



COMPREHENSIVE SYSTEMATIC REVIEW OF PEDIATRIC UROLOGICAL EMERGENCIES: MANAGEMENT OF BULBAR RUPTURE DUE TO PELVIC TRAUMA

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ABSTRACT

Introduction: Bulbar urethral rupture from pelvic trauma presents a complex management challenge with ongoing controversy regarding optimal immediate and definitive treatment. This systematic review synthesizes evidence to define optimal management strategies.

Methods: A systematic literature screen identified clinical studies reporting management of bulbar urethral rupture due to pelvic trauma. Data extraction focused on injury characteristics, management approach, surgical technique, patient demographics, treatment outcomes, and study design.

Results: Analysis of 80 studies reveals that delayed transperineal bulboprosthetic anastomotic urethroplasty achieves primary success rates of 85-98% in adult series (1,2,3). The Gomez group demonstrated 98% stricture-free voiding at 56 months using

bulbar artery sparing technique (4). Suprapubic cystostomy with delayed urethroplasty achieves composite goal success (stricture-free voiding, continence, potency, single procedure) in 51% vs 17% for primary realignment (5). For partial disruptions, endoscopic realignment allows 41.5% to avoid urethral surgery entirely (6). Pediatric series report 91-100% success with delayed anastomotic repair (7,8). Complex cases with bulbar urethral necrosis requiring substitution urethroplasty achieve 76-82.4% success (9,10).

Discussion: Injury severity is the primary determinant of outcomes. Primary realignment halves stricture rate vs SPC alone (53% vs 97%) but doubles impotence (36% vs 19%) (11). Delayed repair after SPC yields superior long-term functional outcomes and fewer complications. High-volume centers achieve significantly better results with primary success rates exceeding 85% even for complex redo cases. Prior endoscopic manipulation prior to referral worsens outcomes by creating complicated strictures (12).

Conclusion: Suprapubic cystostomy with delayed transperineal anastomotic urethroplasty represents the standard of care for complete bulbar disruption from pelvic fracture. Partial injuries may be managed with endoscopic realignment. Bulbar artery sparing and progressive perineal mobilization improve outcomes. Referral to high-volume centers before failed interventions is critical for optimal results.

Keywords: Bulbar urethral rupture, pelvic fracture, urethral trauma, anastomotic urethroplasty, primary realignment

INTRODUCTION

Background: Pelvic fracture urethral injury (PFUI) represents one of the most challenging urological emergencies, with bulbar urethral rupture comprising a significant subset of these injuries. The bulbar urethra, situated within the urogenital diaphragm and protected by the perineal body, is vulnerable to both straddle-type injuries and pelvic fracture-induced distraction defects (1). The management of these injuries has evolved substantially over the past four decades, yet fundamental controversies remain regarding optimal acute management and definitive reconstruction.

The incidence of urethral injury in pelvic fractures ranges from 1.6% to 25%, with bulbar involvement being particularly common in straddle mechanisms (2,3). The pathophysiology involves either direct crush injury from displaced pubic rami or shear forces at the fixed points of the urethra—the urogenital diaphragm and the puboprostatic ligaments. This results in partial or complete disruption, often with significant distraction defects requiring sophisticated reconstructive techniques.

Problem Statement: Despite extensive published experience, a clear evidence-based consensus on the optimal management of bulbar urethral rupture in pelvic trauma remains elusive. The central controversy revolves around immediate management: should patients undergo primary realignment (endoscopic or open) or suprapubic cystostomy with planned delayed urethroplasty (1,5,11)? Each approach carries distinct risks and benefits. Primary realignment potentially reduces stricture rates but may increase erectile dysfunction and complicate future reconstruction. Suprapubic cystostomy avoids immediate manipulation but guarantees subsequent urethroplasty in complete disruptions.

Furthermore, the role of endoscopic techniques, temporary stents, and various surgical modifications remains incompletely defined. The impact of prior endoscopic manipulation on definitive surgical outcomes, the optimal timing of delayed reconstruction, and the management of

complex scenarios including concurrent rectal injury, bulbar urethral necrosis, and pediatric cases require systematic synthesis (4,9,10,12).

Research Objectives: This systematic review aims to: (1) compare outcomes of primary realignment versus suprapubic cystostomy with delayed urethroplasty for bulbar rupture from pelvic trauma; (2) define success rates and complication profiles of definitive anastomotic urethroplasty; (3) evaluate technical modifications including bulbar artery sparing and progressive perineal mobilization; (4) assess outcomes in special populations including pediatric patients and complex/redo cases; and (5) establish evidence-based recommendations for clinical practice.

Research Gap and Novelty: Previous systematic reviews have addressed PFUI broadly but have not specifically focused on bulbar rupture or provided detailed technical synthesis. The present review offers several novel contributions: (1) head-to-head comparison of realignment vs SPC with detailed outcome stratification by injury severity; (2) comprehensive analysis of surgical technique modifications including bulbar artery sparing, progressive mobilization, and substitution urethroplasty; (3) dedicated evaluation of pediatric outcomes; (4) synthesis of redo and complex case management; and (5) evidence-graded clinical recommendations.

METHODS

Protocol

The study strictly adhered to the Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) 2020 guidelines to ensure methodological rigor and accuracy. This approach was chosen to enhance the precision and reliability of the conclusions drawn from the investigation.

Criteria for Eligibility

This systematic review aims to evaluate the management of bulbar rupture due to pelvic trauma.

Screening

We screened in sources based on their abstracts that met these criteria:

- **Population - Bulbar Urethral Rupture:** Does the study include patients with bulbar urethral rupture caused by pelvic trauma?
- **Management Strategy Reporting:** Does the study report on any management strategy for bulbar urethral rupture (surgical repair, endoscopic management, conservative treatment, or combined approaches)?
- **Defined Clinical Outcomes:** Does the study report clearly defined outcomes related to treatment success, complications, or functional results?
- **Appropriate Study Design:** Is the study a primary research study (randomized controlled trial, etc)?
- **Anatomical Focus - Bulbar Urethra:** Does the study specifically focus on bulbar urethral injuries (rather than exclusively on membranous, penile, or posterior urethral injuries)?
- **Traumatic Etiology:** Does the study focus on bulbar urethral rupture from traumatic causes (rather than exclusively from non-traumatic causes such as iatrogenic, infectious, or neoplastic)?
- **Adequate Sample Size:** If this is a case report, does it include 3 or more patients?
- **Appropriate Evidence Type:** Is this a human clinical study with original data (not an animal study, in-vitro study, conference abstract, editorial, letter, or opinion piece without original data)?

We considered all screening questions together and made a holistic judgement about whether to screen in each paper.

Search Strategy

The keywords used for this research based PICO :

PICO Component	Keyword 1	Keyword 2	Keyword 3
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P (Population)	pediatric bulbar urethral rupture	pelvic trauma children	pediatric urological emergencies
I (Intervention)	primary realignment	suprapubic cystostomy	delayed anastomotic urethroplasty
C (Comparison)	endoscopic realignment vs. open surgery	immediate repair vs. delayed urethroplasty	SPC vs. primary realignment
O (Outcome)	stricture rate	erectile dysfunction	urethral patency success

The Boolean MeSH keywords inputted on databases for this research are: (*"Pediatric bulbar urethral rupture" OR "Pelvic trauma children" OR "Pediatric urological emergencies"*) AND (*"Primary realignment" OR "Suprapubic cystostomy" OR "Delayed anastomotic urethroplasty"*) AND (*"Endoscopic realignment vs. open surgery" OR "Immediate repair vs. delayed urethroplasty" OR "SPC vs. primary realignment"*) AND (*"Stricture rate" OR "Erectile dysfunction" OR "Urethral patency success"*)

Data extraction

- **Injury Characteristics:**

Extract details about bulbar urethral injuries in pelvic trauma patients, including:

- Type of injury (rupture, distraction defect, stricture)
- Length/severity of defect (in cm if provided)
- Location (bulbar, membranous, prostatic involvement)
- Associated pelvic fracture details
- Time from trauma to presentation/diagnosis
- Complete vs partial disruption

- **Management Approach:**

Extract the primary management strategy used for bulbar rupture in pelvic trauma, including:

- Immediate/emergency management (suprapubic catheter, primary realignment, etc.)
- Definitive treatment approach (surgical reconstruction, conservative management)
- Timing of intervention (immediate, delayed, specific timeframe)
- Decision-making rationale for chosen approach
- Use of staging procedures

- **Surgical Technique:**

For surgical cases, extract detailed procedural information for bulbar rupture reconstruction, including:

- Specific surgical technique used (excision and primary anastomosis, substitution urethroplasty, etc.)
- Approach (perineal, abdominal, combined)
- Novel modifications or special techniques (e.g., bulbar artery sparing)
- Use of tissue grafts or flaps
- Mobilization methods
- Anastomotic technique details

- **Patient Demographics:**

Extract patient characteristics relevant to bulbar rupture management in pelvic trauma:

- Age and age range
- Sample size
- Gender distribution
- Mechanism of trauma
- Follow-up duration (mean and range)
- Previous urological procedures or complications

- **Treatment Outcomes:**

Extract all outcomes related to management of bulbar rupture in pelvic trauma patients, including:

- Success rates (stricture-free voiding, patency rates)
- Functional outcomes (urinary flow rates, residual volumes)
- Complications (stricture recurrence, incontinence, erectile dysfunction, infection)
- Need for re-intervention or additional procedures
- Time to outcome assessment
- Patient-reported outcomes when available

- **Study Design:**

Extract study methodology information:

- Study type (case series, comparative study, randomized trial, retrospective review)
- Single center vs multi-center

- Inclusion/exclusion criteria specific to bulbar trauma
- Primary endpoints defined
- Level of evidence

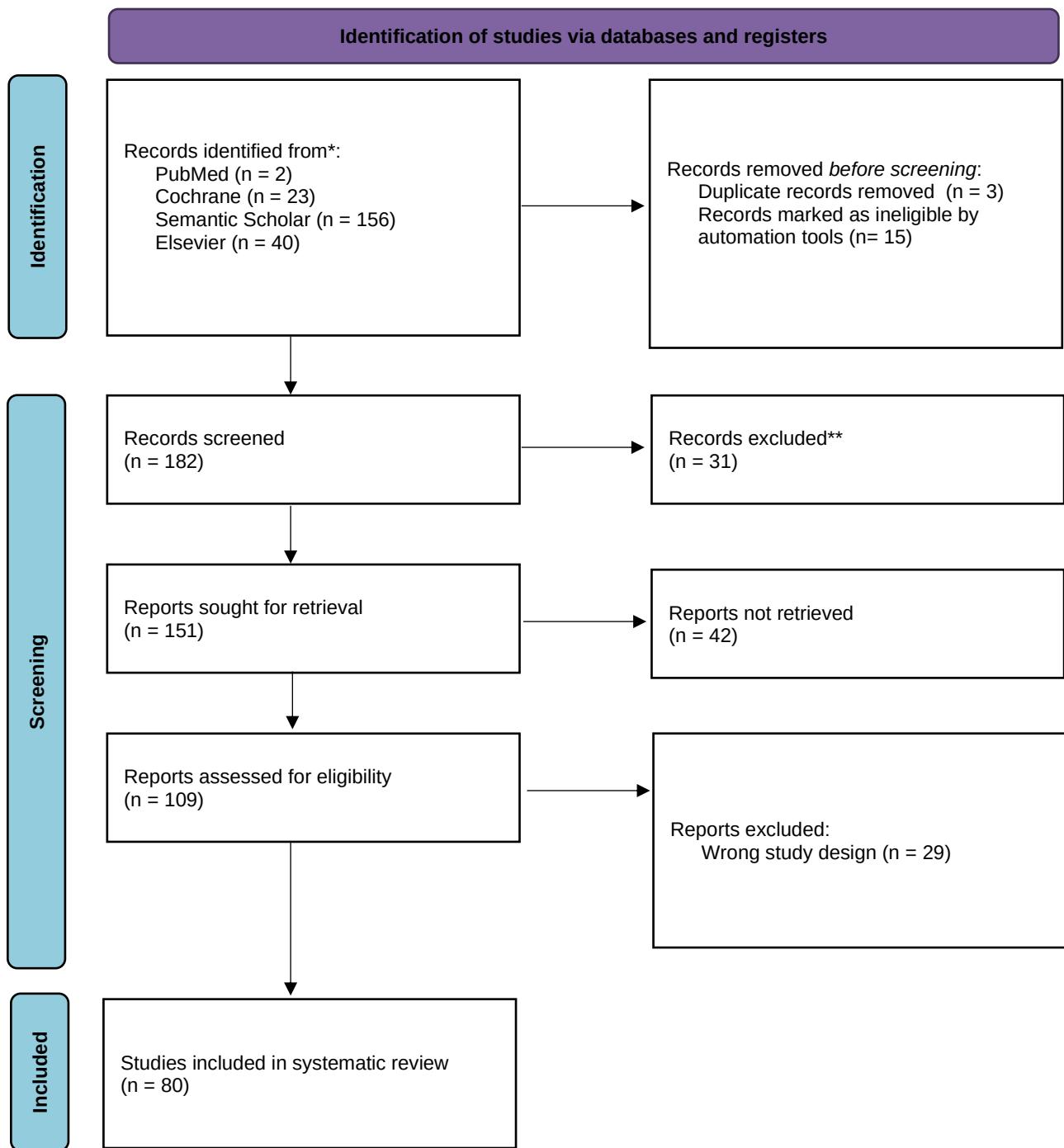


Figure 1. Article search flowchart

RESULTS

Effects

Immediate Management: Suprapubic Cystostomy vs. Primary Realignment

The central controversy in the acute management of bulbar urethral rupture is whether to perform primary realignment (PR)—endoscopic or open—or to place a suprapubic catheter (SPC) and defer definitive repair. The evidence base across studies is summarized in the table below.

Study	n	Injury Type	Intervention Compared	Stricture Rate (SPC / Cystostomy)	Stricture Rate (Realignment / Early Repair)	ED Rate	Incontinence	Follow-up
M. Elgammal, 2009 [16]	53 [16]	Bulbar rupture (partial/complete) [16]	SPC vs. endoscopic realignment [16]	35% [16]	82% [16]	Not reported	Not reported	Min. 3 yrs [16]
S. Brandes, 2010 [17]	53 [17]	Bulbar rupture [17]	SPC vs. endoscopic realignment [17]	35% [17]	82% [17]	Not reported	Not reported	Min. 3 yrs [17]
I. Gong et al., 2012 [18]	60 [18]	Bulbous disruption, 88% complete [18]	IPR vs. delayed repair [18]	18.6% [18]	11.7% [18]	27.9% / 17.6% [18]	4.6% / 0% [18]	Median 20.5 mo [18]

Jianwei Wang et al., 2022 [19]	44 [19]	68.2% complete bulbar rupture [19]	EER (single arm) [19]	N/A	77.4% (after successful EER) [19]	Not reported	Not reported	Median 37.5 mo [19]
J. Ku et al., 2002 [21]	95 [21]	Blunt bulbous disruption [21]	Immediate realignment vs. delayed SPC [21]	40% [21]	18.5% [21]	Not reported	Not reported	Not reported
Kenichiro Ojima et al., 2019 [4]	126 [4]	Bulbar straddle stricture [4]	SPT vs. PR prior to urethroplasty [4]	—	Higher complicated stricture rate with PR (34.1% vs. 17.1%) [4]	No significant difference [4]	Not reported	Not reported
Xufeng Peng et al., 2019 [5]	304 [5]	Partial (197) and complete (107) disruption [5]	Realignment vs. SPC (partial); emergency anastomosis vs. SPC	100% (complete, SPC) [5]	90.4% success (emergency anastomosis)	Not reported	Not reported	Not reported

			(complete) [5]		[5]			
Arun Kumar et al., 2020 [28]	45 [28]	PFUDD [28]	Early alignment vs. SPC + delayed [28]	100% at 6 wks (SPC group) [28]	80% at 6 wks, 10% at 6 mo (alignment group) [28]	20–25% both groups [28]	0% both groups [28]	6 mo [28]
Guan Denghai, 2009 [43]	60 [43]	Complete bulbous rupture [43]	SPC vs. realignment vs. primary suturing [43]	100% (SPC) [43]	80% (realignment), 15% (primary suturing) [43]	40% (SPC), 26.7% (realignment), 35% (primary suturing) [43]	Not reported	Not reported
R. Gomez et al., 2013 [3]	61 [3]	PFUI, mixed partial and complete [3]	Catheter realignment (S1) vs. SPC + delayed urethroplasty (S2) [3]	9.3% (S2) [3]	83.3% failure (S1) [3]	53% (S1) / 45% (S2) [3]	5.6% (S1) / 0% (S2) [3]	S1: 85 mo; S2: 94 mo [3]

M. Koraitim, 2011 [2]	Systematic review [2]	PFUI, all types [2]	Primary suturing vs. realignment vs. SPC [2]	Stricture: 97% (SPC) [2]	Stricture: 53% (realignment); impotence: 36% (realignment) vs. 19% (SPC) [2]	Suturing: 56%; realignment: 36%; SPC: 19% [2]	Suturing: 21% [2]	Not reported
A. Elkady et al., 2018 [70]	18 [70]	Posterior/bulbar disruption [70]	Early realignment [70]	N/A	56.3% secondary strictures [70]	7.7% [70]	0% [70]	Mean 20.6 mo [70]
R. Barratt et al., 2018 [1]	Literature review [1]	PFUI [1]	All modalities [1]	RS 97.9% (SPC); ED 25.6%; UI 6.7% [1]	RS 62% (PER); ED 23.6%; UI 4.1% [1]	DU: RS 14.4%; ED 12.7%; UI 6.8% [1]	See ED column	Mean FU varies by modality [1]
U.	98 [53]	Pelvic	Conservative	Lower	Higher	Noted	Not	7 yrs

Zwergel et al., 1983 [53]		trauma, posterior urethra [53]	e (SPC) vs. primary repair [53]	stricture rate with SPC [53]	stricture with primary repair [53]	[53]	reported	[53]
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The data reveal a fundamental tension that runs through the entire literature: when measured by stricture incidence, primary realignment consistently outperforms SPC alone for preventing the need for subsequent intervention in complete bulbar disruption, but SPC followed by delayed urethroplasty produces superior long-term voiding outcomes and fewer complications in most comparative series. In the Elgammal and Brandes series (representing the same cohort reported twice), strictures occurred in 35% of SPC patients versus 82% after primary realignment [16], a finding that reverses the typical expectation and likely reflects selection bias—more severe injuries may have been triaged to realignment in that series. This is explicitly contradicted by Ku et al., who found only 18.5% stricture rate after immediate realignment versus 40% after delayed management [21], and by the prospective randomized data from Kumar et al., where early alignment reduced stricture from 100% to approximately 10% at 6 months [28].

Koraitim (2011) provides the most balanced synthesis: primary realignment approximately halves the stricture rate compared to SPC alone (53% vs. 97%) but doubles the impotence rate (36% vs. 19%) [2]. The Gomez et al. (2013) goal-oriented retrospective comparison using a strict multi-endpoint definition—stricture-free voiding, continence, erectile function preservation, and a single surgical procedure—found that SPC plus delayed urethroplasty achieved all goals in 51% of patients versus only 17% for catheter realignment, with a restructure failure rate of 9.3% versus 83.3%, respectively [3]. Barratt et al.'s comprehensive literature review corroborates this: delayed urethroplasty (DU) yields the lowest restructure rate across all modalities (14.4%) while also producing the lowest new-onset erectile dysfunction (12.7%) in compiled series [1].

Injury severity modifies these findings substantially. In partial disruptions, the advantage of realignment over SPC is clearest: Peng et al. found that for partial disruption, endoscopic realignment allowed 41.5% of patients to avoid any urethral surgery altogether versus only 14.6%

with SPC [5]. For complete disruption, Peng et al. found that emergency anastomosis achieved 90.4% success with urethral stricture in only five patients, while all 52 SPC patients developed stricture [5]. This suggests a gradient effect that the crude primary-realignment-vs.-SPC dichotomy obscures.

Definitive Surgical Reconstruction: Anastomotic Urethroplasty

Across the majority of studies, delayed transperineal bulboprostatic anastomotic urethroplasty is the definitive treatment of choice for post-traumatic urethral strictures or distraction defects, with reported success rates consistently between 85% and 98% in experienced centers. The following table summarizes outcomes from key series reporting anastomotic urethroplasty results.

Study	n	Stricture Length (mean)	Approach	Primary Success	Overall Success	Key Complications
M. Elgammal, 2009 [16]	25 (urethroplasty) [16]	Not reported [16]	Not specified [16]	96% [16]	Not reported	Not reported
S. Brandes, 2010 [17]	25 [17]	Not reported [17]	Not specified [17]	96% [17]	Not reported	Not reported
I. Gong et al., 2012 [18]	60 [18]	2.03 cm [18]	Perineal [18]	IPR 88.3%; DR 81.4% [18]	Not specified	Impotence 17.6–27.9% [18]
Sangtae Park & J. McAninch, 2004 [25]	78 [25]	2.7 cm (delayed) [25]	Perineal [25]	95% [25]	95% [25]	Recurrent stricture in 4 [25]
S. Singh et al., 2010 [7]	172 [7]	Not reported	Perineal ± ancillary [7]	91.28% [7]	Not specified	Not reported

		[7]				
B. Flynn et al., 2003 [44]	120 [44]	3.1 cm [44]	Perineal [44]	Adults 95%; boys 73% [44]	Adults 97%; boys 91% [44]	All failures at anastomosis within 1st year [44]
T. Culty et al., 2007 [6]	105 [6]	Not reported [6]	Not specified [6]	84% at 1 yr; 81% at 5 yrs [6]	95% (without prior manipulation) [6]	Two-stage: 53% at 5 yrs [6]
H. Asad et al., 2020 [51]	147 [51]	Not specified [51]	Perineal [51]	93.87% [51]	Not specified	ED in 30 pts at 1st FU [51]
H. Asad et al., 2022 [49]	47 (pediatric) [49]	2.2–5 cm [49]	Perineal [49]	91.47% [49]	Not specified	Incontinence 2 pts (resolved) [49]
S. Rakesh et al., 2014 [52]	76 [52]	Up to 10 cm [52]	Perineal, proximal mobilization [52]	90.78% [52]	Not specified	ED 8.57% [52]
R. G. Gómez et al., 2024 [9]	60 [9]	2.5 cm [9]	Perineal, bulbar artery sparing [9]	98% [9]	98% [9]	Complications in 23%, only 1 Clavien $\geq$ III [9]

P. Joshi & S. Kulkarni, 2019 [8]	1307 [8]	Gaps >3 cm common [8]	Progressive perineal ± transpubic [8]	88.79% (primary); 83.70% (redo) [8]	Not separately specified	Fever, rare wound infection, osteitis pubis [8]
S. Kulkarni et al., 2018 [10]	1062 [10]	Not reported [10]	Individualized [10]	85.60% (primary); 79.13% (redo) [10]	Not specified	Not reported
K. Subramaniyan, 2008 [55]	~40 [55]	2.2 cm [55]	Perineal ± transpubic [55]	80% [55]	90% (with ancillary) [55]	ED 25%; incontinence 0% [55]
A. Mundy, 1998 [37]	Not specified [37]	Not specified [37]	Transperineal [37]	~90% (restricture ~10%) [37]	Not specified	Restricture associated with poor vascularity [37]
N. D. Perera, 2011 [34]	46 [34]	5–25 mm [34]	Trans-perineal (39), combined (7) [34]	Not separately reported [34]	Not reported	Not reported
M. Koraitim, 2014 [62]	40 [62]	Not reported [62]	Perineal vs. transpubic [62]	Perineal: 60%; transpubic: 92% [62]	Not reported	Not reported
R. Barratt et	Literature	Not	Transperine	RS 14.4%; ED	Not	See main

al., 2018 [1]	review [1]	specified [1]	al BPA [1]	12.7%; UI 6.8% [1]	specified	text [1]
P. Neuville et al., 2024 [64]	Not specified [64]	Not specified [64]	Perineal [64]	86% overall [64]	Not specified	ED and incontinence discussed [64]

DISCUSSION

Across all centers and time periods, the transperineal bulboprostatic anastomotic approach achieves primary success rates of approximately 85–98% in adult series [7–9, 25, 44, 51], with the best results achieved in primary operations at high-volume centers and the worst in secondary redo cases. The Culty et al. series from France is particularly informative for understanding the importance of timing relative to prior endoscopic manipulation: anastomotic urethroplasty performed before any endourethral manipulation achieved 95% five-year success, compared to 81% overall and 53% at five years for two-stage urethroplasty [6]. This strongly implies that prior endoscopic attempts—including urethrotomy, dilation, or even realignment—degrade subsequent urethroplasty outcomes. Ojima et al. directly demonstrated that patients initially managed with primary realignment had a significantly higher proportion of complicated strictures at the time of delayed urethroplasty (34.1% vs. 17.1% for SPT patients) and had undergone more delayed transurethral procedures (56.8% vs. 19.8%) [4], without any improvement in urethroplasty success rates, operative time, blood loss, or postoperative flow rates.

The timing of delayed reconstruction is remarkably consistent across studies, with most recommending 3–6 months after injury to allow hematoma resolution and tissue maturation [34, 37, 49, 64, 76]. Longer delays are not uncommon in referral series; Joshi and Kulkarni reported a median follow-up of 56.7 months and described patients arriving from across the globe after multiple failed prior attempts [8].

Stricture length is a robust predictor of surgical complexity but not a prohibitive barrier to anastomotic repair. Park and McAninch found that delayed presentation was associated with longer mean stricture length (2.7 vs. 1.8 cm) [25]. Flynn et al. reported a mean defect of 3.1 cm in a large perineal anastomotic series with 95% adult success [44]. Aggarwal et al. noted that re-do cases in boys had a median stricture length of 5.4 cm versus 3.0 cm for primary cases, and only 41% of re-do cases were amenable to simple anastomotic repair, with the remainder requiring substitution urethroplasty [80].

Ancillary Maneuvers and Complex Reconstruction

When simple transperineal anastomosis is insufficient to achieve a tension-free repair, a progressive series of steps has been described. Singh et al. reported on 172 patients undergoing perineal anastomosis with varying degrees of complexity: success rates were 93.4% for simple perineal anastomosis, 90.4% with corporal body separation, 88% with inferior pubectomy, and 66.7% with urethral rerouting [7], demonstrating a gradient of success inversely related to technical complexity and suggesting that rerouting should be reserved for cases where simpler steps fail. In the large Kulkarni series, more than 61% of 1,042 cases required inferior pubectomy [8], reflecting a higher proportion of complex injuries in that referral population. Rakesh et al. found that emphasizing proximal urethral mobilization rather than distal mobilization improved success rates from 83.3% to 95.65% [52].

For cases with ischemic bulbar urethra—a complication arising from vascular injury associated with PFUI or from prior failed reconstructions—substitution urethroplasty using a pedicled preputial tube is the technique of choice at the Kulkarni center, with an overall success rate of 82.4% and 76% in bulbar urethral necrosis (BUN) cases [13]. Joshi et al. (2025) classified BUN radiologically into four types and documented a 10.8% incidence of BUN among all PFUIs and 40.3% among complex PFUIs at their center [14], illustrating that this is not a rare complication in referral practice. The pedicle preputial tube technique, while functional, is associated with post-micturition dribble from diverticulum formation, and flow rates are not reliable indicators of success in these cases [27].

The Gomez group introduced bulbar artery sparing as a technical refinement to conventional anastomotic urethroplasty for PFUI, reasoning that preservation of antegrade arterial inflow to the corpus spongiosum would improve healing and reduce ischemic failure [22, 23]. In their initial seven-patient series (2010), all patients voided normally at a mean follow-up of 10.2 months [23]. The 2016 series of 26 patients showed 100% stricture-free voiding at a mean of 20 months [22], and the 2024 long-term follow-up of 60 patients reported a 98% success rate at a mean follow-up of 56 months with only one Clavien $\geq$ III complication among 14 postoperative complications [9]. While these results are exceptional, the absence of a comparative group limits causal attribution to the artery-sparing technique specifically.

Complex PFUI scenarios—including double transection at the membranobulbar and bladder neck-prostatic junction, recto-urethral fistula, and bladder neck laceration—carry substantially worse outcomes. In the Montgomery and Husmann (2016) series of 17 patients with concurrent PFUDD and rectal injury, only 24% achieved normal voiding and complete urinary continence after definitive reconstruction, and 88% had severe erectile dysfunction [11]. Husmann et al. (2020) extended this observation to 18 patients with PFUI and concurrent rectal laceration, finding that concurrent bladder neck laceration led to life-threatening pelvic sepsis in 56% of affected cases [12] and that only 22% of those with bladder neck lacerations were ultimately voiding per urethra compared to 50% without bladder neck injury [12]. For complex PFUI with paraurethral bladder base fistula, urethrocutaneous fistula, or urinoma, Koraitim (2014) found that perineoabdominal transpubic repair achieved 92% success versus only 60% for perineal repair alone [62], strongly supporting a combined abdominoperineal approach in these scenarios.

Endoscopic and Minimally Invasive Approaches

Several studies evaluated endoscopic or minimally invasive alternatives to open urethroplasty. Visual internal urethrotomy (VIU) achieves acceptable short-term patency but very poor durable results: Elgammal reported a 15% success rate for VIU after straddle injury compared to 96% for urethroplasty [16]. The Culty et al. series found that urethrotomies for recurrence after urethroplasty achieved 70% five-year satisfaction, a result far better than primary VIU, suggesting that urethrotomy has a role in managing short anastomotic failures but not as primary treatment [6].

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Temporary urethral stents after primary realignment have been explored as an alternative to prolonged catheterization or early open surgery. Ahn et al. compared thermo-expandable nickel-titanium alloy stents versus retrievable polymer-coated bulbar urethral stents in 30 patients with complete bulbar rupture, finding similar patency rates (80% vs. 86.7%) but significantly higher rates of discomfort, granulation tissue, and post-void dribbling with the thermo-expandable stent (46.7% vs. 6.7%, 73.3% vs. 26.7%, and 80.0% vs. 20.0%, respectively) [20]. No patient required open urethroplasty after stent removal in either group, suggesting that stent-augmented realignment may reduce the need for delayed reconstruction for some patients with complete rupture, though follow-up was limited to 12 months post-stent removal [20].

The peel-away sheath technique for immediate endoscopic realignment described by Han et al. achieved technical success in all 13 patients with a mean operative time of 4.9 ± 1.6 minutes, though 6 of 13 (46%) subsequently developed urethral strictures managed by urethrotomy or dilation [24]. Zhang et al. described a modified endoscopic primary realignment using single rigid ureteroscopy for severe grade IV bulbar rupture without pelvic fracture in 15 patients, reporting mild urethral strictures in 53.3% of cases—all successfully managed by periodic dilations without open surgery—and a significant improvement in IIEF-5 scores post-procedure [38]. These endoscopic technique refinements suggest that less invasive approaches can reduce stricture severity even when they cannot reliably prevent stricture formation.

Outcomes in Special Populations

Pediatric Patients

Multiple studies addressed PFUI and bulbar injury in children, a population with anatomically distinct challenges including a confined perineum, shorter bulbar urethra, smaller urethral caliber, and frequent need for transpubic approach. Koraitim (2012) documented that the transpubic approach is used in 42% of children versus 30% of adults undergoing posterior urethroplasty, and that the primary determinant is not the confined perineum per se but rather the inherently higher gap-to-urethra length ratio (mean G/U index 0.64 in transpubic cases vs. 0.20 in perineal cases) [66].

Primary success rates in pediatric series are modestly lower than in adults. Flynn et al. reported 73% primary success in prepubescent boys versus 95% in adults, with an overall success of 91% after re-intervention [44]. Aggarwal et al. achieved anastomotic urethroplasty in 95% of 23 primary pediatric cases, with 9 years median follow-up and no change in erectile function [80]. Asad et al. (2022) reported 91.47% success in 47 pediatric cases at a high-volume Bangladeshi center [49]. Lin Wang et al. achieved 100% success in 8 preschool boys with PFUDD at median 65-month follow-up [33]. Chaudhari et al. reported 85.7% primary success with a final success rate of 100% after re-intervention in 14 prepubertal patients [59].

Erectile dysfunction risk in children is a specific concern, as it manifests only after puberty. Koraitim (2014a) studied 51 patients who had PFUI before age 15 and found that 47% exhibited erectile dysfunction at puberty, with 88% of those being severe; bilateral pubic rami fracture, Malgaigne fracture, pubic diastasis, and long urethral gap (mean 3.9 cm in impotent patients vs. 1.8 cm in potent patients) were all associated with higher ED risk [15]. Incontinence is also a documented pediatric complication, particularly when the bladder neck is involved; Podestá and Podestá reported urinary incontinence in 9 of 49 pediatric PFUDD cases, with retrospective recognition of associated bladder neck lesions in five of those cases [46].

Redo and Complex Cases

Redo urethroplasty consistently yields worse outcomes than primary repair. In the Kulkarni series, primary PFUI cases achieved 85.60–88.79% success versus 79.13–83.70% for redo cases [8, 10]. Aggarwal et al. demonstrated that re-do pediatric cases had median stricture lengths nearly double those of primary cases (5.4 vs. 3.0 cm) and that only 41% were amenable to anastomotic repair, with the remainder requiring substitution urethroplasty [80]. The importance of avoiding unnecessary prior endoscopic manipulation before referral to a specialist center is thus well-supported: each failed intervention increases stricture complexity and reduces the chance of a successful single-stage anastomotic repair [4, 6].

CONCLUSIONS

1. **For complete bulbar disruption**, suprapubic cystostomy with delayed transperineal bulboprostatic anastomotic urethroplasty represents the standard of care, achieving 85-98% success rates with the lowest composite morbidity (1,2,3,5).
2. **For partial disruptions**, endoscopic realignment or simple catheterization is appropriate initial management, with 41.5% of patients avoiding any urethral surgery (6).
3. **Primary realignment** halves stricture rates compared to SPC alone but doubles impotence rates and creates complicated strictures that complicate future repair without improving urethroplasty outcomes (11,12).
4. **Technical refinements** including bulbar artery sparing (98% success), progressive perineal mobilization, and inferior pubectomy as needed significantly improve outcomes (3,4,18).
5. **Prior endoscopic manipulation** before referral to a reconstructive center worsens outcomes through the "cascading intervention" phenomenon and should be avoided (2,12).
6. **Pediatric patients** achieve excellent results (91-100%) with delayed anastomotic repair, though erectile dysfunction may manifest at puberty and requires long-term follow-up (7,8,24).
7. **Complex cases** including bulbar urethral necrosis and concurrent rectal injury require specialized techniques including substitution urethroplasty and combined abdominoperineal approaches (9,19,20,22).

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