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Complete primary repair versus modern staged repair for bladder exstrophy-epispadias complex: a systematic review and meta-analysis

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Abstract

Introduction. Bladder exstrophy-epispadias complex requires complex surgical repair. Complete primary repair of exstrophy and modern staged repair of exstrophy are the two principal approaches, but their comparative outcomes have not been quantitatively pooled.

This review assessed whether complete primary repair differs from staged repair in continence, surgical morbidity, reoperation, and upper urinary tract outcomes.

Materials & methods. PubMed / MEDLINE, Scopus, Europe PMC, and Epistemonikos were searched from inception to April 1, 2026. Comparative studies of patients with classic bladder exstrophy or bladder exstrophy-epispadias complex were included. Two authors independently selected studies, extracted data, and assessed risk of bias with the Newcastle-Ottawa Scale. Random-effects meta-analysis generated risk ratios with 95% confidence intervals.

Results. Eight studies including 878 patients were analyzed. No significant difference was detected for overall continence, spontaneous voiding, dry interval, or subsequent bladder neck reconstruction. Complete primary repair was associated with higher redo bladder closure, overall reoperation, and febrile urinary tract infection. The redo-closure finding depended on one referral-center study and became non-significant after its exclusion. Upper urinary tract outcomes were comparable.

Conclusion. No significant continence difference was detected, but equivalence cannot be inferred because several analyses were underpowered. Complete primary repair carried higher closure-related and infectious morbidity in the available observational evidence. Surgical choice should be individualized according to patient factors and institutional expertise.

Keywords: bladder exstrophy; epispadias; complete primary repair; staged repair; systematic review; meta-analysis

Financing. The study was not sponsored. **Conflict of interest.** The authors declare no conflict of interest. **Ethical statement.** Ethical approval was not required because this study analyzed previously published aggregate data only. **Informed consent.** Not applicable for this systematic review and meta-analysis. **Data availability.** All data analyzed during this study are included in the article and supplementary information files. **Supplementary materials.** Additional file 1: Full electronic search strategy, search strategy full.docx. Additional file 2: Completed PRISMA 2020 checklist, PRISMA_2020_checklist.docx.

Authors' contribution: A.F. Alhanifa — study concept, study design development, literature review, data acquisition, data analysis, statistical data processing, drafting the manuscript, final approval; I.M.B.D. Abhikrama — literature review, data acquisition, data analysis, drafting the manuscript, final approval; P.M.W. Tirtayasa — supervision, critical review, scientific editing, final approval; G.W.K. Duarsa — supervision, critical review, scientific editing, final approval.

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Сравнение полной первичной реконструкции и современной поэтапной реконструкции при комплексе экстрофии мочевого пузыря и эписпадии: систематический обзор и метаанализ

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Аннотация

Введение. Комплекс экстрофии мочевого пузыря и эписпадии относится к числу наиболее сложных врождённых пороков развития и требует многоэтапного хирургического лечения. В клинической практике основными подходами служат полная первичная реконструкция экстрофии и современная этапная коррекция, однако их сравнительная эффективность до настоящего времени оставалась недостаточно обобщённой.

Цель настоящего обзора заключалась в оценке различий между указанными подходами по частоте достижения континенции, хирургическим осложнениям, потребности в повторных вмешательствах и состоянию верхних мочевых путей.

Материалы и методы. Поиск литературы проводили в базах PubMed/MEDLINE, Scopus, Europe PMC и Epistemonikos с момента их создания до 1 апреля 2026 года. В обзор включали сравнительные исследования пациентов с классической экстрофией мочевого пузыря либо комплексом экстрофии мочевого пузыря и эписпадии. Отбор публикаций, извлечение данных и оценку риска систематической ошибки по шкале Newcastle-Ottawa выполняли два исследователя независимо друг от друга. Для метаанализа с моделью случайных эффектов рассчитывали отношения рисков с 95% доверительными интервалами.

Результаты. В анализ были включены 8 исследований, включавших 878 пациентов. Достоверных различий по общей континенции, спонтанному мочеиспусканию, длительности «сухого» периода и необходимости последующей реконструкции шейки мочевого пузыря не выявлено. Вместе с тем полная первичная реконструкция ассоциировалась с более высокой частотой повторного закрытия мочевого пузыря, общим числом повторных операций и фебрильных инфекций мочевых путей. При этом эффект в отношении повторного закрытия во многом определялся результатами одного исследования из референс-центра и после его исключения утрачивал статистическую значимость. Показатели со стороны верхних мочевых путей в сравниваемых группах были сопоставимы.

Заключение. Достоверных различий по континенции не установлено, однако делать вывод об эквивалентности методов преждевременно ввиду недостаточной статистической мощности ряда анализов. По имеющимся данным, полная первичная реконструкция сопровождается более высокой частотой осложнений, связанных с закрытием мочевого пузыря, а также инфекционной морбидностью. Выбор хирургической тактики должен определяться индивидуально с учётом клинической ситуации и опыта специализированного центра.

Ключевые слова: экстрофия мочевого пузыря; эписпадия; полная первичная реконструкция; этапная реконструкция; систематический обзор; метаанализ

Финансирование. Исследование не имело спонсорской поддержки. **Раскрытие интересов.** Авторы заявляют об отсутствии конфликта интересов. **Этическое заявление.** Получение этического одобрения не требовалось, поскольку в данном исследовании проведен анализ ранее опубликованных сводных данных. **Информированное согласие.** Не применимо для данного систематического обзора и метаанализа. **Доступность данных.** Все данные, проанализированные в ходе исследования, включены в статью и дополнительные информационные файлы. **Дополнительные материалы.** Дополнительный файл 1: Полная электронная стратегия поиска, search strategy full.docx. Дополнительный файл 2: Заполненный контрольный список PRISMA 2020, PRISMA_2020_checklist.docx.

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Introduction

Bladder exstrophy-epispadias complex (BEEC) is a rare congenital malformation of the genitourinary system, occurring in approximately 1 in 30,000 to 50,000 live births, with a male-to-female ratio of about 2.3:1 [1, 2]. Classic bladder exstrophy is the most common and clinically relevant form and is characterized by an exposed bladder plate, pubic diastasis, and epispadias. Without surgical reconstruction, patients may develop continuous urinary incontinence, recurrent infection, progressive renal injury, and psychosocial impairment [3].

Two reconstructive strategies dominate contemporary management. Modern staged repair of exstrophy (MSRE), as developed from the Jeffs approach, begins with neonatal bladder and abdominal wall closure, followed by epispadias repair at approximately 6 to 12 months and bladder neck reconstruction at about 4 to 6 years when bladder capacity is adequate [4]. Complete primary repair of exstrophy (CPRE), introduced by Mitchell and

Bagli, combines bladder closure, epispadias repair, and partial bladder-neck reconstruction during one neonatal operation [5, 6].

The optimal approach remains uncertain. Comparative studies are mostly retrospective, single-center, and limited by small samples, heterogeneous continence definitions, and variable follow-up. Reported continence after CPRE ranges from 23% to 80%, while multi-institutional data suggest that few patients achieve continence with spontaneous voiding after one CPRE procedure [7]. MSRE outcomes also vary by institutional experience [8]. Whether the potential reduction in planned operations with CPRE offsets greater risks of closure failure, urinary tract infection, and re-operation remains unclear [9].

Objective. This systematic review and meta-analysis evaluated whether CPRE, compared with MSRE, is associated with differences in continence and functional outcomes, surgical complications and reoperations, and renal or urologic outcomes in patients with classic bladder exstrophy or BEEC [10].

Materials and methods

Protocol and registration. This systematic review and meta-analysis was conducted according to PRISMA 2020 guidance [11, 12]. The protocol was registered prospectively in PROSPERO (registration number: CRD420261292831).

Eligibility criteria. Eligible studies compared CPRE, including technical variants, with MSRE in patients with classic bladder exstrophy or BEEC. Outcomes of interest included continence and functional endpoints, surgical complications and reoperations, and renal or urologic complications. Randomized and nonrandomized comparative cohort studies were eligible regardless of date, language, or sample size. Non-comparative studies, isolated epispadias, cloacal exstrophy, case reports, editorials, narrative reviews, expert opinion, and non-human or cadaveric studies were excluded.

Search strategy and selection of studies. PubMed/MEDLINE, Scopus, Europe PMC, and Epistemonikos were searched from inception to April 1, 2026. MeSH terms and keywords for BEEC were combined with terms for complete primary repair and staged reconstruction; equivalent strategies were adapted for each database. Reference lists of included studies and relevant reviews were hand-searched, and trial registries were screened for completed unpublished comparative studies. The full search strategy is provided in Additional file 1.

Data extraction. Two investigators independently extracted study characteristics, patient demographics, surgical techniques, use of osteotomy, follow-up duration, and functional, surgical, and renal outcomes using a standardized form. Extracted data were checked by another independent investigator.

Risk of bias assessment. Risk of bias was assessed with the Newcastle-Ottawa Scale (NOS) for nonrandomized studies [13]. The scale evaluates selection, comparability, and outcome ascertainment. Studies were classified according to Agency for Healthcare Research and Quality standards as good, fair, or poor quality.

Outcome measures. Functional outcomes included overall continence, spontaneous voiding without clean intermittent catheterization (CIC), dry interval greater than 2 to 3 hours, and subsequent bladder neck reconstruction. Surgical outcomes included bladder dehiscence, urethrocutaneous fistula, urethral stricture, redo bladder closure, and overall reoperation. Renal and urologic outcomes included febrile urinary tract infection (UTI), vesicoureteral reflux (VUR), new or worsening hydronephrosis, and renal impairment or scarring.

Data synthesis and statistical analysis. Analyses were conducted in R software v3.13 (The R Foundation for Statistical Computing, Vienna, Austria). Pooled risk ratios (RRs) and 95% confidence intervals (CIs) were calculated using random-effects meta-analysis with restricted maximum likelihood estimation. Heterogeneity was assessed with the I^2 statistic, interpreted as 0 – 25% low, 26 – 50% moderate, 51 – 75% substantial, and > 75% considerable. Leave-one-out sensitivity analyses were performed for outcomes with substantial heterogeneity or disproportionate study weighting. Funnel plots and Egger's regression were exploratory [14]. Statistical significance was set at $p < 0.05$.

Results

Study selection. The search identified 1,113 records. After 487 duplicates were removed, 626 records were screened and 616 were excluded. Nine reports were sought for full text, 1 could not be retrieved, and 8 studies were assessed for eligibility and included

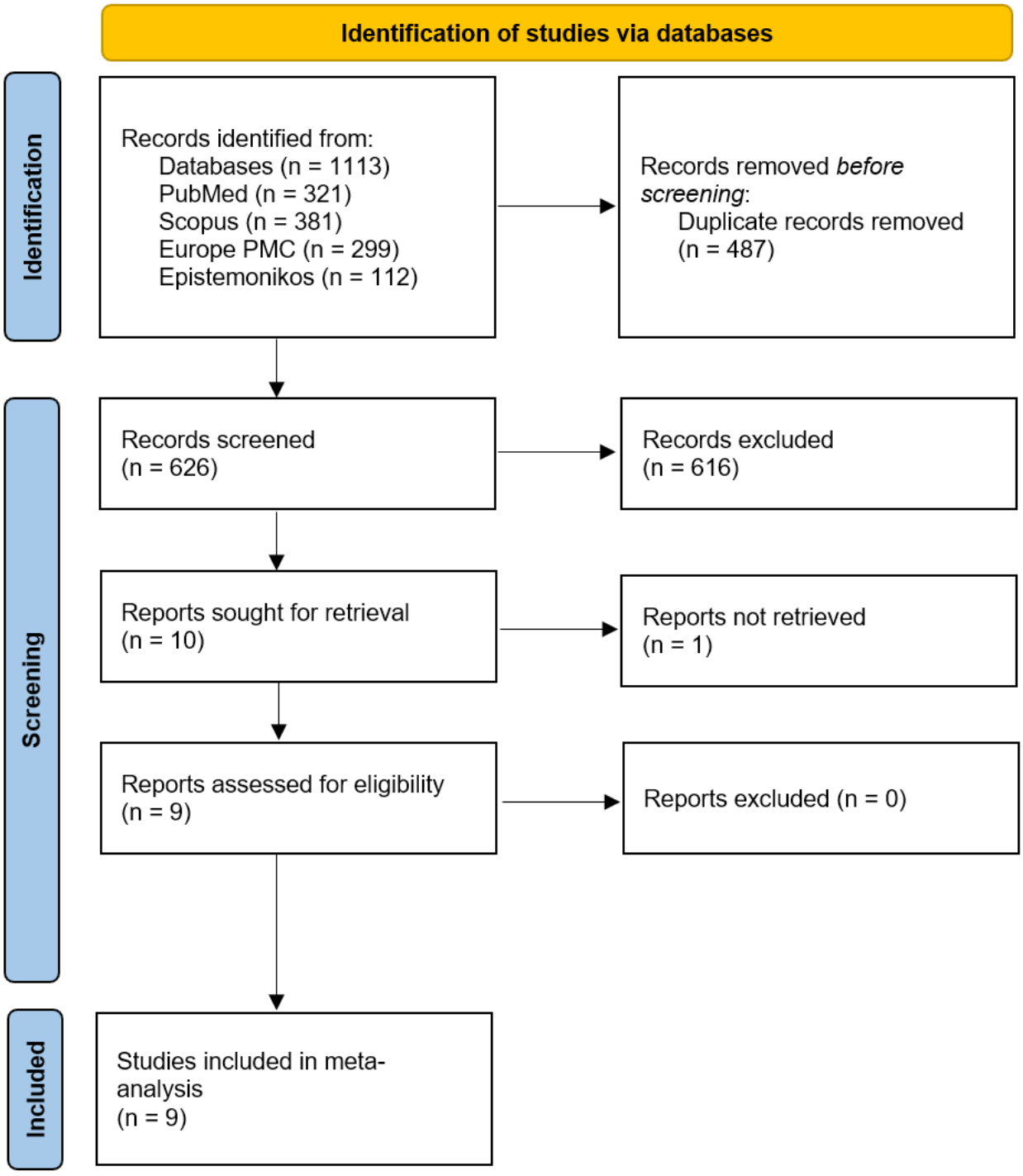

Figure 1. Preferred Reporting Items for Systematic Reviews and Meta-Analyses 2020 flow diagram of study selection

in the final meta-analysis (Fig. 1) [4, 9, 15 – 20].

Study characteristics. The 8 included studies were published from 2005 to 2026 and comprised 878 patients with BEEC (315 CPRE, 563 MSRE) (Table 1). Seven studies were retrospective and 1 was prospective. Studies were conducted in North America, Europe, and Asia. Age at initial surgery ranged from neonatal repair to a median of 17 months, and follow-up ranged from about 1 year to 18 years where reported. Techniques included Mitchell, Mitchell-Bagli, delayed primary, and single-stage Erlangen CPRE variants compared with staged closure, epispadias repair, and later bladder neck reconstruction. Osteotomy use varied widely across centers.

Risk of bias in included studies. Seven studies were classified as good quality and 1 as

Table 1. Characteristics of included studies

Study	Country	Design	N (CPRE / MSRE)	Male % (CPRE / MSRE)	Age at Initial Surgery (CPRE / MSRE)	Follow-up Duration (CPRE / MSRE)	Core Surgical Strategy (CPRE vs. MSRE)	Osteotomy % (CPRE / MSRE)
O. Alsowayan et al., 2016 [15]	Canada	Retro Cohort	10 / 6	40% / 50%	≤ 2 days / ≤ 2 days	Mn 18 yrs (Combined)	CPRE: NR MSRE: Closure (neonatal) → Epispadias (1.5–2y) → BNR (by 5y)	30% / 67%
J.G. Borer et al., 2005 [5]	USA	Retro Cohort	23 / 14	70% / 57%	≤ 3 days / NR	Mn 2.2 yrs / Mn 4.1 yrs	CPRE: Mitchell technique MSRE: BNR via modified Young-Dees-Leadbetter	NR
A. Bueno-Jiménez et al., 2020 [20]	Spain	Retro Cohort	6 / 13	100% / 100%	Med 56 days / 1 day	Mn 1 yr / Mn 9 yrs	CPRE: Delayed primary closure w/ epispadias repair MSRE: 3-stage (Neonatal closure → Epispadias → BNR)	0% / 15%
M.E. Chua et al., 2018 [17]	Canada	Retro Cohort	10 / 11	100% / 100%	Med 4.5 days / 2 days	Med 9.7 yrs / Med 4.0 yrs	CPRE: Mitchell-Bagli w/ complete disassembly & reimplant MSRE: Closure w/ BNR tailoring → Deferred epispadias	100% / 100%
A.K. Ebert et al., 2020 [18]	Germany	Prosp Cohort	64 / 83	67% (Overall)	Mn 0.5 yrs / 0.7 yrs	Med 8 yrs / Med 10 yrsa	CPRE: Single-stage (Erlangen) MSRE: Postnatal closure → Delayed BNR (Med age 6)	6% / 7%
B.M. Inouye et al., 2018 [9]	USA	Retro Cohort	159 / 406	70% (Overall)	Early (≤ 30d) vs. Delayed (> 30d)	NR	CPRE: NR MSRE: NR	39% (Overall)
A.A. Khawaja et al., 2012 [19]	Pakistan	Retro Cohort	8 / 10	38% / 100%	Mn 4 mos / Mn 6 mos	Up to 2 yrs	CPRE: 1-stage w / penile disassembly & urethroplasty MSRE: Closure & early BNR → Deferred penile disassembly	100% / 100%
K.J. Rathod et al., 2026 [20]	India	Retro Cohort	35 / 20	66% / 60%	Mn 17 mos / Mn 13 mos	NR	CPRE: Bladder/epispadias closure + early BNR MSRE: Closure → Delayed BNR (often requiring diversions)	29% / 5%

Note. CPRE — Complete Primary Repair of Exstrophy; MSRE — Modern Staged Repair of Exstrophy; Retro — retrospective; Prosp — prospective; Mn — mean; Med — median; NR — not reported; BNR — bladder neck reconstruction. Follow-up durations for Ebert 2020 represent the specific continence subgroup evaluated

Table 2. Newcastle-Ottawa Scale risk of bias assessment of included studies

Study	Selection	Comparability	Outcome	Quality	AHRQ Classification
O. Alsowayan et al., 2016 [15]	4	1	3	8	Good quality
J.G. Borer et al., 2005 [5]	4	2	3	9	Good quality
A. Bueno-Jiménez et al., 2020 [20]	4	1	3	8	Good quality
M.E. Chua et al., 2018 [17]	4	1	3	8	Good quality
A.K. Ebert et al., 2020 [18]	4	1	2	7	Good quality
B.M. Inouye et al., 2018 [9]	3	2	3	8	Good quality
A.A. Khawaja et al., 2012 [19]	3	0	3	6	Poor quality
K.J. Rathod et al., 2026 [20]	4	2	3	9	Good quality

Note. AHRQ — Agency for Healthcare Research and Quality

poor quality (Table 2). Selection and outcome domains were generally strong, with mean scores of 3.75 / 4 and 2.88 / 3, respectively. Comparability was the most frequent limitation: 3 studies used multivariable adjustment for key confounders [4, 9, 20], whereas others lacked formal adjustment. The study by A.A. Khawaja et al. (2012) was rated poor because of a comparability score of 0, reflecting gender imbalance without adjustment [19].

Meta-analysis results. *Functional and continence outcomes.* Overall continence did not differ significantly between CPRE and MSRE (RR 0.98, 95% CI 0.52 to 1.84, p = 0.95) (Fig. 2), with mod-

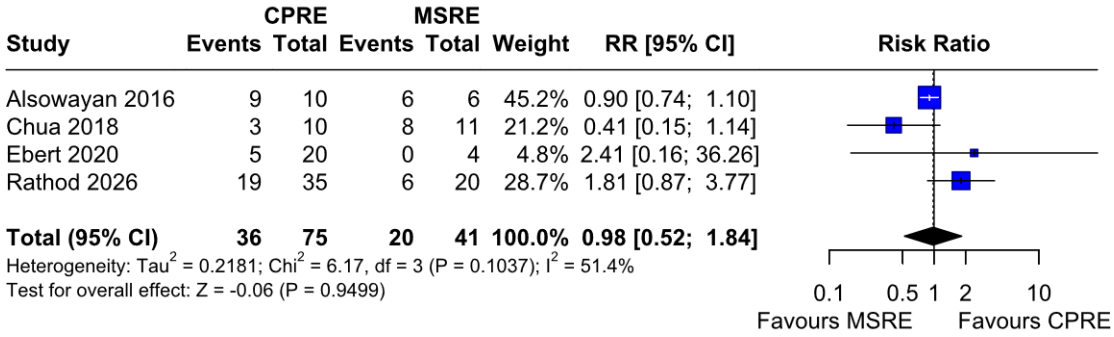

Figure 2. Forest plot of pooled risk ratios for overall continence (CPRE — Complete Primary Repair of Exstrophy; MSRE — Modern Staged Repair of Exstrophy; RR — risk ratio; CI — confidence interval)

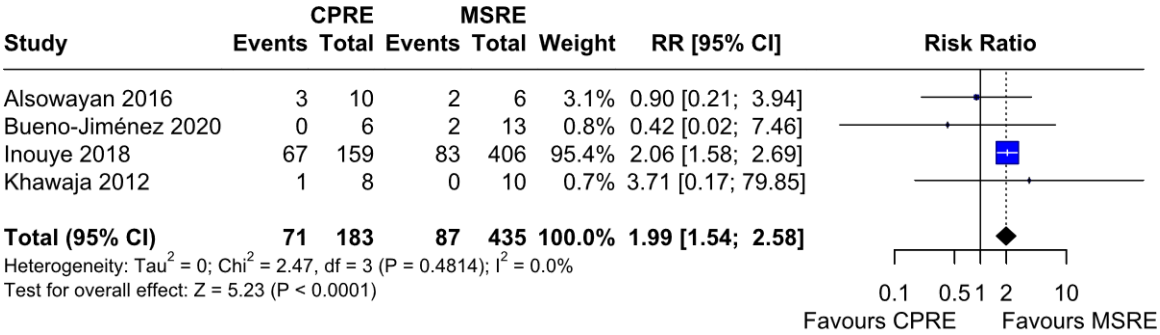

Figure 3. Forest plot of pooled risk ratios for redo bladder closure (CPRE — Complete Primary Repair of Exstrophy; MSRE — Modern Staged Repair of Exstrophy; RR — risk ratio; CI — confidence interval)

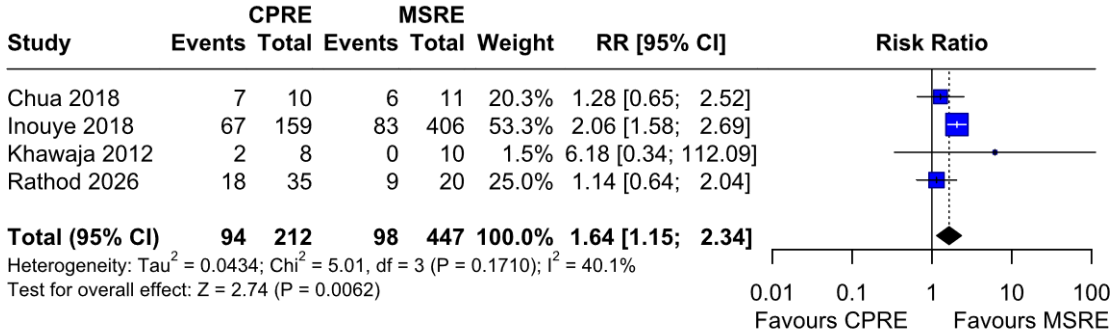

Figure 4. Forest plot of pooled risk ratios for overall reoperation (CPRE — Complete Primary Repair of Exstrophy; MSRE — Modern Staged Repair of Exstrophy; RR — risk ratio; CI — confidence interval)

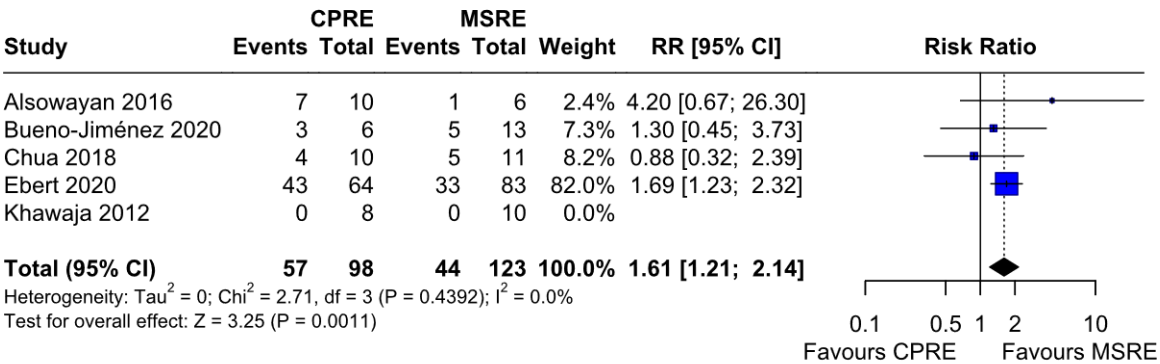

Figure 5. Forest plot of pooled risk ratios for febrile urinary tract infection (CPRE — Complete Primary Repair of Exstrophy; MSRE — Modern Staged Repair of Exstrophy; RR — risk ratio; CI — confidence interval)

Table 3. Pooled meta-analysis results comparing complete primary repair of exstrophy versus modern staged repair of exstrophy

Outcome Domain	Outcome	Studies (n)	Patients (Total)	RR (95% CI)	p-value	I^2 (%)	Significance
Functional and Continence	Overall continence	4	116 (75 / 41)	0.98 (0.52 – 1.84)	0.95	51.4%	Non-significant
Functional and Continence	Spontaneous voiding w/o CIC	3	58 (38 / 20)	0.94 (0.55 – 1.62)	0.82	0.0%	Non-significant
Functional and Continence	Dry interval > 2 – 3 hours	2	34 (18 / 16)	0.91 (0.76 – 1.10)	0.35	0.0%	Non-significant
Functional and Continence	Need for bladder neck reconstruction	3	184 (98 / 86)	0.77 (0.53 – 1.10)	0.15	0.0%	Non-significant
Surgical Complications & Reoperations	Bladder dehiscence	4	108 (59 / 49)	0.50 (0.14 – 1.76)	0.28	40.8%	Non-significant
Surgical Complications & Reoperations	Urethrocutaneous fistula	4	168 (81 / 87)	1.22 (0.65 – 2.30)	0.54	0.0%	Non-significant
Surgical Complications & Reoperations	Urethral stricture	2	39 (18 / 21)	2.40 (0.34 – 16.89)	0.38	0.0%	Non-significant
Surgical Complications & Reoperations	Redo bladder closure	4	618 (183 / 435)	1.99 (1.54 – 2.58)	< 0.0001	0.0%	Significant (Higher in CPRE)
Surgical Complications & Reoperations	Overall reoperation rate	4	659 (212 / 447)	1.64 (1.15 – 2.34)	0.006	40.1%	Significant (Higher in CPRE)
Renal and Urologic Complications	Febrile urinary tract infection	4	221 (98 / 123)	1.61 (1.21 – 2.14)	0.001	0.0%	Significant (Higher in CPRE)
Renal and Urologic Complications	Vesicoureteral reflux (VUR)	3	94 (53 / 41)	0.99 (0.80 – 1.22)	0.90	0.0%	Non-significant
Renal and Urologic Complications	New or worsening hydronephrosis	5	257 (124 / 133)	1.22 (0.36 – 4.16)	0.75	39.1%	Non-significant
Renal and Urologic Complications	Renal function and scarring	2	163 (74 / 89)	1.25 (0.30 – 5.26)	0.76	32.1%	Non-significant

Note. Total pooled patients across all studies in the meta-analysis is 878 (315 CPRE, 563 MSRE). Patient numbers for individual outcomes are formatted as total (CPRE / MSRE)

erate heterogeneity (I^2 = 51.4%). Spontaneous voiding without CIC (RR 0.94, 95% CI 0.55 to 1.62, p = 0.82), dry interval > 2 to 3 hours (RR 0.91, 95% CI 0.76 to 1.10, p = 0.35), and subsequent bladder neck reconstruction (RR 0.77, 95% CI 0.53 to 1.10, p = 0.15) were also comparable.

Surgical complications and reoperations. Bladder dehiscence did not differ significantly between approaches (RR 0.50, 95% CI 0.14 to 1.76, p = 0.28). No significant differences were found for urethrocutaneous fistula (RR 1.22, 95% CI 0.65 to 2.30, p = 0.54) or urethral stricture (RR 2.40, 95% CI 0.34 to 16.89, p = 0.38). CPRE was associated with higher redo bladder closure (RR 1.99, 95% CI 1.54 to 2.58, p < 0.0001) (Fig. 3) and overall reoperation (RR 1.64, 95% CI 1.15 to 2.34, p = 0.006; Fig. 4).

Renal and urologic complications. CPRE was associated with a higher incidence of febrile UTI (RR 1.61, 95% CI 1.21 to 2.14, p = 0.001; Fig. 5). VUR (RR 0.99, 95% CI 0.80 to 1.22, p = 0.90), new or worsening hydronephrosis (RR 1.22, 95% CI 0.36 to 4.16, p = 0.75), and renal function or scarring outcomes (RR 1.25, 95% CI 0.30 to 5.26, p = 0.76) were not significantly different between groups.

Sensitivity analyses. Leave-one-out analyses showed that overall continence remained non-significant regardless of which study was omitted, although heterogeneity varied. The higher redo-closure risk with CPRE depended on the B.M. Inouye et al. (2018) cohort; after excluding this study, the pooled estimate became non-significant (RR 0.98, 95% CI 0.29 to 3.28, p = 0.97). Hydronephrosis remained non-significant across all iterations, with persistent between-study variability [9].

Publication bias. Egger's regression was exploratory because few studies contributed to most outcomes. No statistically significant funnel-plot asymmetry was detected for outcomes with at least 3 contributing studies, including overall continence, redo bladder closure, overall reoperation, febrile UTI, VUR, and hydronephrosis. Outcomes with only 2 studies could not be assessed; therefore, publication bias cannot be excluded.

Discussion

This meta-analysis of 8 comparative studies involving 878 children found no significant differences between CPRE and MSRE for continence, spontaneous voiding, dry interval,

or subsequent bladder neck reconstruction. CPRE was associated with higher redo bladder closure, overall reoperation, and febrile UTI, whereas upper urinary tract outcomes were not significantly different. These findings reflect the central trade-off between the techniques: CPRE may reduce planned stages but may increase early infectious and closure-related morbidity, while MSRE distributes operative risk across planned stages.

The continence findings are consistent with previous literature. Continence rates after CPRE vary widely, and secondary interventions remain common even after successful initial closure [10]. Multi-Institutional Bladder Exstrophy Consortium data indicate that only 16.7% of patients achieved spontaneous voiding continence after single CPRE, with 40% achieving dry intervals greater than 1 hour at intermediate follow-up [7]. Institutional selection and referral patterns may partly explain differences observed in the cohorts reported by B.M. Inouye et al. (2018), A.K. Ebert et al. (2020), and K.J. Rathod et al. (2026) [9, 18, 20].

The higher febrile UTI risk with CPRE was the most consistent adverse association. Concomitant bladder neck reconstruction may produce early outlet resistance in a system where VUR is common after exstrophy closure [21, 22]. This combination may promote ascending infection. In contrast, MSRE delays bladder neck reconstruction, maintaining a lower-pressure system during early childhood. Recent collaborative data suggest that concomitant bilateral ureteric reimplantation during CPRE may reduce postoperative VUR and pyelonephritis, but this strategy requires further evaluation [22].

Despite the UTI signal, pooled renal outcomes did not show significant differences. This should be interpreted cautiously because renal surveillance differed across studies, including ultrasound, serum creatinine, annual diethylenetriamine pentaacetic acid scanning, and dimercaptosuccinic acid radionuclide imaging. Such heterogeneity may underestimate subtle renal impairment. Longer standardized follow-up is needed before concluding that upper tract risk is equivalent between approaches.

Mechanical closure failure also requires caution. The redo-closure result was strongly influenced by the B.M. Inouye et al. (2018) referral-center cohort; removing that study eliminated statistical significance [9]. Referral centers may receive a disproportionate number of closure failures from outside institutions, inflating risk estimates. Nevertheless, the potential mechanical stress of one-stage reconstruction remains clinically plausible and should be considered alongside center experience and patient anatomy.

Variation in osteotomy use further complicates comparison. Rates ranged from 0% to 100% among included studies, reflecting institutional practice rather than standardized criteria. Osteotomy may facilitate tension-free closure and reduce dehiscence risk, especially when closure is delayed beyond 72 hours [23, 24]. However, the model by K.J. Rathod et al. (2026) suggested no significant effect on continence after adjustment [20]. M.E. Chua et al. (2019) also emphasized that aggressive pubic approximation during CPRE can contribute to pelvic compartment syndrome and penile ischemia [17].

Several limitations should be acknowledged. Outcome-specific sample sizes were often small, ranging from 34 to 659 patients, and confidence intervals were wide for rare events. All included studies were observational and vulnerable to selection bias, reporting bias, and confounding by anatomy, surgeon preference, surgical era, center volume, immobilization, and osteotomy use. Definitions of continence also varied, limiting direct comparison. Formal tests did not detect publication bias, but the small number of studies per outcome substantially limits confidence in those tests.

In practice, neither approach can be recommended universally. CPRE may be appropriate in expert centers seeking to reduce scheduled stages and promote early bladder cycling, but the risks of closure failure and febrile UTI must be weighed carefully. MSRE may offer more reliable initial closure at the cost of planned staged operations. Prospective multicenter registries with standardized definitions, long-term follow-up, quality-of-life outcomes, cost-effectiveness data, and reproductive outcomes are needed.

Conclusion

This meta-analysis found no significant differences between CPRE and MSRE in continence, spontaneous voiding, dry interval, or subsequent bladder neck reconstruction. CPRE was associated with higher redo bladder closure, overall reoperation, and febrile UTI,

while upper urinary tract outcomes were not significantly different. Because the evidence is observational and several analyses are underpowered, treatment should be individualized according to anatomy, family priorities, institutional expertise, and surgeon experience.

Keypoints

1. Continence and spontaneous voiding outcomes were not significantly different between complete primary and staged repair.

2. Complete primary repair was associated with higher redo bladder closure, overall reoperation, and febrile urinary tract infection.

3. Upper urinary tract outcomes were comparable, but renal assessment methods were heterogeneous.

4. Prospective multicenter data with standardized continence and renal definitions are needed.

References | Список литературы

1. Ebert A.K., Zwink N., Reutter H.M., Jenetzky E.A. Prevalence Estimation of Exstrophy and Epispadias in Germany From Public Health Insurance Data. Front Pediatr. 2021;9:648414. DOI: 10.3389/fped.2021.648414
2. Nelson C.P., Dunn R.L., Wei J.T. Contemporary epidemiology of bladder exstrophy in the United States. J Urol. 2005;173(5):1728-1731. DOI: 10.1097/01.ju.0000154821.21521.9b
3. Reiner W.G., Gearhart J.P.. Anxiety disorders in children with epispadias-exstrophy. Urology. 2006;68(1):172-174. DOI: 10.1016/j.urology.2006.01.056
4. Borer J.G., Gargollo P.C., Kinnamon D.D., Bauer S.B., Khoshbin S., Hendren W.H., Peters C.A., Diamond D.A., Atala A., Chin S., Retik A.B. Bladder growth and development after complete primary repair of bladder exstrophy in the newborn with comparison to staged approach. J Urol. 2005;174(4 Pt 2):1553-1557; discussion 1557-1558. DOI: 10.1097/01.ju.0000176636.85476.5d
5. Mitchell M.E., Bagli D.J. Complete Penile Disassembly for Epispadias Repair: The Mitchell Technique. The Journal of Urology. 1996;155(1):300-304. DOI: 10.1016/S0022-5347(01)66649-7
6. Grady R.W., Mitchell M.E. Complete primary repair of exstrophy. The Journal of Urology. 1999;162(4):1415-1420. DOI: 10.1016/S0022-5347(05)68327-9
7. Weiss D.A., Groth T.W., Abdulfattah S.A., Eftekharzadeh S., Lee T., Lee R., Canning D.A., Kryger J.V., Shukla A.R., Roth E.B., Mitchell M.E., Borer J.G. Multi-Institutional Bladder Exstrophy Consortium After 8 Years: The Short- and Intermediate-Term Outcomes. J Urol. 2024;212(1):177-184. DOI: 10.1097/JU.0000000000003971
8. Baird A.D., Nelson C.P., Gearhart J.P. Modern staged repair of bladder exstrophy: a contemporary series. J Pediatr Urol. 2007;3(4):311-315. DOI: 10.1016/j.jpurol.2006.09.009
9. Inouye B.M., Purves J.T., Routh J.C., Maruf M., Friedlander D., Jayman J., Gearhart J.P. How to close classic bladder exstrophy: Are subspecialty training and technique important? J Pediatr Urol. 2018;14(5):426.e1-426.e6. DOI: 10.1016/j.jpurol.2018.02.025
10. Pathak P., Ring J.D., Delfino K.R., Dynda D.I., Mathews R.I. Complete primary repair of bladder exstrophy: a systematic review. J Pediatr Urol. 2020;16(2):149-153. DOI: 10.1016/j.jpurol.2020.01.004
11. Page M.J., McKenzie J.E., Bossuyt P.M., Boutron I., Hoffmann T.C., Mulrow C.D., Shamseer L., Tetzlaff J.M., Akl E.A., Brennan S.E., Chou R., Glanville J., Grimshaw J.M., Hróbjartsson A., Lalu M.M., Li T., Loder E.W., Mayo-Wilson E., McDonald S., McGuinness L.A., Stewart L.A., Thomas J., Tricco A.C., Welch V.A., Whiting P., Moher D. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ. 2021;372:n71. DOI: 10.1136/bmj.n71
12. Page M.J., Moher D., Bossuyt P.M., Boutron I., Hoffmann T.C., Mulrow C.D., Shamseer L., Tetzlaff J.M., Akl E.A., Brennan S.E., Chou R., Glanville J., Grimshaw J.M., Hróbjartsson A., Lalu M.M., Li T., Loder E.W., Mayo-Wilson E., McDonald S., McGuinness L.A., Stewart L.A., Thomas J., Tricco A.C., Welch V.A., Whiting P., McKenzie JE. PRISMA 2020 explanation and elaboration: updated guidance and exemplars for reporting systematic reviews. BMJ. 2021;372:n160. DOI: 10.1136/bmj.n160
13. Wells G., Shea B., O'Connell D., Peterson J., Welch V., Losos M., Tugwell P. The Newcastle-Ottawa Scale (NOS) for assessing the quality of nonrandomized studies in meta-analyses. Ottawa Hospital Research Institute; 2011. Accessed on April 17, 2025. URL: https://ohri.ca/en/who-we-are/core-facilities-and-platforms/ottawa-methods-centre/newcastle-ottawa-scale
14. Egger M., Davey Smith G., Schneider M., Minder C. Bias in meta-analysis detected by a simple, graphical test. BMJ. 1997;315(7109):629-634. DOI: 10.1136/bmj.315.7109.629
15. Alsowayan O., Capolicchio J.P., Jednak R., El-Sherbiny M. Long-term functional outcomes after bladder exstrophy repair: A single, low-volume centre experience. Can Urol Assoc J. 2016;10(3-4):E94-8. DOI: 10.5489/cuaj.3104
16. Bueno-Jiménez A., Serradilla J., Nava B., Rivas S., Lobato R., Amesty V., López-Pereira P., Castillo S., Martínez-Urrutia MJ. Preliminary results of complete delayed primary bladder exstrophy reconstruction in male patients. Cir Pediatr. 2020;33(2):75-78. (In English, Spanish). PMID: 32250070
17. Chua M.E., Ming J.M., Fernandez N., Varghese A., Farhat W.A., Bagli D.J., Lorenzo A.J., Pippi Salle JL. Modified staged repair of bladder exstrophy: a strategy to prevent penile ischemia while maintaining advantage of the complete primary repair of bladder exstrophy. J Pediatr Urol. 2019;15(1):63.e1-63.e7. DOI: 10.1016/j.jpurol.2018.09.005
18. Ebert A.K., Zwink N., Reutter H.M., Jenetzky E., Stein R., Hölscher A.C., Lacher M., Fortmann C., Obermayr F., Fisch M., Mortazawi K., Schmiedeke E., Promm M., Hirsch K., Schäfer F.M., Rösch WH. Treatment Strategies and Outcome of the Exstrophy-Epispadias Complex in Germany: Data From the German CURE-Net. Front Pediatr. 2020;8:174. DOI: 10.3389/fped.2020.00174
19. Khawaja A.A., Aslam M., Imran M. Single Stage Primary Closure of Bladder Exostrophy VS Two Stage Closure: Experience of 18 Patients. Medical Forum Monthly. 2012;23(3):70-74. Accessed on April 17, 2025. URL: https://www.researchgate.net/publication/287945582_Single_stage_primary_closure_of_bladder_exostrophy_vs_two_stage_closure_Experience_of_18_patients
20. Rathod K.J., Agrawal V., Babu R., Acharya H., Chandrashekhar V., Rao S., Kurbet S.B., Patil M.V., Rahul S.K., Keshri R., Bendre P.S., Sharma S., Babu N., Nayak S., Biswas SK. Long-term Outcomes of Bladder Exstrophy-Epispadias Complex: A Multicenter Study by Indian Association of

Pediatric Surgeons. J Indian Assoc Pediatr Surg. 2026;31(2):230-238. DOI: 10.4103/jiaps.jiaps_339_25

21. Borer J.G., Vasquez E., Canning D.A., Kryger J.V., Bellows A., Weiss D., Groth T., Shukla A., Kurtz M.P., Mitchell ME. Short-term outcomes of the multi-institutional bladder exstrophy consortium: Successes and complications in the first two years of collaboration. J Pediatr Urol. 2017;13(3):275.e1-275.e6. DOI: 10.1016/j.jpurol.2017.01.006
22. Weiss D.A., Shukla A.R., Borer J.G., Sack B.S., Kryger J.V., Roth E.B., Groth T.W., Frazier J.R., Mitchell M.E., Canning DA. Evaluation of outcomes following complete primary repair of bladder exstrophy at three individual sites prior to the establishment of a multi-institutional collaborative model. J Pediatr Urol. 2020;16(4):435.e1-435.e6. DOI: 10.1016/j.jpurol.2020.05.153
23. Wild A.T., Sponseller P.D., Stec A.A., Gearhart JP. The role of osteotomy in surgical repair of bladder exstrophy. Semin Pediatr Surg. 2011;20(2):71-78. DOI: 10.1053/j.sempedsurg.2010.12.002
24. Inouye B.M., Lue K., Abdelwahab M., Di Carlo H.N., Young E.E., Tourchi A., Grewal M., Hesh C., Sponseller P.D., Gearhart JP. Newborn exstrophy closure without osteotomy: Is there a role? J Pediatr Urol. 2016;12(1):51.e1-4. DOI: 10.1016/j.jpurol.2015.07.010

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