs are possibly less dangerous and are associated with lower odds of urethral injury. It is vital to conduct further studies with larger samples and comprehensive lists of mechanisms of injury to leverage these insights and develop more personalized management strategies, potentially significantly enhancing the overall quality of care for patients with pelvic fractures and ensuring timely and effective treatment of urogenital injuries. Given the above information, it is important to reiterate that these results are far from confirmatory, and further studies with larger sample sizes are required to establish the possible associations presented.

While this study provides valuable insights, several limitations must be acknowledged. The generalizability of the results is limited by the relatively small sample size of 45 patients, which may reduce the power of our multivariate regression and lead to inconsistent associations. This also affects the ability to assess subtle changes or evaluate rare complications. Additionally, the retrospective nature of the study introduces potential biases in data collection and inconsistent documentation of urological complications. Another potential bias is patient selection, as not all patients with pelvic fractures who are experiencing urogenital complications are included.

Furthermore, the study did not follow standardized protocols for diagnosing and managing these complications, which, in turn, affects the reported rates. Conducting the study in a single geographic area also limits the applicability of the findings to other populations, especially those with different trauma patterns and healthcare practices.

Future research should consider larger, prospective studies to validate these results and investigate factors that could influence the risk of urological complications in a grander patient cohort. Prospective study designs would be useful for establishing standardized assessments of the timing and nature of urological injuries and for better controlling for confounding variables. Conducting multicenter studies could also yield more robust data, enabling more detailed statistical analyses and the development of predictive models.

Conclusion

This study highlights the strong link between specific types of fractures, particularly APC III, and urogenital complications in patients with pelvic fractures. It underscores the importance of careful monitoring of high-risk patients and implementing early diagnostic interventions based on the mechanism of injury. Although the findings provide valuable clinical insights, further research is necessary to validate these results in larger, more

diverse patient cohorts and to establish predictive models for managing urogenital complications in patients with pelvic fractures.

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