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Operative Repair Versus Catheter Drainage of Extraperitoneal Bladder Injuries with Pelvic Fracture: A Systematic Review and Meta-analysis of Infectious Complications

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ADMINISTRATIVE INFORMATION**Support** - No support.**Review Stage at time of this submission** - Completed but not published.**Conflicts of interest** - None declared.**INPLASY registration number:** INPLASY2026100028**Amendments** - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 6 October 2026 and was last updated on 6 October 2026.**INTRODUCTION**

Review question / Objective Population: Adults aged 18 years or older with extraperitoneal bladder injury and a traumatic pelvic fracture requiring operative fixation (open reduction and internal fixation, percutaneous screw fixation or external fixation).

Intervention: Surgical repair of the extraperitoneal bladder injury, concurrently with or staged relative to pelvic fracture fixation.

Comparator: Non-operative management with catheter drainage alone.

Outcomes: Primary, infectious complications, comprising surgical site infection, infection requiring debridement, hardware infection, deep pelvic infection, osteomyelitis, urosepsis and pelvic abscess. Secondary, catheter duration, hospital length of stay, reoperation rate, voiding dysfunction and sexual dysfunction.

Rationale Pelvic fractures occur in 9.3% of trauma patients and are associated with various concomitant injuries and complications given the adjacent anatomical structures. Four percent of pelvic fractures are associated with bladder injuries, and up to 10% of pelvic fractures are associated with urethral injuries. Extraperitoneal bladder injuries (EBI) represent approximately 22.4% to 61.1% of bladder injuries and represent a significant clinical challenge. The presence of bladder injury, with a pelvic fracture requiring internal fixation, creates a theoretical risk for hardware contamination leading to surgical site infection, hardware infection, osteomyelitis, or a pelvic abscess warranting surgical debridement.

Historically, guidelines have favored managing uncomplicated EBIs conservatively with catheter drainage. However, for a patient requiring an open reduction internal fixation (ORIF) of a pelvic fracture, the question is whether concurrent repair of the bladder injury with a pelvic fixation reduces the risk of infectious complications compared to catheter drainage alone.

Current guidelines from the American Urological Association (AUA), European Association of Urology (EAU), and Eastern Association for the Surgery of Trauma (EAST) provide an overview for surgical management of EBIs but lack guidance for patients undergoing pelvic fixation. All guidelines acknowledge limited available evidence. A preliminary search showed that no systematic reviews or meta-analyses have covered this topic, and there are no randomized controlled trials. Most available data exist in retrospective cohort studies. The heterogeneity of outcomes reported in small sample size retrospective cohorts has limited the ability to achieve higher levels of evidence with meta-analytic procedures.

The purpose of this systematic review is to identify the available comparative literature on operative outcomes versus non-operative management of extraperitoneal bladder injuries in patients undergoing pelvic fracture fixation. The primary aim is to determine whether concurrent EBI repair, along with pelvic fixation, reduces the risk of infectious complications, including surgical site infections (SSIs), osteomyelitis, hardware infections, and pelvic abscesses. Secondary aims of this study include evaluating catheter duration, hospital stay length, and re-operative rates.

Condition being studied Traumatic extraperitoneal bladder injury in adults with a concomitant pelvic fracture requiring operative fixation, and the infectious complications that follow its management by surgical repair or by catheter drainage, including surgical site infection, hardware infection, deep pelvic infection, osteomyelitis, pelvic abscess and urosepsis.

METHODS

Search strategy Databases searched: MEDLINE (via PubMed), Embase, Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science Core Collection, from January 2010 to the date of search execution. Search executed January 18, 2026. The strategy was developed in consultation with a medical librarian and combines three concepts: bladder injury, pelvic fracture, and infectious outcomes. An English language restriction was applied at the search stage where the platform supported it.

PubMed: ((bladder injur*) OR (bladder rupture*) OR (bladder trauma*) OR (bladder laceration*) OR (extraperitoneal bladder*) OR (vesical injur*) OR (vesical rupture*) OR (ruptured bladder) OR (bladder repair*) OR (bladder perforation*) OR (bladder disruption*) OR (vesical trauma*)) AND

(pelvic fracture* OR pelvis fracture* OR pelvic trauma* OR pelvic ring OR unstable pelv* OR pelvic ring injur* OR pubic rami*) AND (infection* OR infectious OR surgical site infection OR wound infection OR hardware infection OR osteomyelitis OR abscess OR sepsis OR morbidity OR adverse OR debridement OR reoperation OR urosepsis) AND 2010:2025[pdat]

Embase: (bladder:ti,ab AND (injur*:ti,ab OR rupture*:ti,ab OR repair*:ti,ab OR trauma*:ti,ab) OR 'extraperitoneal bladder':ti,ab OR 'vesical injury':ti,ab OR 'genitourinary trauma':ti,ab) AND (pelvic:ti,ab AND (fracture*:ti,ab OR trauma*:ti,ab OR ring*:ti,ab) OR 'pelvis fracture':ti,ab OR 'acetabular fracture':ti,ab OR 'unstable pelvis':ti,ab OR 'pelvic ring':ti,ab) AND (infection*:ti,ab OR morbidity:ti,ab OR SSI:ti,ab OR osteomyelitis:ti,ab OR abscess:ti,ab OR sepsis:ti,ab OR 'adverse event':ti,ab) AND [2010-2025]/py AND [humans]/lim AND [english]/lim

Web of Science: (bladder OR vesical OR genitourinary) AND (trauma OR pelvic OR pelvis) AND fracture* AND (infection* OR complication* OR outcome*)

Cochrane Library: (bladder OR vesical OR genitourinary) AND (injury OR rupture OR trauma OR repair) AND pelvic AND fracture

Grey literature: conference proceedings from the American Urological Association, European Association of Urology, and American Association for the Surgery of Trauma annual meetings (2019 to 2024) were searched through PubMed's supplement filter, and the Conference Proceedings Citation Index within Web of Science Core Collection was searched for unpublished conference presentations.

Participant or population Adults aged 18 years or older with a traumatic extraperitoneal bladder injury, diagnosed by CT cystography, conventional cystography, or at initial operative exploration, and a concomitant traumatic pelvic fracture requiring operative fixation (open reduction and internal fixation, percutaneous screw fixation, or external fixation). Studies limited to intraperitoneal injuries, studies that do not characterize the location of the bladder injury, studies primarily reporting penetrating mechanisms, pediatric populations, and animal models are excluded.

Intervention Operative repair of the extraperitoneal bladder injury, performed either concurrently with pelvic fracture fixation or staged relative to it. Repair technique, timing relative to

fixation, type of pelvic fixation, and concurrent procedures are recorded as extracted variables.

Comparator Non-operative management of the extraperitoneal bladder injury with catheter drainage alone, by urethral or suprapubic catheter, in patients undergoing pelvic fracture fixation. Catheter type, duration of catheterization, and antibiotic regimen are recorded as extracted variables.

Study designs to be included Randomized controlled trials, prospective cohort studies, retrospective cohort studies, and case control studies comparing operative bladder repair with conservative catheter management.

Eligibility criteria Inclusion criteria:

Adult patients (18 years or older) with extraperitoneal bladder injury diagnosed by CT cystography, conventional cystography, or during initial operative intervention.

Traumatic pelvic fractures requiring operative fixation (open reduction and internal fixation, percutaneous screw fixation, or external fixation) with documented extraperitoneal bladder injury.

Comparative studies (randomized controlled trials, prospective or retrospective cohort studies, case control studies) comparing operative bladder repair with conservative catheter management.

Studies reporting at least one infectious outcome (surgical site infection, hardware infection, abscess, osteomyelitis, or infection requiring debridement).

Injury diagnosed by axial contrast imaging (CT or MRI).

Publication date January 2010 to the date of search.

English language publications, or publications with an available English translation.

Exclusion criteria:

Studies reporting only intraperitoneal bladder injuries.

Studies that do not characterize the location of the bladder injury.

Studies primarily reporting penetrating bladder trauma.

Pediatric populations (under 18 years).

Single arm case series without a comparison group.

Studies not reporting infectious outcomes.

Case reports with fewer than 5 patients, editorials, letters, and conference abstracts without full text availability.

Studies with overlapping patient populations, where the most recent or comprehensive study is retained.

Animal models.

Information sources MEDLINE (via PubMed), Embase, Cochrane Central Register of Controlled Trials (CENTRAL), and Web of Science Core Collection, searched from January 2010 to the date of search execution (January 18, 2026). Grey literature was sought in conference proceedings of the American Urological Association, European Association of Urology, and American Association for the Surgery of Trauma annual meetings (2019 to 2024) through PubMed's supplement filter, and in the Conference Proceedings Citation Index within Web of Science Core Collection. No trial registries were searched, and study authors were not contacted for unpublished data.

Main outcome(s) Composite infectious complications occurring within 90 days of pelvic fixation, defined as any of the following: surgical site infection (superficial, deep, or organ space), hardware or metalware infection, pelvic abscess, pelvic osteomyelitis, or any infection requiring return to the operating room for debridement. Dichotomous, analyzed as an odds ratio with 95% confidence interval, with operative repair as the intervention. The protocol's PICO table additionally lists deep pelvic infection and urosepsis among the infectious complications of interest.

Additional outcome(s) Secondary outcomes, assessed over each study's reported follow up period: duration of urinary catheterization (days), hospital length of stay (days), intensive care unit length of stay (days), all cause reoperation rate, long term voiding dysfunction where reported, sexual dysfunction where reported, and mortality (in hospital and at 90 days). Dichotomous outcomes are analyzed as odds ratios with 95% confidence intervals. Continuous outcomes are analyzed as weighted mean differences or standardized mean differences as appropriate, with narrative description where the reported statistics do not allow pooling.

Data management All identified records are imported into Rayyan systematic review software for deduplication and screening. Title and abstract screening and full text review are performed independently by two reviewers against the prespecified eligibility criteria, disagreements are resolved by discussion, persistent disagreements are adjudicated by a third reviewer, and inter-rater reliability is assessed with Cohen's kappa. Reasons for exclusion at the full text stage are documented and reported in a PRISMA flow diagram. Data are extracted into a standardized extraction form, pilot tested on three studies and

refined as needed, by one reviewer and independently verified against the source publications by a second reviewer. Extracted variables cover study characteristics (first author, year, country, design, single or multicenter, enrollment period, follow up), population (sample size total and per arm, age, sex, injury mechanism, Injury Severity Score, pelvic fracture classification, AAST bladder injury grade, bladder injury location, concomitant injuries), intervention details (repair technique, timing relative to fixation, type of fixation, concurrent procedures), comparator details (catheter type, duration of catheterization, antibiotic regimen), and outcome data (infection events by type, time to infection, reoperation for infection, catheter duration, hospital and intensive care unit length of stay, voiding outcomes, mortality).

Quality assessment / Risk of bias analysis Risk of bias is assessed independently by two reviewers using validated tools appropriate to study design. Non-randomized comparative studies are assessed with the Risk Of Bias In Non-randomized Studies of Interventions tool (ROBINS-I). Domains assessed are confounding, selection of participants, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of the reported result. Each study is rated as low, moderate, serious, or critical risk of bias. Disagreements are resolved by discussion.

Strategy of data synthesis All included studies are summarized in narrative form and in evidence tables describing study characteristics, patient populations, interventions, and outcomes. A qualitative synthesis is performed regardless of whether meta-analysis is feasible. A meta-analysis is performed if at least three studies provide extractable data for the primary outcome with sufficient homogeneity. Given anticipated heterogeneity in study designs and populations, a random effects model is used. For dichotomous infectious outcomes, pooled odds ratios with 95% confidence intervals are calculated. For continuous outcomes such as catheter duration, weighted mean differences or standardized mean differences are used as appropriate. Statistical heterogeneity is assessed with the Cochran Q test (significance threshold p less than 0.10) and quantified with the I^2 statistic, interpreted as 0 to 40% low, 40 to 60% moderate, 60 to 75% substantial, and above 75% considerable heterogeneity. Analyses are conducted in Review Manager (RevMan 5.4), ProMeta 3, or R statistical software.

Subgroup analysis None planned in the protocol. Analyses added before any model was run are

reported as departures from the protocol in the published review.

Sensitivity analysis None planned in the protocol. Analyses added before any model was run are reported as departures from the protocol in the published review.

Language restriction English.

Country(ies) involved United States.

Other relevant information This review is registered retrospectively. The protocol was finalized on January 18, 2026, the date the database searches were run, and it was not registered before the search. Screening, data extraction, risk of bias assessment, and analysis were completed before this registration was submitted on October 6, 2026. Registration is sought now at the request of the journal to which the manuscript was submitted. The manuscript reports every departure from the protocol.

Keywords extraperitoneal bladder rupture; pelvic fracture; surgical wound infection; fracture fixation; urinary catheterization; meta-analysis.

Dissemination plans The completed review has been submitted for publication in a peer reviewed urology journal. No other dissemination is planned.

Contributions of each author

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