REVIEW

Update on Suprapubic Cystostomy Diversion vs. Primary Realignment for the Management of Blunt Posterior Urethral Injuries: A Systematic Review and Meta-Analysis

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Purpose: This paper reviewed studies comparing the effectiveness of primary urethral realignment (PUR) and suprapubic cystostomy diversion (SCD) in the early treatment of blunt posterior urethral injuries (PUI).

Materials and Methods: We conducted a systematic review of original studies that directly compared the incidence of urethral strictures (US), urinary incontinence (UI), and erectile dysfunction (ED) in patients receiving primary management for pelvic fracture posterior urethral injuries with PUR versus SCD. We used Review Manager 5.3 for statistical analysis.

Results: The initial search yielded 205 articles, and 14 met the inclusion criteria for the final systematic review. Meta-analysis showed that PUR was significantly more effective than SCD in reducing the proportion of US in the 365 and 335 cases of PUR and SCD, respectively (OR 0.09, 95% CI 0.04-0.22, $p < 0.0001$). However, there was no significant difference between PUR and SCD in the incidence of UI (OR 0.60, 95% CI 0.33-1.11) or ED (OR 0.70, 95% CI 0.45-1.11).

Conclusion: PUR is more effective than SCD in reducing the incidence of US in patients with pelvic fracture posterior urethral injuries. However, there was no significant difference between PUR and SCD in the incidence of UI or ED.

Keywords: suprapubic cystostomy; primary realignment; blunt posterior urethral injuries

INTRODUCTION

Posterior urethral injury (PUI) is a common consequence of blunt pelvic trauma, resulting from major shearing forces that displace the urethra from the fixed urogenital diaphragm at the bulbomembranous junction.[1] The incidence of PUI varies from 1.54% to 25% in different studies.[2-5] These injuries can cause significant suffering and devastating consequences, including urethral stricture (US), urinary incontinence (UI), and erectile dysfunction (ED).

The initial management options for PUI include immediate open surgical repair, primary urethral realignment (PUR), and suprapubic cystostomy diversion (SCD) with delayed urethral stricture repair. However, immediate surgical repair of the disrupted urethra has fallen out of favor due to the high risk of complications, including incontinence and impotence.[2] Instead, the interlocking sound technique and the practice of open cystotomy led to the development of realignment of the disrupted urethra over a urethral catheter.[3-5] More recently, the development of flexible urethroscopy has led to a renewed interest in early PUR as an immediate management option.[2,6-9] A systematic review by Barrett et al. in 2014 found that PUR appears to be more effective than SCD in reducing the incidence of urethral strictures after pelvic fracture-associated PUI.[10]

However, controversy still exists regarding the optimal treatment for PUI, with ongoing arguments regarding the relative merits of PUR and SCD.[8,9,11] Therefore, to provide more comprehensive evidence on the rates of UI, US, and ED in men with pelvic fracture posterior urethral injuries whose early treatment was by PUR or SCD, we conducted an updated meta-analysis that builds upon the previous work by Barrett et al.[10] This new analysis aims to inform clinical decision-making and guide the choice of treatment for patients with PUI.

METHODS

Search Strategy

The search strategy for this systematic review and meta-analysis adhered to the PRISMA guidelines and included the following steps. The MEDLINE, Embase, Web of Science, Scopus, and Cochrane databases were searched from January 1980 to October 2023. The following keywords were used: “posterior urethral injury/injuries”, “posterior urethral trauma/traumas”, “realignment”, “suprapubic cystostomy”, “cystostomy”, “pelvic fracture”, and “suprapubic tube”. No language restrictions were applied. Previous reviews and reference lists from included studies were also reviewed. Two reviewers (T.Q.W. and D.H.C.) independently searched and screened all articles. Disagreements were resolved by consulting with a third author (L.C.).

Eligibility Criteria

Inclusion criteria included human males with posterior urethral injuries caused by blunt trauma, a direct comparison of PUR versus SCD for initial treatment, and reporting of the incidence of US, ED, or UI. Exclusion criteria included clinical studies that did not meet the above criteria, as well as reviews and historical articles.

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Table 1. Characteristics of Included Studies Comparing Primary Realignment (PUR) and Suprapubic Cystostomy (SCD)

Reference	Design	N (PUR/SCD)	Injury Type (C/P)	Method of PUR	Timing of PUR	Diagnosis of US	Diagnosis of ED	Diagnosis of UI	Follow-up (PUR/SCD)
Abdalla, 2015	PCS	16 / 16	16C/0P (PUR) 16C/0P (SCD)	Flexible cystoscopy	Unclear	Flow rate	Unclear	Unclear	12-30 mo / -
Asci et al, 1999	RCS	20 / 18	Mostly PUD	Catheter /Interlocking sounds	Immediate	Hx/PVR/ Flow/RUG	Inability to achieve penetration	Pads	38.7 mo / 37.1 mo
Balkan et al, 2005	RCS	11 / 8	9C/2P (PUR) 5C/3P (SCD)	Interlocking sounds	1-10 d	RUG/Flow rate	N/A	Unclear	4.9 yr / 5.1 yr
Chang et al, 2011	RCS	11 / 11	11C/0P (PUR) 11C/0P (SCD)	Flexible cystoscopy	< 2 wk	Hx/PVR/RUG	N/A	N/A	2 yr / -
Follis et al, 1992	RCS	20 / 13	20C/0P (PUR) 13C/0P (SCD)	Interlocking sounds/ Catheter pull-through	Immediate	Hx/Flow rate/PVR	Hx of decreased potency	Pads	- / -
Hadjizacharia et al, 2008	PCS	14 / 7	3C/11P (PUR) 4C/3P (SCD)	Flexible cystoscopy/ Catheterization	4 h to 2.8 d	Unclear	N/A	N/A	7 mo / -
Husmann et al, 1990	RCS	17 / 64	Unclear	Interlocking sounds	Immediate	Obstructive symptoms	Hx/Perceived loss of function	Pads	- / -
Johnsen et al, 2015	RCS	27 / 14	18C/9P (PUR) 10C/4P (SCD)	Flexible cystoscopy	Early	Hx/Flow rate/ PVR/Cystoscopy	Subjective patient evaluation	Patient report	39 mo / 41 mo
Koraitim et al, 1996	RCS	23 / 73	Mostly CUD	Interlocking sounds	Immediate	Failure to void	Hx/Incapable of penetration	Unclear	4-5 yr / -
Ku et al, 2002	RCS	65 / 30	32C/33P (PUR) 16C/14P (SCD)	Cystoscopy/Fluoroscopy	Immediate	Hx/Flow rate/ RUG/Cystoscopy	Patient report	Pads	29.2 mo / 26.0 mo
Mouraviev et al, 2005	RCS	57 / 39	Unclear	Catheter/Interlocking sounds	Early	Hx/PVR/Flow/RUG	Patient report	Pads	8.8 yr / -
Podesta et al, 1997	RCS	10 / 19	10C/0P (PUR) 19C/0P (SCD)	Catheterization	Unclear	RUG/Flow rate	N/A	Urodynamics	9.1 yr / -
Webster et al, 1983	RCS	19 / 11	Unclear	Various/Unspecified	Initial	Unspecified	Chart review	Unspecified	- / -
Zhu et al, 2012	RCS	55 / 12	25C/30P (PUR) 12C/0P (SCD)	Catheter/Interlocking sounds	Early	Hx/PVR/Flow/RUG	Patient report	Patient report	7.7 yr / -

Abbreviations: C, complete urethral disruption; P, partial urethral disruption; ED, erectile dysfunction; Hx, history; N, number of patients; N/A, not applicable; PCS, prospective cohort study; PUD, posterior urethral disruption; PVR, post-void residual; RCS, retrospective cohort study; RUG, retrograde urethrogram; UI, urinary incontinence; US, urethral stricture.

This systematic review only included retrospective and prospective cohort studies.

Data Extraction and Quality Assessment

The extraction of data from the included studies was conducted by two independent reviewers, with any discrepancies resolved through consultation with a third author. The data extracted included the population, study type, intervention (SCD or PUR), timing of PUR, severity of injuries, methods of PUR, and outcomes measured (US, ED, and UI), as well as ages and follow-up time. In the case of missing data, the study authors were contacted for more information. If relevant data could not be obtained, it was estimated.

The ranking of evidence was defined for each study based on the standard provided by the Oxford Centre for Evidence-Based Medicine.[12] The methodological quality of the included non-randomized controlled trials (N-RCTs) was evaluated using the Newcastle-Ottawa Scale (NOS). The NOS assigns a maximum of 9 points to each study, with higher scores indicating better methodological quality.(13) Two trials were prospective studies, and twelve studies were retrospective studies. The methodological quality of included studies was divided into three parts: high (NOS: 6 to 9 points), medium (NOS: 3 to 5 points), and low (NOS: 0 to 2 points).

Statistical Analysis

This meta-analysis was conducted using RevMan 5.3, with dichotomous data presented as odds ratios (OR) and continuous outcomes as mean difference (MD), both with a 95% CI. The unadjusted ORs were pooled using fixed-effects (Mantel-Haenszel) or random-effects (DerSimonian-Laird) models, depending on the degree of heterogeneity. Heterogeneity was evaluated using the Higgins-Thompson I^2 and Chi^2 test method. If $I^2 < 50\%$ and $p > 0.1$, indicating homogeneity, fixed-effects models were used. If $I^2 > 50\%$ and $p < 0.1$, indicating heterogeneity, random-effects models were used. Sensitivity analysis was performed if low-quality trials were included in the analysis.

RESULTS

The Literature Screening Process

After the initial search on the aforementioned databases, a total of 205 articles were retrieved. After removing duplicates, 145 citations were left for screening. Following the screening of titles and abstracts, 122 studies were excluded. Through a manual search of references, an additional 3 articles were identified, which left 26 articles for full-text assessment. Finally, after applying the study inclusion and exclusion criteria, 14 studies were included in the meta-analysis. The flow of article selection is presented in (**Figure 1**).

Study Characteristics and Quality

A total of 14 clinical cohort studies containing 700 male patients with posterior urethral disruption were included in this review. Two of the studies were prospective in design,[6,8] while the others were retrospective.[2,7,9,14-22] The basic characteristics of the 14 included studies are presented in (**Table 1**).

The NOS scores of the included studies varied from 6 to 9 points: three studies scored 9 points,[15,16,23] two studies scored 8 points,[8,17] eight studies scored 7 points,[2,6,7,14,18,20-22] and one study scored 6 points.[19]

Urethral Stricture (US) Rates

All 14 studies reported on US rates for 700 patients. US rates for PUR (n=365) varied from 14.29% to 100%, and from 40% to 100% for SCD (n=335), with follow-up ranging from 14 days to 22 years (**Table 1**). In the meta-analysis, the overall US rates were 46.58% for PUR versus 92.24% for SCD. Patients undergoing

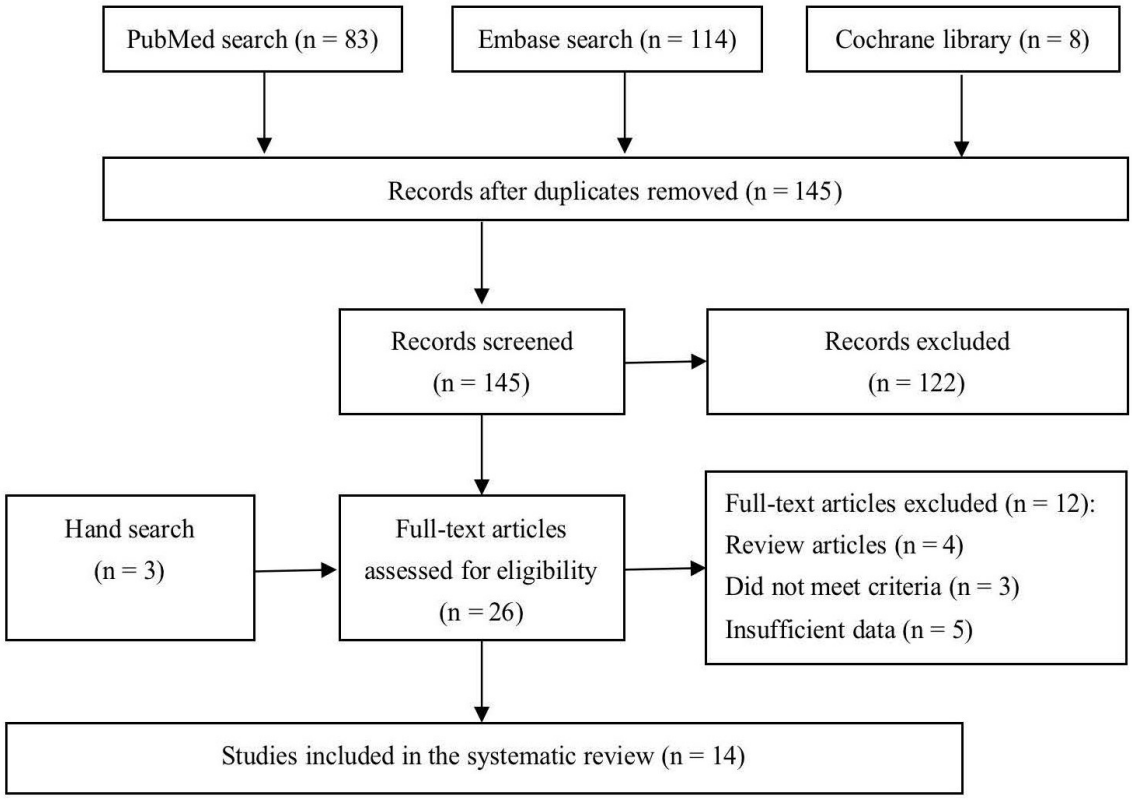

Figure 1. Flow diagram for the literature screening process

PUR showed a lower incidence of US (OR 0.09, 95% CI 0.04-0.22, $p < 0.001$, (**Figure 2**)). In the subgroup analysis, a similar result was found for complete urethral disruption groups, with a lower incidence of US in the PUR group (OR 0.05, 95% CI 0.01-0.3, $p < 0.01$, as shown in (**Figure 2**)).

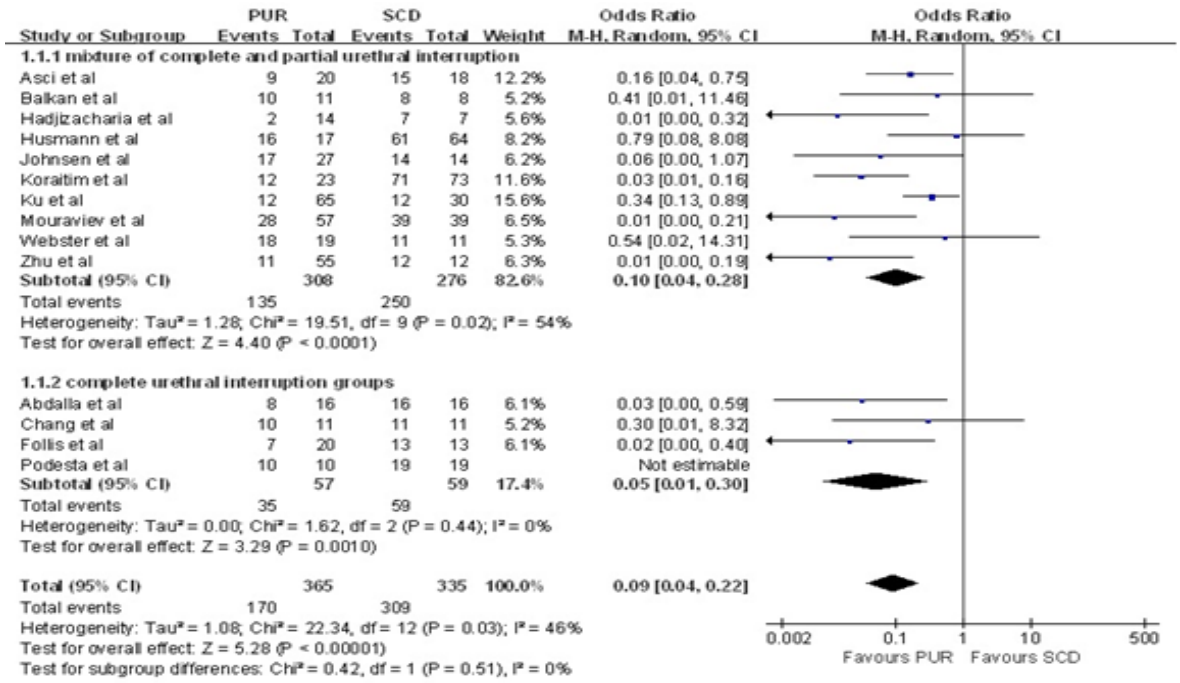

Figure 2. Forest plot of the rate of urethral stricture between primary urethral realignment (PUR) and suprapubic cystostomy diversion (SCD).

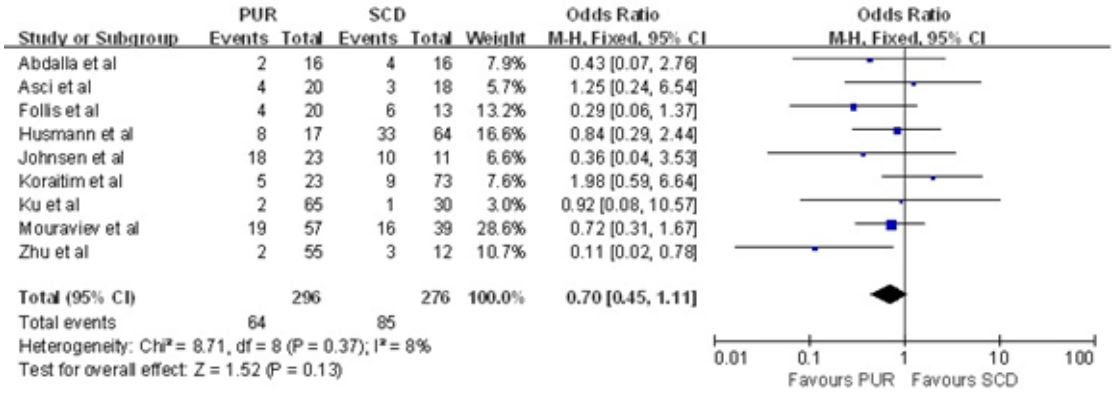

Figure 3. Forest plot of the rate of erectile dysfunction between primary urethral realignment (PUR) and suprapubic cystostomy diversion (SCD).

Erectile Dysfunction (ED) Rates

Nine of the 14 included articles reported on ED rates among a total of 572 patients.[2,8,9,14-18,20] The rates of ED for PUR (n=296) ranged from 3.08% to 78.26%, and for SCD (n=276) ranged from 3.33% to 90.91%. The overall ED rates were 21.62% for PUR versus 30.80% for SCD. The meta-analysis showed no significant difference in ED rates between PUR and SCD (OR 0.70, 95% CI 0.45-1.11, p = 0.13, (**Figure 3**)).

Urinary Incontinence (UI) Rates

The rates of UI were analyzed based on 620 patients from 11 studies.[2,8,9,14-22] The UI rates for PUR (n=317) ranged from 0% to 17.54%, while the rates for SCD (n=303) ranged from 0% to 25.64%. The overall UI rates were 6.31% for PUR and 10.23% for SCD. The results of the meta-analysis did not indicate a significant difference in UI rates between PUR and SCD (OR 0.60, 95% CI 0.33-1.11, p = 0.10, (**Figure 4**)).

DISCUSSION

The choice between PUR and SCD for the initial treatment of PUI remains a matter of debate. In 2014, a meta-analysis by Barrett et al. suggested that PUR appeared to reduce the incidence of US after pelvic fracture-associated PUI as compared to SCD.[10] Since then, two new clinical cohort studies have reported results comparing the initial treatment of PUI using PUR and SCD.[8,9] To enlarge the sample size and attain more reliable conclusions, we included these two recent studies and three past clinical cohort studies[20-22] in our meta-analysis, in addition to the studies included in the Barrett et al. analysis.[10]

Patient recruitment periods in the studies included in our analysis span more than four decades, from 1983 to 2023. This resulted in significant methodological differences among the studies, as shown by the identified heterogeneity (I^2=54%, (**Figure 2**)). To minimize bias, we only included studies that directly compared the results of PUR and SCD, thus unifying the methodology within each study.

After the initial injury, the timing of realignment is not identical, varying from immediate or early to up to 17 days after the primary trauma.[7,8,16,24] A few authors have reported that delayed realignment is feasible even as late as 10-17 days after trauma.[7,24]

The techniques of urethral realignment have also evolved. Initially, catheterization and interlocking

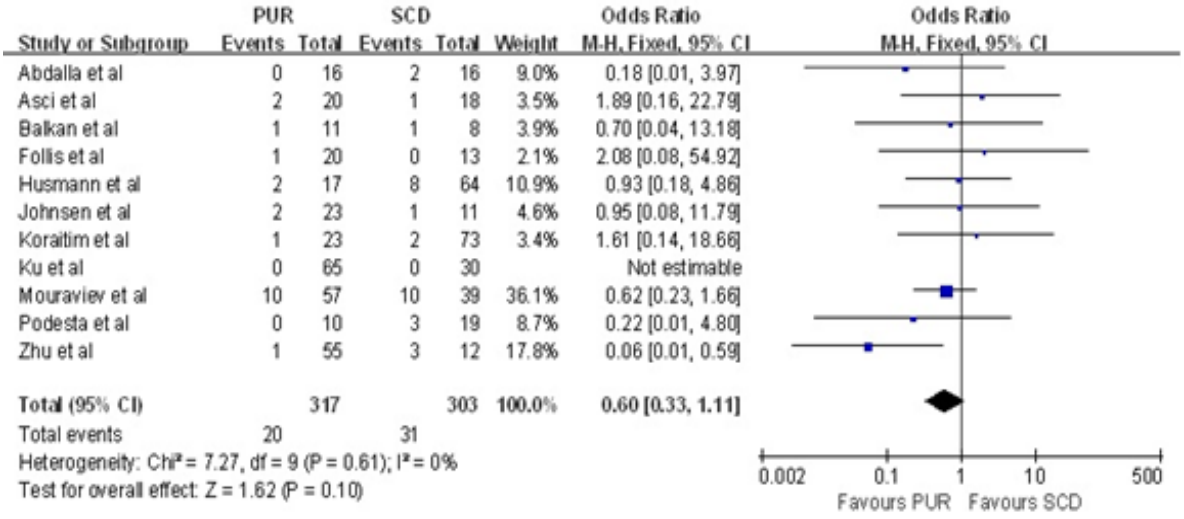

Figure 4. Forest plot of the rate of urinary incontinence between primary urethral realignment (PUR) and suprapubic cystostomy diversion (SCD).

sounds were the main methods used.[2,16,18,19,21] Later, fluoroscopy or cystoscopy was added to aid in realignment.[15] In recent years, endoscopic realignment has become more popular, using rigid urethroscopy, flexible cystoscopy, or a combination of both, with success rates ranging from 70% to 100%.[6-9,17,25-28] Success rates have also been positively correlated with experience.[24,29]

Regarding the duration of urethral catheterization after PUR, recommendations vary from 3 to 8 weeks.[3,6,16,22,25,30-33] Most experts suggest removing the Foley catheter as soon as feasible. A reasonable approach involves performing a peri-catheter retrograde urethrogram or voiding cystourethrogram at the time of catheter removal, after a minimum of 3 weeks for partial distraction and 6 weeks for complete distraction.[25] If there is no extravasation, the urethral catheter can be removed. Otherwise, it should be retained or replaced until the absence of urethral extravasation is confirmed.[34]

In our meta-analysis, the rate of US in PUR groups was significantly lower than that in SCD groups (OR 0.09, 95% CI 0.04-0.22, $p < 0.01$). This finding supports the previous conclusion that PUR appears to reduce the incidence of stricture formation after pelvic fracture-associated PUI compared with SCD.[10] Most published studies have also reported a decrease in the incidence of stricture formation with PUR, usually in the range of 50%, which is similar to our statistical data (49%).[14] However, the incidence of stricture formation can reach up to 93% in SCD groups.

The severity of the injury could potentially impact the outcomes. However, we found that most injuries were classified as grade 3 (partial urethral distraction) or grade 4-5 (complete urethral disruption). Moreover, the four studies in our meta-analysis that involved only patients with complete distraction of the urethra[7,8,17,21] still showed a significant difference in US rates between PUR and SCD groups (OR 0.05, 95% CI 0.01-0.3, $p < 0.01$, (**Figure 2**)). Additionally, the severity of trauma was comparable between the groups, indicating that the observed differences in stricture rates cannot be attributed to less severe trauma in the PUR groups.

In 1983, Webster et al. reported that patients who underwent PUR had a higher incidence of ED (44%) and incontinence (20%) compared to those who underwent SCD (ED 12%, incontinence 2%).[19] Similarly, Koraitim found that patients who underwent PUR had a higher rate of ED compared to those who underwent SCD (36% vs. 19%).[2]

However, it should be noted that many studies in these two reviews were not clinical cohort studies, were conducted at multiple centers, and had different severities of injury between groups.[2,19] Moreover, the technique for PUR and the follow-up period were not uniform, which could have produced significant bias. In contrast, many authors have found that PUR does not increase the risk of ED or incontinence.[14,16,35] Recent studies have also reported similar results,(8,36,37) and our meta-analysis found no statistically significant difference in the rate of UI (OR 0.60, 95% CI 0.33-1.11) or ED (OR 0.70, 95% CI 0.45-1.11) between PUR and SCD. The incidence of ED or incontinence may be mainly determined by the trauma itself rather than the initial treatment.[10,31] Therefore, while there is no consensus, there is a tendency to agree that initial management with either PUR or SCD does not increase the risk of ED or incontinence.

Our report has several limitations. All included studies are clinical cohort studies, and most are retrospective. The methods of diagnosis, severity of initial injury, and the time and techniques used for PUR are also varied. Due to the lack of data, we were not able to perform subgroup analyses for trauma severity or realignment methods. The review's reliance on existing literature may introduce selection bias. The focus on US, UI, and ED overlooks other important factors such as quality of life. The duration of follow-up and the search strategy may also be limitations. Furthermore, most included studies lack statistics on the outcomes of sequential treatment for cases using SCD or for stricture formation after PUR. Therefore, we cannot answer questions about whether failed PUR would increase the severity of urethral stricture or the difficulty of subsequent operations.

CONCLUSIONS

Compared with SCD, a lower incidence of urethral stricture formation was found in patients treated with PUR for pelvic fracture urethral injuries. Regarding complications such as ED and UI, there was no significant difference between the PUR and SCD groups. With advances in endoscopic techniques, more authors support primary endoscopic realignment as a suitable and less invasive method for the initial management of pelvic fracture urethral trauma. However, since some authors still do not endorse this approach, further studies are needed, especially multi-center randomized controlled trials, to obtain more conclusive evidence.

SUMMARY

Early urethral repair (PUR) after pelvic injury reduces scarring compared to urinary diversion (SCD), with no difference in incontinence or erectile dysfunction rates. PUR is a suitable initial treatment for these injuries.

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None.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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