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Original Article

# Is computed tomography cystography indicated in children with pelvic fractures?

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ABSTRACT

*Purpose:* Pelvic fracture evaluation with abdominopelvic computed tomography (CT) and formal CT cystography for rule out of urine bladder injury have been commonly employed in pediatric trauma patients. The additional delayed imaging required to obtain optimal CT cystography is, however, associated with increased doses of ionizing radiation to pelvic organs and represent a significant risk in the pediatric population for future carcinogenic risk. We hypothesized that avoidance of routine CT cystography among pediatric pelvic fracture victims would not result in an appreciable rate of missed bladder injuries and would aid in mitigating the radiation exposure risk associated with these additional images.

*Methods:* A retrospective cohort study involving blunt trauma pelvic fractures among pediatric trauma patients (age<14) between the years 1997 and 2016 was conducted utilizing the Israeli National Trauma Registry. Statistical analysis was performed using SAS statistical software version 9.4 via the tests of Chi-square test and two-sided Fisher's exact test. A $p$ value of less than 0.05 was considered statistically significant.

*Results:* A total of 1072 children were identified from the registry for inclusion. Mean age of patients was 7.7 years (range 0–14) and 713 (66.5%) were male. Overall mortality in this population was 4.1% (44/1072). Only 2.1% (23) of pediatric patients with pelvic fractures had bladder injury identified, with just 9 children having intraperitoneal bladder rupture (0.8% of all the patients).

*Conclusion:* The vast majority of blunt pediatric trauma victims with pelvic fractures do not have urine bladder injuries. Based on our study results we do not recommend the routine utilization of CT cystography in this unique population.



## Introduction

Pelvic fractures (PF) represent a significant portion of trauma admissions, and remain a significant issue in the worldwide trauma care.[1] The presence of PF is often associated with major source of bleeding and multiple associated injuries. Contemporary diagnostic evaluation among stable PF blunt trauma victims commonly includes abdominopelvic computed tomography (CT) scan, in order to diagnose the existence of intraperitoneal injuries, pelvic vascular extravasation and to define the pattern of PF. Association of these injuries with bladder rupture has been well described in adults, with several studies reporting an approximately 30% incidence of bladder rupture in patients with PF.[2,3] As a result, several investigators have recommended that the presence of PF mandate performance of supplementary bladder evaluation via cystography

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or CT cystography.[4,5] These imaging modalities are, however, associated with a high doses of ionizing radiation that represents significant mutagenic risk, particularly for vulnerable younger trauma victims.[6,7] The actual incidence of urine bladder rupture in pediatric populations has not, to date, been well elucidated, and largely the similar approach was applied regardless of patient age following PF.

Based on our own clinical observations, we hypothesized that the incidence of urine bladder injury resulting from blunt mechanisms of injury is significantly lower in pediatric patients compared to adults. Accordingly, we hypothesize that this unique population should be optimally managed using protocols distinct from adult counterparts.

The primary aim of the present research was to conduct an epidemiologic study of the incidence of urinary bladder injury in blunt trauma pediatric population with PFs. In doing so, we hope to both define and identify potential risk factors for bladder rupture and provide data useful for the re-appraisal of appropriate utilization of ionizing radiation for children after these specific injuries.

## Methods

We performed a retrospective cohort study including blunt PFs trauma patients, between the years 1997 and 2016, evaluating the incidence of urine bladder injury in pediatric patients aged 0–14 years old. Data were obtained from the records of the Israeli National Trauma Registry (INTR) maintained by Israel's National Center for Trauma and Emergency Medicine Research, in the Gertner Institute for Epidemiology and Health Policy Research. This institute records information concerning trauma patients hospitalized in 20 hospitals, of which 6 are Level I trauma centers and 14 are Level II trauma centers.

Data collected includes age, gender, injury severity score (ISS), site by ICD9, type and abbreviated injury score (AIS) of PFs, presence of urine bladder injury, systolic blood pressure at admission and mortality.

Patients with isolated acetabulum fractures, vaginal laceration and hemoscrotum were excluded. The patients with blood pressure less than 90 mmHg on arrival were defined as hemodynamically unstable. We evaluated the incidence of the overall urine bladder injury and also its association according to the severity of different types of PF. The PFs were defined according to their location and AIS.

Statistical analysis was performed using SAS statistical software version 9.4 (SAS, Cary, NC). Statistical tests performed included chi-square test and two-sided Fisher's exact test. A $p$ value of less than 0.05 was considered statistically significant.

## Results

Among 470,026 blunt trauma patients included in the National Trauma Registry during the period 1997–2016, 128,175 were children under 14 years old. A total of 1072 children were identified suffered from PFs. Mean age of patients was 7.7 years (range 0–14 years), 713 (66.5%) were boys, and 359 (33.5%) were girls. Overall mortality in this population was 4.1% (44/1072).

Pedestrian hit by car was found as the most common mechanism of injury 50.6% (542/1072), followed by falls 23.4% (251/1072) and car passengers in road traffic accidents 11.8% (126/1072).

The distribution of ISS, GCS and AIS in patients with PF is shown in Fig. 1. GCS 13–15 (78.2%) and AIS = 2 (71.1%) were the dominant.

Of 1072 children 750 (70.0%) sustained isolated pelvic bone fracture, and 322 (30.0%) had multiple PF. Only 1.5% of patients with isolated PF (11/750) had bladder injury, compared to 3.7% of children with multiple PF (12/322, $p = 0.02$).

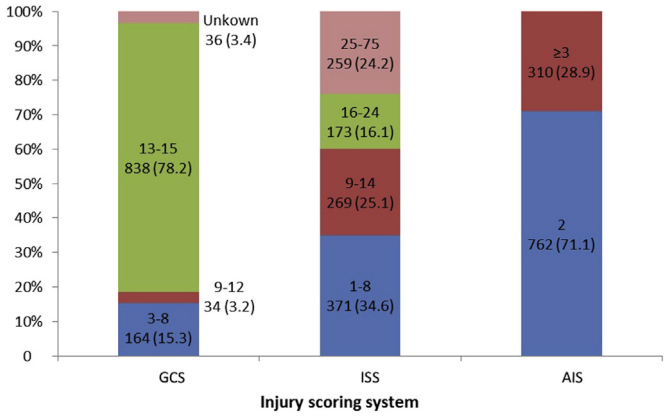


**Fig. 1.** The distribution of ISS, GCS and AIS of pelvic fractures. ISS: injury severity score; GCS: Glasgow coma scale; AIS: abbreviated injury scale.

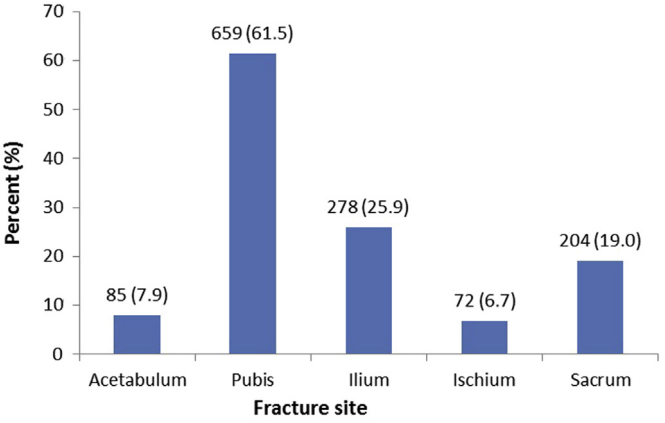


**Fig. 2.** The distribution of PF by site based on ICD9.

In overall population, the most common fracture found was the pubis fracture (61.4%), followed by ilium (25.9%) and sacrum fractures (19.0%). The distribution of PF by site is shown in Fig. 2.

In subgroup of patients suffered from urine bladder injury and concomitant multiple fractures ($n = 12$), 5 (41.7%) had complete pelvic ring disruption. The other 7 patients (58.3%) had pubis fracute: 3 (23%) combined with ilium fracture, 3 (25%) with ischium fracture, and the rest 1 with combined pubis, ischium and sacrum fractures.

## Discussion

PFs in pediatric blunt trauma patients are uncommon, with most resulting from pedestrian hit by car and falls.[8] The incidence has been reported to be 3%–4.5% of all pediatric trauma admissions.[9,10] This is much lower than the occurrence in adult population, estimated in the literature as 10%–26%.[9,11] However, due to the high elasticity associated with younger osseous pelvic structures, PF encountered in this unique population has traditionally been considered as a marker of severe traumatic impact.[10] Several investigators have supported this contention, documenting the presence of multiple associated injuries up to 60% of pediatric trauma patients with PFs.[12–14]

Common initial evaluation of such trauma victims has included abdominopelvic CT scan in order to rule out intra-abdominal organs injury, vascular extravasation and to determine more precisely

the specific pattern of PF. The optimal utilization of additional radiologic evaluation of the urinary tract, while not well defined, has also been employed as a part of these imaging practices. While a common trauma protocol abdominal CT has proven an effective modality for subsequent evaluation for renal and ureteral injuries, the confirmation of bladder injury requires additional delayed images.[15] The resulting conventional cystogram has both high sensitivity and specificity for either intraperitoneal or extraperitoneal injuries. However, performance of these cystographic images requires additional time and expertise to interpret – and additional radiation.[16] These additional requirements have largely been superseded, however, by the immediate availability of CT imaging at most centers and the rapidity with which this modality can effectively exclude these injuries.[17]

Limitation of the existing literature, however, is that it has not effectively served to delineate the relative risk for associated bladder injury relative to other factors – including age. Comparatively less is known about the incidence and patterns of bladder injuries in the pediatric population relative to adult counterparts. Musemeche et al.[18] in a study on 57 pediatric PF patients reported only one bladder laceration (0.17%, 18/57). Similar findings were shown by Tarman and colleagues[19] in a study of 212 consecutive pediatric patients with PF. In contrast, Koraitim and co-investigators[20] reported an 8.3% incidence of bladder rupture in children with PF after trauma.

According to American Urological Association, all adult patients with gross hematuria and PF should undergo CT cystography. CT cystography is also recommended following PF in the setting of microhematuria if there are clinical findings with high risk of possible bladder injury such as obturator ring displacement or significant symphysis pubis diastasis. On the other hand there are no guidelines for genitourinary imaging in pediatric patients sustaining blunt PF. Prior to our present results, existing investigations have been confined primarily to smaller single center studies. We report the largest examination of the topic to date using a national trauma registry. Accordingly we have identified in this population that the overall bladder injury incidence among blunt pediatric trauma patients is 0.02% and that, among these patients that had confirmed PFs, the rate of bladder injury was 2.1%.

Estimated lifetime cancer mortality risks attributable to the radiation exposure from an abdominopelvic CT in a 1-year-old is 0.18%. In the United States, of approximately 600,000 abdominal and head CT examinations annually performed in children under the age of 15 years, a rough estimate is that 500 of these individuals might ultimately die from cancer attributable to the CT radiation.[21]

Our findings suggest that routine CT cystography among pediatric trauma victims likely results in unnecessary radiation exposure. This exposure may prove particularly disadvantageous to young pelvic organs and genitalia, especially when gonads shields are not routinely used during trauma imaging.[22] In our present effort we additionally attempted to identify if any specific PF pattern proved as a useful marker for bladder injury. Such efforts in adult populations have identified that PF patterns involving the symphysis pubis, sacroiliac joint and sacrum were commonly associated with bladder injuries.[23] Unfortunately, however, we were unable to definitively identify similar associations among PF victims from our national trauma registry. Our results suggest that there may be a link between the burden of fracture and bladder injuries – although additional study is required on this topic to better elucidate these potential relationships. Bjurlin[24] in a large study based on the American College of Surgeons National Trauma Databank found that AIS of the pelvis among adult PF patients strongly correlated with the incidence of bladder rupture. It is likely that, with a larger examination of this topic in the pediatric population, similar relationships may be found in this unique population.

One key finding of our study was that all 9 patients with identified intraperitoneal bladder rupture had an associated intra-abdominal trauma required surgical repair. These findings suggest that, in the absence of other abdominal injuries requiring surgical intervention, the diagnosis of intra-peritoneal bladder injury is likely to be safely excluded.

Another observation of this study which probably requires additional prospective evaluation is an association of urine bladder injury and number of pelvic bones fractures. In our study we found that incidence of urine bladder rupture was significantly higher in case of multiple PFs compared with single fracture.

Our study does have some important limitations that must be highlighted, beginning with the inherent limitations of a retrospective registry review. Specifically, it warrants mention that this registry does not provide information regarding the presence and severity of hematuria. In addition, there may have been significant variability between centers with regard to the algorithms for management, particularly with regards to timing and type of bladder diagnostic investigation. Despite these limitations, however, we present a nationwide experience that demonstrates the rarity of the bladder injuries in PFs pediatric patients and highlights the need to caution against the routine utilization of CT cystographic imaging in this population.

In conclusion, our study demonstrates that urinary bladder injuries are rare in blunt trauma pediatric patients with PFs. The benefit of routine CT cystography utilization in this unique population seems still controversial and in our opinion may be avoided in vast majority of the cases. Additional study is required to better define the optimal selection criteria for bladder injury screening in pediatric patients, as well as the appropriate imaging protocols that should be utilized.

## Funding

Nil.

## Ethical Statement

This study has been approved by the local ethical committee (IRB No. 5138-18SMC).

## Declarations of competing interest

The authors declare no competing interest.

## Appendix A

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## Appendix B. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.cjtee.2019.09.002.

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