DARTOS FASCIA AS AN INTERPOSITIONAL LAYER IN HYPOSPADIAS URETHROPLASTY: A SYSTEMATIC REVIEW

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ABSTRACT

Introduction: *Hypospadias is a common congenital anomaly of the male genitalia (1 in 300 births), characterized by a ventrally displaced meatus, often with chordee and a dorsal hooded prepuce.* ***Objective:*** *This systematic review evaluated the role of dartos fascia as an interpositional layer in primary hypospadias repair.* ***Material & methods:*** *Search was conducted in PubMed, EMBASE, Scopus, CENTRAL, and Web of Science (2019–2025) for studies in patients ≤ 18 years undergoing hypospadias repair. Primary outcomes were urethrocutaneous fistula (UCF), dehiscence, meatal/urethral stenosis, and reoperation; secondary outcomes were infection and cosmetic scores. Narrative synthesis was used.* ***Results:*** *Eleven studies met criteria, predominantly distal TIP. No randomized trial compared any second layer versus none; one cohort (n=425) showed similar UCF with periurethral/dartos coverage versus none (6.7% vs 7.3%). A randomized trial favored double- over single-layer dartos (3.3% vs 23.3%). Another trial found ventral preferable to dorsal dartos with fewer flap-related complications at similar UCF rates. Tunica vaginalis flap reduced UCF and improved cosmetics but is more invasive. Platelet-rich fibrin adjunct lowered UCF and infection in two studies. Spongioplasty produced comparable UCF but higher meatal stenosis, though selected robust spongiosum allowed zero fistulas.* ***Conclusion:*** *Dartos remains the workhorse; double-layer and ventral harvest optimize outcomes, while tunica vaginalis and PRF offer effective alternatives in selected cases.Further randomized trials are needed to clarify the necessity of a second layer.*

Keywords: *Hypospadias, urethroplasty, dartos fascia, urethrocutaneous fistula, tunica vaginalis flap.*

ABSTRAK

Tujuan: *Tinjauan sistematis ini bertujuan menilai peran fasia dartos sebagai lapisan interposisi pada perbaikan hipospadia primer.* ***Bahan &cara:****Pencarian dilakukan pada PubMed, EMBASE, Scopus, CENTRAL, dan Web of Science (2019–2025) untuk studi pada pasien ≤ 18 tahun yang menjalani perbaikan hipospadia. Luaran primer meliputi fistula uretrokutan, dehisensi, stenosis meatus/uretra, dan reoperasi; luaran sekunder meliputi infeksi dan skor kosmetik. Sintesis naratif digunakan.* ***Hasil:*** *Sebelas studi memenuhi kriteria, sebagian besar pada TIP distal. Tidak ada uji acak yang membandingkan penggunaan lapisan kedua versus tanpa lapisan; satu kohort (n=425) menunjukkan UCF serupa antara periurethral/dartos versus tanpa lapisan (6.7% vs 7.3%). Satu uji acak menunjukkan keunggulan dartos dua lapis dibanding satu lapis (3.3% vs 23.3%). Uji lain menunjukkan dartos ventral lebih disukai dibanding dorsal dengan komplikasi flap lebih sedikit pada tingkat UCF yang serupa. Flap tunika vaginalis menurunkan UCF dan memperbaiki kosmetik namun lebih invasif. Penambahan platelet-rich fibrin menurunkan UCF dan infeksi pada dua studi. Spongioplasti menghasilkan UCF yang sebanding tetapi stenosis meatus lebih tinggi, meskipun spongiosum yang baik dapat memberikan hasil tanpa fistula.* ***Simpulan:*** *Dartos tetap menjadi andalan; penggunaan dua lapis dan pengambilan ventral mengoptimalkan hasil, sementara tunika vaginalis dan PRF merupakan alternatif efektif pada kasus terpilih. Uji acak lebih lanjut diperlukan untuk memperjelas kebutuhan lapisan kedua.*

Kata kunci: *Hipospadia, uretraplasti, fasia dartos, fistula uretraokutaneus, flap tunika vaginalis.*

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INTRODUCTION

Hypospadias is a common congenital anomaly of the male genitalia (1 in 300 births), characterized by a ventrally displaced meatus, often with chordee and a dorsal hooded prepuce. Surgery aims to straighten the penis and reconstruct a functional, cosmetically acceptable urethra. TIP

urethroplasty, first described by Snodgrass, is the preferred technique for most distal and midshaft cases, whereas onlay or staged approaches are typically used for proximal or complex cases. No single technique serves as a universal gold standard, as each has distinct advantages and complication profile.[1]

The most common postoperative complication is urethrocutaneous fistula (UCF), occurring in about 4% in distal repairs, alongside meatal stenosis, glans dehiscence, and, in proximal cases, stricture or diverticulum.[1] A key operative principle to reduce fistula risk is placement of a well-vascularized interposition layer between the neourethra and skin closure. Dartos fascia is commonly used due to its accessibility and reliable vascularity[2]; modifications include single vs double layers and dorsal vs ventral harvest. Alternatives such as tunica vaginalis flap, spongioplasty, Buck's fascia, and biologic adjuncts like platelet-rich fibrin have been explored to optimize coverage and healing.[3] Although earlier reviews supported using a second layer, the optimal choice remained unclear.[4] Over the past five years (2019–2025), comparative trials evaluating dartos variations, tunica vaginalis, spongioplasty, and PRF have provided new data. To guide pediatric urologists in evidence-based practice, an updated synthesis of these findings is needed.

OBJECTIVE

This systematic review aims to determine the use of dartos fascia as an interpositional layer in primary hypospadias repair, addressing its impact on complications, technical variations, and comparative efficacy against alternative flaps.

MATERIAL & METHODS

This review included studies of children ≤ 18 years undergoing primary hypospadias repair (distal–proximal), excluding reoperations. The intervention was a dartos fascia interposition layer, allowing any variation in origin, transfer, or single vs double layering; platelet-rich fibrin (PRF) was treated as an adjunct. Comparators included no layer, alternative dartos techniques, or other tissues such as tunica vaginalis flap (TVF) or spongioplasty. Primary outcomes were urethrocutaneous fistula, dehiscence, meatal/urethral stenosis, and reoperation; secondary outcomes included infection, HOSE/PPPS cosmetic scores, satisfaction, and donor-site morbidity, with ≥3 months follow-up.

A comprehensive search of PubMed, EMBASE, Scopus, Cochrane CENTRAL, and Web of Science (01 Jan 2019– 30 Sept 2025) was performed using controlled vocabulary and keywords for hypospadias and interposition layers. Only human pediatric studies were included, without language restrictions. Data extracted covered study design, patient characteristics, operative details, interposition method, comparators, follow-up, outcomes, and complications. Due to clinical and methodological heterogeneity, no meta-analysis was conducted; instead, a narrative synthesis prioritized RCTs and structured comparisons of dartos vs no layer, dartos technique variations, and dartos vs alternative tissues, considering anatomical subgroups and center-level factors.

RESULTS

Table 1 summarizes 11 studies published between 2019 and 2025: 4 RCTs, 3 prospective controlled (non-randomized quasi-experiments or controlled) studies, and 4 retrospective comparative cohorts. Most (8 of 11) were single-center tertiary pediatric surgical experiences; 3 were multi-center or multi-surgeon. Sample sizes ranged from 21 to 120 patients (44–84 in RCTs). Most focused on distal hypospadias, with few including proximal or

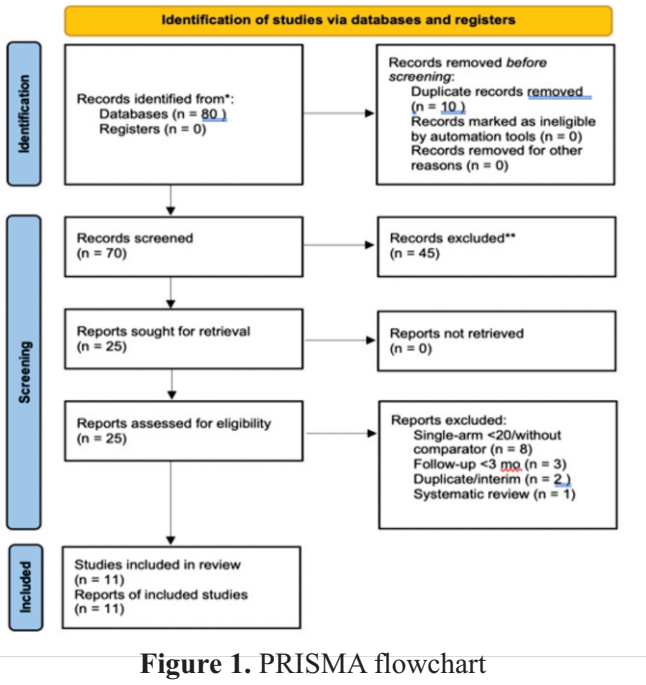

Figure 1. PRISMA flowchart

Table 1. The characteristic of included articles.

Study (year)	Country/setting	Design	N (total; per arm)	Hypospadias location	Urethroplasty technique	Interposition layer details (origin, layers, transfer, pedicle, adjunct)	Comparator	Follow-up & notes
Ramez et al., 2025 [5]	Tertiary center, Egypt	Single-center RCT (envelope 1:1)	88 (DF 44; TVF 44) – analyzed 84 (DF 43; TVF 41)	Distal & mid-shaft	TIP	Dartos flap: dorsal preputial (buttonhole) or ventral "turned-up," pedicled; single layer. TVF: pedicled scrotal	Tunica vaginalis flap	12-mo FU. UCF 20.9% (DF) vs 4.9% (TVF); higher total HOSE with TVF; longer operative time with TVF (median 145 vs 100 min); TVF donor-site: scrotal edema; testicular ascent 7.3%.
Tahmasbi et al., 2025 [6]	Single-center (Iran)	RCT	60 (Ventral DF 30; Dorsal DF 30)	Distal	TIP	Ventral dartos(ventral-based "turned-up") vs dorsal dartos(preputial, buttonhole), pedicled; single layer	Dorsal DF	6-mo FU. Numerically lower UCF with ventral (˜ 6.7% vs 10%); lower necrosis/rotation and fewer reoperations (per abstract).
Mamun et al., 2024 [7]	Referral center (India)	Quasi-experimental (alternate assignment)	41 (TVF 21; DF 20)	Distal	TIP	TVF pedicled vs dartos fascia single layer	Dartos fascia	6-mo FU. UCF 14.3% (TVF) vs 45% (DF); wound infection 14.3% vs 50%; cosmetic & flow outcomes reported.
Mansour et al., 2024 [3]	Single-center (Egypt)	RCT	44 (DF 22; PRF+DF 22)	Distal	TIP	Single-layer DF vs autologous PRF membrane + DF; pedicled; no transfer change	PRF + DF vs DF	Mean FU 17.9 ± 7.2 mo (range 6–30). UCF 4.5% (PRF+DF) vs 18.2% (DF); wound infection 0% vs 22.7% (p<0.05).
Abdelazim et al., 2024 [8]	Single-center (Egypt)	Controlled prospective (computer randomization)	40 (PRF 20; DF 20)	Distal	TIP	PRF membraneover the repair vs single-layer DF(preputial/local), pedicled	Single DF	Early FU 6 mo. Early UCF 10%(PRF) vs 35% (DF); by 6 mo two PRF fistulas closed spontaneously (0%); meatal stenosis 5% vs 10%; no wound infection; single surgeon; stent 6–8 Fr, 6-0 Vicryl reported.
Naumeri et al., 2021 [9]	Single-center (Pakistan)	RCT	60 (Double DF 30; Single DF 30)	Distal	TIP	Double dorsal dartos (two layers, preputial; buttonhole), pedicled	Single dorsal dartos	FU =6 mo. UCF 3.3% (double) vs 23.3% (single); no torsion/necrosis; buttonhole technique described.
Verma et al., 2021 [10]	Teaching hospital (India)	Prospective comparative	30 (DF 15; Spongioplasty 15)	Distal	TIP	Single-layer dartos flap vs spongioplasty(corpus spongiosum)	Spongioplasty	12-mo FU. UCF 3 vs 4 (NS); meatal stenosis 1 vs 5 (˜ 33% with spongioplasty).
Maheshwari et al., 2022 [2]	Tertiary center (India)	Retrospective cohort (selected, non-comparative)	21(spongioplasty only)	Distal/Mid/Prox (selected, favorable GMS)	TIP	Spongioplasty only(single second layer; robust Type-3 spongiosum)	— (descriptive)	FU 12–36 mo. UCF 0%; meatal stenosis 4.7%; selection for robust spongiosum & strict GMS criteria.
Chandni et al., 2023 [11]	Tertiary center (India)	Prospective comparative	120 (TIP 60; TIP + double-breasted spongioplasty60)	Distal & mid-shaft	TIP	Double-breasted spongioplasty(thick spongiosal cushion)	No spongioplasty	FU 4–12 mo. UCF 8.33% (no spongio) vs 3.33% (with spongio); higher HOSE with spongioplasty (˜ 15.4 vs 14.7; p = 0.02).
Issi & Bilir, 2022 [12]	Single-center (Türkiye)	Retrospective cohort	NR (two groups)	Distal & mid	TIP	Dorsal dartosprepared beforeurethroplasty vs after urethroplasty; single layer	"Before" vs "After" prep	Preparing the flap beforeurethroplasty reduced bleedingand operative time; UCF/stenosis not significantly different.
Zulli et al., 2024/2025 [13]	Single-center (Italy)	Retrospective cohort	425 (Second-layer 164; nosecond-layer 261)	Distal & mid	One-stage TIP/Duplay	Periurethral/dartos layer vs no layer	No interposition	Mean FU ˜ 3 years. UCF 6.7%(with layer) vs 7.3% (no layer), not significant (p = 0.8); 37% of UCF associated with meatal stenosis.

midshaft cases without subgroup analysis. All involved TIP (Snodgrass) urethroplasty in at least one arm; some mentioned onlay or two-stage repairs for proximal cases, but comparisons were typically within the same repair type.

No randomized trials in 2019–2025 directly compared urethroplasty with vs without an interposition layer, so evidence for "no-cover" repairs remains limited. The largest recent cohort (n=425 distal/midshaft) reported similar fistula rates with and without a second layer (6.7% vs 7.3%), though non-randomized design likely reflects the selection of favorable, low-risk cases for the no-layer approach. Notably, over one-third of fistulas co-occurred with meatal stenosis, suggesting that outflow obstruction and urethral calibration technique may strongly influence outcomes in distal repairs. These findings imply that, in select distal cases, meticulous urethral closure may be more impactful than the choice of interposition. However, without RCT data and with uncertain applicability to proximal or revision cases, routine multilayer coverage remains recommended until clearer comparative evidence emerges.[13]

Across recent head-to-head studies, three technical choices matter. First, double vs single dartos: one RCT (n=60) showed significantly lower UCF with double-layer coverage (3.3% vs 23.3%; p=0.02) without increased stenosis or torsion.[10] Second, ventral vs dorsal dartos in distal TIP:

another RCT (n=60) reported similar UCF (6.7% vs 10%) but fewer flap-related complications with ventral tissue (necrosis 0% vs 26.7%; torsion 0% vs 13.3%), suggesting benefit when ventral tissue is adequate.[6] Third, preparing a dorsal flap before urethroplasty reduced bleeding (≈16 vs 27 mL) with comparable short-term UCF/stenosis outcomes.[12]

Across 2019–2025, the strongest comparative evidence favors the tunica vaginalis flap (TVF) over dartos for distal and midshaft TIP repairs. An RCT (n=84) reported significantly lower UCF with TVF (4.9% vs 20.9%) and higher cosmetic scores, though with longer operative time and minor donor-site risk.[5] A quasi-experimental study (n=41) similarly showed reduced UCF (14.3% vs 45%) and fewer wound infections, supporting TVF as particularly beneficial in proximal or redo cases where dartos is insufficient.[7]

Two studies evaluating platelet-rich fibrin (PRF) applied over dartos demonstrated improved healing: fistula rates were lower (4–10% vs 18–35%) and infections markedly reduced (0% vs 22%), positioning PRF as a safe, inexpensive adjunct with minimal added operative time.[3,14] Three studies assessing spongioplasty reported fistula rates comparable to dartos (~4–10%), though meatal stenosis varied more widely (4–13%), reflecting reliance on the adequacy of available spongiosum and meticulous technique.[2,10,11]

DISCUSSION

This five-year review updates the role of dartos fascia and alternative interposition layers in hypospadias repair. Interpositional tissue remains key in reducing fistula, and technique optimization is the current focus. Although some distal cases with a thick urethral plate may heal without a second layer, the low added risk of a dartos flap supports its continued routine use; separating urethral and skin suture lines remains fundamental.

Our review highlights meaningful refinements to dartos use. Naumeri et al.'s RCT showed that a double dartos layer can reduce fistula rates to near zero without increasing ischemic or stenotic complications, particularly benefiting proximal, thin-plate, or revision cases.[9] Ventral dartos flaps have emerged as an alternative to the traditional dorsal approach; Tahmasbi's RCT demonstrated similar fistula rates but lower torsion risk, though ventral dartos may be limited in proximal repairs.[6] Issi and Bilir noted that harvesting the flap before urethroplasty improves visualization without altering outcomes.[12]

Among alternative layers, the tunica vaginalis flap (TVF) consistently offers the lowest fistula rates and is preferred when dartos is insufficient, although donor-site morbidity and operative complexity limit routine use.[5,15] Platelet-rich fibrin is a low-cost, autologous adjunct that reduces infection and may further lower fistula rates. Spongioplasty is effective only when the spongiosum is robust; double-breasting may improve support and cosmesis, but insufficient tissue risks meatal stenosis.[2,10,11]

Limitations include small sample sizes, single-center bias, non-uniform outcome definitions, and lack of meta-analysis due to heterogeneity. Nonetheless, trends are consistent: dartos remains the workhorse, with technique refinements improving results, while TVF, PRF, and spongioplasty serve selective roles based on tissue quality and case complexity. Future research should include multicenter RCTs comparing dartos versus no layer in anatomically favorable distal repairs and longer-term follow-up into adolescence to clarify functional outcomes.

CONCLUSION

Studies from the past five years reaffirm that a well-vascularized interposition layer is central to hypospadias urethroplasty. Dartos fascia remains the workhorse; using a double layer, preferably ventral when anatomy allows, reduces fistula risk with little added complexity. Tunica vaginalis offers even stronger protection when dartos is insufficient, though with greater operative burden. Platelet-rich fibrin is a promising adjunct, and spongioplasty is useful when robust spongiosum is available. Evidence comparing repairs without a second layer remains limited, supporting layered coverage as current standard and underscoring the need for further randomized trials.

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