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SCROTAL RECONSTRUCTION WITH LOCAL FLAPS AFTER FOURNIER GANGRENE: FUNCTIONAL AND AESTHETIC OUTCOMES AND COMPLICATIONS

RECONSTRUÇÃO ESCROTAL COM RETALHOS LOCAIS APÓS GANGRENA DE FOURNIER: RESULTADOS FUNCIONAIS E ESTÉTICOS E COMPLICAÇÕES

RECONSTRUCCIÓN ESCROTAL CON COLGAJOS LOCALES DESPUÉS DE GANGRENA DE FOURNIER: RESULTADOS FUNCIONALES Y ESTÉTICOS Y COMPLICACIONES

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ABSTRACT

Background: Extensive debridement for Fournier gangrene may leave the testes exposed and produce complex scrotal and perineal defects. Local and locoregional pedicled flaps can provide durable vascularized coverage, but technique selection and the interpretation of functional and aesthetic results remain inconsistent. Objective: To evaluate indications, functional and aesthetic outcomes, and complications of scrotal reconstruction with local flaps after Fournier gangrene, and to propose a clinically useful method of selecting reconstructive techniques. Methods: A structured narrative review was performed using PubMed/MEDLINE and backward citation tracking through September 2026. Systematic reviews, reconstructive algorithms, comparative or observational cohorts, case series, and studies reporting patient-reported outcomes were prioritized. Evidence was synthesized by defect characteristics, flap type, function, appearance, and complications. No meta-analysis was attempted because of major heterogeneity in case selection, definitions, and follow-up. Results: Residual scrotal advancement is generally appropriate for defects that can be closed without tension, often involving less than approximately half of the scrotal surface. Pudendal and internal pudendal artery perforator flaps offer thin, potentially sensate tissue for larger defects, whereas superomedial or medial thigh flaps provide robust coverage for subtotal loss and perineal extension. Gracilis muscle-based reconstruction is most useful when dead space, contamination, or deeper perineal involvement requires vascularized bulk. Across the flap literature, complete flap loss is uncommon; a 2026 systematic review reported 1.6% overall loss. However, wound-edge necrosis, partial loss, seroma, dehiscence, infection, bulkiness, contour asymmetry, and donor-site morbidity remain relevant. Functional and aesthetic claims are limited by small retrospective series and infrequent use of validated patient-reported measures. Conclusion: Local flap reconstruction is reliable when the wound is

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controlled and the technique is matched to defect size, location, dead space, patient risk, and reconstructive goals. Native scrotal tissue should be preserved whenever tension-free closure is possible; larger or composite defects require a tailored pedicled flap. Current evidence supports low rates of total flap loss but does not establish the superiority of one flap or prove preservation of fertility or thermoregulation. Standardized long-term assessment is needed.

Keywords: Fournier Gangrene. Scrotum. Reconstructive Surgical Procedures. Surgical Flaps. Treatment Outcome. Postoperative Complications.

RESUMO

Antecedentes: O desbridamento extenso da gangrena de Fournier pode deixar os testículos expostos e produzir defeitos escrotais e perineais complexos. Os retalhos pediculados locais e locoregionais podem fornecer cobertura vascularizada durável, mas a seleção de técnicas e a interpretação de resultados funcionais e estéticos permanecem inconsistentes. Objetivo: Avaliar as indicações, os resultados funcionais e estéticos e as complicações da reconstrução escrotal com retalhos locais após gangrena de Fournier, e propor um método clinicamente útil para seleção de técnicas reconstrutivas. Métodos: Uma revisão narrativa estruturada foi realizada usando PubMed/MEDLINE e rastreamento de citações retrospectivas até setembro de 2026. Revisões sistemáticas, algoritmos reconstrutivos, coortes comparativas ou observacionais, séries de casos e estudos relatando resultados relatados pelos pacientes foram priorizados. As evidências foram sintetizadas por características de defeito, tipo de retalho, função, aparência e complicações. Nenhuma metanálise foi tentada devido à heterogeneidade importante na seleção de casos, definições e acompanhamento. Resultados: O avanço escrotal residual é geralmente apropriado para defeitos que podem ser fechados sem tensão, frequentemente envolvendo menos de aproximadamente metade da superfície escrotal. Os retalhos de artéria pudenda e artéria pudenda interna perfurante oferecem tecido fino e potencialmente sensível para defeitos maiores, enquanto os retalhos da coxa superomedial ou medial fornecem cobertura robusta para perda subtotal e extensão perineal. A reconstrução baseada em músculo grácil é mais útil quando o espaço morto, a contaminação ou o envolvimento perineal mais profundo requer volume vascularizado. Em toda a literatura de retalhos, a perda total de retalho é incomum; uma revisão sistemática de 2026 relatou 1,6% de perda geral. No entanto, necrose de borda de ferida, perda parcial, seroma, deiscência, infecção, espessura, assimetria de contorno e morbidade do local doador permanecem relevantes. As alegações funcionais e estéticas são limitadas por pequenas séries retrospectivas e uso infrequente de medidas validadas relatadas pelos pacientes. Conclusão: A reconstrução com retalho local é confiável quando a ferida está controlada e a técnica é adaptada ao tamanho do defeito, localização, espaço morto, risco do paciente e objetivos reconstrutivos. O tecido escrotal nativo deve ser preservado sempre que o fechamento sem tensão for possível; defeitos maiores ou compostos requerem um retalho pediculado personalizado. As evidências atuais apoiam baixas taxas de perda total de retalho, mas não estabelecem a superioridade de um retalho ou provam preservação da fertilidade ou termorregulação. É necessária avaliação padronizada de longo prazo.

Palavras-chave: Gangrena de Fournier. Escroto. Procedimentos Cirúrgicos Reconstrutivos. Retalhos Cirúrgicos. Resultado do Tratamento. Complicações Pós-operatórias.

RESUMEN
Antecedentes: El desbridamiento extenso de la gangrena de Fournier puede dejar los testículos expuestos y producir defectos escrotales y perineales complejos. Los colgajos pediculados locales y locoregionales pueden proporcionar cobertura vascularizada duradera, pero la selección de técnicas y la interpretación de los resultados funcionales y estéticos siguen siendo inconsistentes. Objetivo: Evaluar las indicaciones, los resultados funcionales y estéticos, y las complicaciones de la reconstrucción escrotal con colgajos locales después de la gangrena de Fournier, y proponer un método clínicamente útil para la selección de técnicas reconstructivas. Métodos: Se realizó una revisión narrativa estructurada utilizando PubMed/MEDLINE y rastreo de citas retrospectivas hasta septiembre de 2026. Se priorizaron las revisiones sistemáticas, los algoritmos reconstructivos, las cohortes comparativas u observacionales, las series de casos y los estudios que reportaron resultados reportados por los pacientes. Las evidencias se sintetizaron por características del defecto, tipo de colgajo, función, apariencia y complicaciones. No se intentó un metanálisis debido a la heterogeneidad importante en la selección de casos, definiciones y seguimiento. Resultados: El avance escrotal residual es generalmente apropiado para defectos que pueden cerrarse sin tensión, frecuentemente involucrando menos de aproximadamente la mitad de la superficie escrotal. Los colgajos de arteria pudenda e arteria pudenda interna perforante ofrecen tejido fino y potencialmente sensible para defectos más grandes, mientras que los colgajos de muslo superomedial o medial proporcionan cobertura robusta para pérdida subtotal y extensión perineal. La reconstrucción basada en músculo grácil es más útil cuando el espacio muerto, la contaminación o el compromiso perineal más profundo requiere volumen vascularizado. En la literatura de colgajos, la pérdida total de colgajo es poco común; una revisión sistemática de 2026 reportó 1,6% de pérdida general. Sin embargo, la necrosis del borde de la herida, la pérdida parcial, el seroma, la dehiscencia, la infección, el volumen, la asimetría de contorno y la morbilidad del sitio donante siguen siendo relevantes. Las afirmaciones funcionales y estéticas se ven limitadas por pequeñas series retrospectivas y el uso infrecuente de medidas validadas reportadas por los pacientes. Conclusión: La reconstrucción con colgajo local es confiable cuando la herida está controlada y la técnica se adapta al tamaño del defecto, ubicación, espacio muerto, riesgo del paciente y objetivos reconstructivos. El tejido escrotal nativo debe preservarse siempre que el cierre sin tensión sea posible; los defectos más grandes o compuestos requieren un colgajo pediculado personalizado. Las evidencias actuales apoyan tasas bajas de pérdida total de colgajo, pero no establecen la superioridad de un colgajo ni demuestran la preservación de la fertilidad o la termorregulación. Se necesita evaluación estandarizada a largo plazo.

Palabras clave: Gangrena de Fournier. Escroto. Procedimientos Quirúrgicos Reconstructivos. Colgajos Quirúrgicos. Resultado del Tratamiento. Complicaciones Postoperatorias.

1 INTRODUCTION

Fournier gangrene (FG) is a rapidly progressive necrotizing soft-tissue infection involving the genital, perineal, or perianal region. Although historically described in otherwise healthy young men, contemporary disease is most often associated with diabetes mellitus, obesity, immunosuppression, chronic kidney disease, malignancy, or a genitourinary, anorectal, or cutaneous source. Survival depends on prompt resuscitation, broad-spectrum antimicrobial therapy, and repeated surgical debridement when necessary.[1,2]

The life-saving operation creates a second clinical problem. Excision may leave one or both testes, the spermatic cords, penile shaft, perineum, groin, or lower abdominal wall exposed. The testes usually remain viable because their arterial supply arises independently from the scrotal wall, yet exposed gonads are vulnerable to desiccation, trauma, pain, contamination, and adhesion. Prolonged open care also delays mobility and recovery and may intensify the psychological burden of genital disfigurement.[2,3]

Reconstruction aims to provide stable coverage, eliminate dead space, permit hygiene and ambulation, minimize recurrent infection, restore a dependent scrotal pouch, and limit donor-site harm. An ideal cover would be thin, pliable, durable, sensate, aesthetically compatible with adjacent genital skin, and capable of avoiding excessive testicular heat. No available technique fulfills every goal in every patient. Healing by secondary intention, delayed primary closure, split-thickness skin grafting (STSG), local or regional flaps, temporary or permanent thigh pockets, and combinations of these methods therefore coexist in practice.[3–6]

Published terminology is inconsistent. Some authors reserve “local flap” for tissue immediately adjacent to the defect, such as residual scrotal advancement or a rhomboid transposition flap, while others group pedicled pudendal, groin, and proximal thigh flaps as local or locoregional options. In this review, local-flap reconstruction is used in the practical genital-reconstructive sense and includes residual scrotal, perineal, pudendal, groin, and proximal thigh pedicled flaps. Free tissue transfer is discussed only as an exceptional comparator.[3,4]

The evidence base is dominated by retrospective case series and technique reports. A 2024 systematic review identified 38 articles and 576 reconstructions published during the preceding decade; 77.6% used less invasive strategies such as direct closure, secondary healing, grafts, or local random flaps, and 22.4% used named-vessel locoregional flaps. A broader flap-specific review published in 2026 included 107 studies, 619 patients, and 625

flaps, but most underlying reports remained small and heterogeneous.[3],[4] This review therefore emphasizes what can be concluded reliably, separates technical success from patient-centered function, and avoids treating surgeon-rated appearance as equivalent to validated aesthetic satisfaction.

2 OBJECTIVES

2.1 PRIMARY OBJECTIVE

To analyze the functional and aesthetic outcomes and complications of scrotal reconstruction with local and locoregional pedicled flaps after debridement for Fournier gangrene.

2.2 SECONDARY OBJECTIVES

1. To define the wound and patient factors that guide selection among residual scrotal, pudendal, thigh, groin, and muscle-based flaps.
2. To compare flap reconstruction with skin grafting, delayed closure, secondary healing, and thigh implantation where these alternatives affect clinical choice.
3. To distinguish technical flap survival from long-term protection, comfort, sexual function, thermoregulation, fertility, body image, and patient satisfaction.
4. To summarize early and late complications and identify modifiable contributors to wound failure.
5. To propose a pragmatic defect-based framework for reconstruction and priorities for future research.

3 METHODS

A structured narrative review was chosen because the clinical question includes several interventions and outcome domains that cannot be represented by one homogeneous comparison. PubMed/MEDLINE was searched through September 23, 2026, using combinations of the terms Fournier gangrene, scrotal reconstruction, local flap, scrotal advancement, pudendal thigh flap, internal pudendal artery perforator flap, medial thigh flap, superomedial thigh flap, Limberg flap, gracilis flap, skin graft, complications, cosmetic outcome, functional outcome, sexual function, fertility, quality of life, and patient-reported

outcome. Reference lists of systematic reviews and key primary studies were screened for additional reports.

Systematic reviews, reconstructive algorithms, comparative studies, prospective or retrospective cohorts, and case series reporting operative or patient-centered outcomes after FG were prioritized. Seminal older reports were retained when they established techniques still used in current practice. Isolated case reports were used only when they illustrated a specific indication, such as a gracilis muscle flap for deep dead space, and were not treated as estimates of effectiveness. Studies combining FG with trauma or oncologic defects were interpreted cautiously because wound biology and patient risk differ.

Data were organized according to timing, defect surface and depth, availability of residual scrotal tissue, penile or perineal extension, flap design, technical success, wound complications, donor-site morbidity, functional outcomes, aesthetic outcomes, and study limitations. Numerical results are reported only when the denominator and outcome definition were sufficiently clear. Formal meta-analysis, duplicate screening, risk-of-bias scoring, and certainty grading were not performed; consequently, this manuscript is a critical narrative synthesis rather than a new systematic review.

4 RESULTS AND DISCUSSION

4.1 RECONSTRUCTIVE TIMING AND WOUND READINESS

Reconstruction must not precede infection control. The patient should be hemodynamically stable, serial examination should show no progressive necrosis, and the wound should contain viable tissue capable of supporting closure or transfer. Further debridement takes priority when the margins remain doubtful. Conversely, a fixed waiting period or a requirement for sterile cultures is not supported by comparative evidence. Contemporary practice increasingly preserves viable skin during debridement and closes suitable wounds earlier, thereby reducing the surface requiring reconstruction.[2,7]

Negative-pressure wound therapy (NPWT) can control exudate, reduce dressing frequency, protect the testes, encourage granulation, and bridge the interval to reconstruction. It does not sterilize a wound or replace source control. Prolonged NPWT may also postpone definitive closure without benefit when the wound is already stable. Timing should therefore be based on biological readiness and the patient's ability to tolerate anesthesia rather than on an arbitrary number of days.[2,7]

In a multidisciplinary cohort of 45 patients, 36 underwent reconstruction at a median of 37.5 days after admission, with a range of 11 to 70 days. This variation illustrates the effect of septic severity, repeated debridement, comorbidity, wound location, and institutional pathway. Among 21 patients available for follow-up, 15 (71%) described the functional and aesthetic result as satisfying or extremely satisfying, but selection and nonresponse limit generalization.[7]

4.2 DEFECT AND PATIENT ASSESSMENT

The frequently quoted threshold of 50% scrotal surface loss is a useful starting point, not an anatomical law. Small or moderate defects may be closed with residual scrotal advancement when mobilization produces a tension-free midline repair. A nominally smaller defect may still require a flap if it is anteriorly located, surrounded by scar, accompanied by loss of perineal skin, or if edema prevents safe approximation. Conversely, elastic residual scrotal skin can sometimes cover defects greater than predicted by surface area alone.[5,6]

Depth and composition are as important as area. A clean, superficial bed over intact tunica vaginalis may accept a graft. A cavity, exposed urethral repair, perianal extension, or loss of fascia requires vascularized tissue and sometimes muscle. Penile skin loss is usually reconstructed separately with a thin graft or appropriate flap because bulky scrotal tissue can impair contour and erection. The reconstructive plan should also address whether one testis or both are exposed and whether the spermatic cords can be positioned without kinking or excessive tension.[5,8,9]

Patient factors influence both safety and priorities. Diabetes, malnutrition, anemia, smoking, obesity, peripheral vascular disease, immunosuppression, renal dysfunction, and persistent inflammation increase the probability of wound complications. Body habitus determines whether thigh tissue will be thin and pliable or excessively bulky. Age, sexual activity, baseline urinary and erectile function, fertility goals, ability to perform wound care, occupational demands, and the patient's tolerance of donor scars should be discussed whenever circumstances permit. A technically successful flap may still be a poor patient-centered choice if it produces unacceptable bulk, discomfort, or asymmetry.[2,6]

4.3 RESIDUAL SCROTAL ADVANCEMENT AND RANDOM LOCAL FLAPS

Residual scrotal advancement uses the elasticity and rich collateral circulation of native scrotal tissue. It offers the closest match in color, texture, thickness, hair distribution,

sensation, and dependent contour, avoids a distant donor site, and can often be completed quickly. The method is best for defects that can be closed without tension, commonly after loss of less than approximately one-half of the surface. Bilateral mobilization and midline approximation may recreate a raphe and distribute tension.[5,8,9]

The principal hazard is overestimating mobility. Tight closure can elevate the testes, compromise marginal perfusion, flatten the pouch, and cause dehiscence or edge necrosis. The 2015 systematic review identified 68 scrotal advancement reconstructions among 425 reported patients and supported local closure for smaller defects, but reporting was insufficient for a pooled complication estimate. In the 31-patient reconstructive cohort reported by Chen and colleagues, scrotal advancement was used in 12 patients; across all reconstructive methods, the surgical complication rate was 16%.[5,9]

Rhomboid or Limberg designs can transpose adjacent lax tissue and redirect tension. Dadaci and colleagues evaluated 29 men, including 21 with hemiscrotal loss and eight with defects exceeding half of the scrotal surface. Seroma accompanied by dehiscence occurred in four patients (13.7%); no infection or partial or total flap loss was reported during a mean follow-up of 16 months. The results are reassuring, but there was no comparator and aesthetic acceptability was not measured with a validated instrument.[10]

4.4 PUDENDAL AND INTERNAL PUDENDAL ARTERY PERFORATOR FLAPS

Pudendal thigh flaps are raised from the groin crease or upper medial thigh on external or internal pudendal vascular territories. Their proximity permits a short arc of rotation and concealed donor scar. Tissue is generally thinner and more pliable than a conventional thigh flap, and inclusion of sensory branches can provide protective sensation. Bilateral flaps can recreate a dependent pouch and central seam for subtotal or total scrotal loss.[6,11–13]

A 14-patient series of modified pudendal thigh flaps reported one flap necrosis and described satisfactory contour, cushioning, and protective sensation. The absence of standardized sensory testing and patient-reported aesthetic scales limits the strength of these observations.[11] Perforator-based designs can preserve underlying muscle, reduce bulk, and extend reach. The medial circumflex femoral artery perforator and internal pudendal artery perforator flaps have been described for large defects with favorable survival, but evidence is composed mainly of small series from experienced units.[12,13]

Technical risks include venous congestion, injury or compression of the pedicle during tunneling, distal-edge ischemia, hair-bearing skin in an undesirable position, and scar

contracture. Preoperative Doppler mapping may help when a perforator design is planned, especially after previous groin operations or in patients with vascular disease. A broad, non-kinked pedicle and tension-free inset are more important than maximizing flap length.

4.5 SUPEROMEDIAL AND MEDIAL THIGH FASCIOCUTANEOUS FLAPS

Superomedial and medial thigh fasciocutaneous flaps provide a generous, reliable source of adjacent tissue and are among the most practical options for defects involving more than half of the scrotum, bilateral testicular exposure, or limited perineal extension. They can be unilateral for moderate defects or bilateral for near-total loss. The donor site is close, operative positioning is straightforward, and the flap supplies durable vascularized coverage without microsurgery.[14–16]

Mello and Helene reported 15 patients with 60% to 100% scrotal loss reconstructed with bilateral superomedial thigh flaps. Definitive reconstruction occurred a mean of 30.6 days after initial treatment, and the authors judged functional and aesthetic results adequate.[14] Öcük and colleagues likewise reported 15 patients treated with NPWT followed by superomedial thigh flaps, emphasizing rapid coverage, dead-space control, and preservation of sensation in proportion to flap size.[15] These series demonstrate feasibility but do not establish superiority over grafting or pudendal perforator techniques.

Bulk is the central trade-off. In patients with obesity or thick medial-thigh fat, the reconstructed pouch may be heavy, warm, asymmetric, or uncomfortable during walking. Primary thinning can jeopardize the subdermal or perforator blood supply and should be conservative; secondary contouring after maturation may be safer. Donor-site dehiscence, seroma, widened scars, sensory change, and the need for skin grafting of the donor site are additional considerations.

A Brazilian eight-patient series used thigh fasciocutaneous flaps most often. One of seven flaps developed partial necrosis, corresponding to 14.29%, and there was no total loss; minor complications and simple revisions were common. Six patients had diabetes, underscoring that flap outcomes reflect both design and host biology.[16] Accordingly, a viable flap should not be interpreted as an uncomplicated course.

4.6 GRACILIS MUSCLE AND MYOCUTANEOUS FLAPS

The gracilis muscle or myocutaneous flap is not usually the first choice for a shallow scrotal resurfacing defect because it is bulkier and has a distinct donor site. Its value lies in

filling a deep contaminated cavity, covering an exposed urethral or perineal repair, separating structures, and introducing vascularized tissue into a compromised bed. The muscle can be covered with an STSG when a thin external surface is desirable, or transferred with a skin paddle when additional cutaneous coverage is required.[9,17]

Evidence is limited to small series and case reports. Katusabe and colleagues described pedicled gracilis muscle coverage after FG, and Chen's cohort included gracilis muscle and myocutaneous variants for complex wounds.[9,17] In the eight-patient series by Santos and colleagues, gracilis was used with buccal mucosa to support reconstruction of an injured spongy urethra; the cutaneous island partly necrosed, but the urethral reconstruction did not fistulize.[16] This example illustrates an important distinction: partial skin-paddle loss does not necessarily negate the deeper functional benefit of vascularized muscle.

Potential disadvantages include donor weakness or discomfort, contour bulk, skin-paddle ischemia, limited reach, and an appearance unlike native scrotum. In practice, gracilis is best treated as a problem-solving flap for depth and contamination rather than as the default cosmetic reconstruction.

4.7 GROIN AND OTHER LOCOREGIONAL PEDICLED FLAPS

Groin-based and superficial circumflex iliac artery perforator flaps can deliver relatively thin skin with a concealed donor scar and may be useful when pudendal or medial-thigh tissue is unavailable. Han and colleagues described scrotal reconstruction with a superficial circumflex iliac artery perforator flap after FG, and superthin groin variants have been used for wide defects.[18] These techniques can provide sufficient reach without sacrificing muscle, but pedicle dissection and inset require specific experience.

Pedicled anterolateral thigh (ALT) flaps and posteromedial thigh flaps extend the reconstructive ladder for very large composite defects. They are regional rather than truly local, supply a large skin paddle, and can include fascia or muscle to obliterate dead space. Their disadvantages are greater operative complexity, potential bulk, and donor morbidity. Free flaps are rarely necessary after FG and should be reserved for exceptionally extensive defects or failure of regional options; none appeared necessary in the 2024 systematic review's contemporary reconstruction sample.[3,4]

Table 1

Practical comparison of local and locoregional flaps for scrotal reconstruction

Technique	Best suited to	Principal advantages	Main limitations and complications
Residual scrotal advancement	Small-to-moderate defects with elastic viable scrotal margins and no important dead space	Closest tissue match; short operation; preserved sensation; no distant donor site	Tension-related dehiscence or edge necrosis; high-riding testes; inadequate for extensive or deep defects
Rhomboid/Limberg local flap	Hemiscrotal or selected larger defects with adjacent mobile skin	Redistributes tension; reproducible transposition; acceptable contour	Seroma, wound separation, tip ischemia, scar orientation dependent on design
Pudendal thigh or IPAP flap	Large hemiscrotal, subtotal, or bilateral defects requiring thin, potentially sensate cover	Proximity; concealed scar; pliability; possible protective sensation; muscle preservation	Venous congestion, pedicle kinking, partial necrosis, hair distribution, specialized perforator dissection
Superomedial/medial thigh flap	Defects exceeding approximately 50%, bilateral exposure, and limited perineal extension	Robust vascularity; large surface; simple positioning; unilateral or bilateral use	Bulk and heat retention; asymmetry; seroma; donor-site dehiscence; possible secondary debulking
Gracilis muscle or myocutaneous flap	Deep cavities, urethral/perineal repair, contaminated bed, or need for vascularized bulk	Obliterates dead space; protects deep repair; useful in compromised wounds	Bulk; donor morbidity; skin-paddle loss; poorer texture match; limited role in superficial defects
Groin/SCIP or larger regional thigh flap	Extensive composite defects or unavailable local pudendal/scrotal tissue	Large, reliable skin paddle; muscle-sparing perforator options; hidden donor scar	More complex dissection; pedicle compression; bulk; contour mismatch; longer operation

Source: prepared by the author from the studies cited in the text.

4.8 FUNCTIONAL OUTCOMES

Functional success begins with stable coverage: survival of the testes, freedom from recurrent infection, healed wounds, absence of painful tethering, and the ability to sit, walk, dress, and maintain hygiene. Flaps generally provide more durable padding and greater resistance to shear than a graft. Sensate pudendal or proximal-thigh tissue may restore protective awareness, although most reports describe sensation qualitatively and do not use monofilament, two-point discrimination, or validated symptom measures.[11,15]

Sexual function is more difficult to attribute to the flap. FG survivors may have pre-existing diabetes, vascular disease, neuropathy, depression, urinary symptoms, pain, penile involvement, and prolonged critical illness. In a multicenter survey, 35 patients responded, only 10% of those approached; 57% had undergone reconstruction. Sexual function was reduced across pleasure, desire, arousal, and orgasm domains, but the design could not determine whether reconstruction type caused or prevented the impairment.[21] Similarly, an earlier multicenter study found persistent reductions in physical aspects of quality of life and reported deterioration in sexual function among many survivors.[20]

Long-term Austrian data further demonstrate the burden: among 18 questionnaire respondents, 46.2% reported severe erectile dysfunction, 55.6% had severe lower urinary tract symptoms, and 38.9% reported pain of at least 4 on a 10-point scale. These outcomes describe survivorship after FG, not the performance of a specific flap.[22] A 2026 systematic review found only five retrospective long-term studies comprising 291 patients, all at moderate-to-critical risk of bias, and concluded that sexual, urinary, bowel, psychosocial, and quality-of-life morbidity is substantial but inconsistently measured.[24]

Testicular thermoregulation and fertility are frequently invoked when choosing reconstruction. Native scrotal skin is thin and supports mobility of the testes; a thick flap or permanent thigh pocket may plausibly increase local temperature. Nevertheless, direct human data after FG are sparse, baseline semen studies are rarely available, and spermatogenesis may already be affected by age, fever, sepsis, diabetes, or gonadal injury. It is therefore reasonable to favor thin coverage and avoid unnecessary burial in men who desire fertility, but it is not justified to promise that any flap preserves fertility or to infer impaired fertility from flap thickness alone.[5,6]

4.9 AESTHETIC OUTCOMES AND PATIENT EXPERIENCE

Aesthetic reconstruction seeks a symmetric dependent pouch, adequate separation from the thighs, a central raphe-like contour, compatible color and hair distribution, and a result that does not draw the penis into scar. Residual scrotal tissue offers the best visual match. Bilateral pudendal or thigh flaps can reproduce volume and a midline seam, whereas unilateral flaps may create asymmetry. Bulkiness, flattening, high testicular position, irregular scars, and donor-site deformity are recurrent concerns.

Most studies use terms such as “good,” “acceptable,” or “satisfactory” without defining who judged the outcome, when it was assessed, or whether the patient agreed. Even the

71% satisfaction observed in the 2025 algorithmic cohort was based on a simple five-point scale and only 21 contacted patients.[7] The strongest available patient-reported evidence concerns FG survivorship rather than direct comparison of flap types. Consequently, statements that a particular flap is aesthetically superior should be regarded as expert preference unless supported by standardized photographs, blinded assessment, and validated genital body-image or satisfaction instruments.

A small study of pedicled ALT reconstruction illustrates both promise and uncertainty. Five of eight eligible patients completed long-term questionnaires; four reported quality-of-life scores above 70/100 in most domains, but one minor dehiscence required grafting and one flap was lost and replaced with the contralateral flap.[23] The ALT is not a local scrotal flap, yet these data show the type of outcome reporting needed: technical events and patient experience should be presented together, with the denominator and reoperations explicit.

4.10 COMPLICATIONS

Early complications include hematoma, seroma, infection, wound-edge separation, venous congestion, marginal necrosis, partial flap loss, and—rarely—complete flap failure. Late complications include hypertrophic or contracted scars, tethering, chronic pain, altered sensation, contour asymmetry, bulkiness, recurrent ulceration, donor-site morbidity, and dissatisfaction. Urethral or anal involvement introduces additional risks of fistula and contamination. Complication definitions differ considerably, and studies sometimes count only events requiring reoperation.[3–6]

The largest synthesis specifically addressing flap reconstruction found overall flap loss in 1.6% of 625 flaps. This low value supports the vascular reliability of regional tissue but should not be interpreted as a 98.4% uncomplicated recovery: minor necrosis, dehiscence, seroma, infection, delayed healing, and revision were variably reported and could not be compared consistently.[4] Individual cohorts illustrate the distinction. The Limberg series had no flap loss but a 13.7% seroma/dehiscence rate; the modified pudendal series had one necrosis among 14 patients; and the Brazilian cohort reported 14.29% partial necrosis among seven thigh flaps with no total loss.[10,11,16]

Risk reduction begins before flap elevation. Persistent necrosis, uncontrolled contamination, severe edema, poor nutrition, anemia, hyperglycemia, smoking, and hemodynamic instability should be corrected where possible. During surgery, the flap should be large enough to inset without tension; the pedicle must not be twisted or compressed;

hemostasis and dependent drainage must be meticulous; and the testes and cords should be positioned without constriction. Postoperatively, pressure and shear are minimized, glycemic control is maintained, and any venous congestion or expanding collection is assessed early.

Not every wound problem requires flap abandonment. Small marginal necrosis can often be debrided and allowed to heal or be regrafted; limited separation can be managed with dressings or delayed re-approximation; and contour excess can be corrected after maturation. Reporting should distinguish conservative management, bedside procedure, return to the operating room, partial loss, and total loss because these events have very different consequences for patients.

4.11 COMPARISON WITH NONFLAP STRATEGIES

Secondary healing avoids donor morbidity and may be reasonable for small, shallow defects or patients who cannot tolerate another operation. Its disadvantages are prolonged wound care, contraction, discomfort, delayed rehabilitation, and unpredictable appearance. Delayed primary closure is attractive when sufficient mobile tissue remains and can shorten the treatment course, but tension and residual contamination increase dehiscence risk.[5,6]

STSG remains an important comparator and should not be portrayed as an inferior rescue technique. It is thin, rapid to harvest, conforms to irregular surfaces, has low metabolic demand, and may preserve a cooler environment around the testes. In a 10-year retrospective series of 34 FG cases, grafting was used in 74%, reflecting its efficiency and low donor burden.[19] However, graft take is less predictable on contaminated, mobile, or poorly vascularized beds; the graft may contract, become fragile, adhere to underlying structures, and provide limited padding. A flap is favored when there is deep dead space, exposed repair, unreliable graft bed, recurrent contamination, or need for durable volume.

Medial-thigh testicular pockets can provide rapid temporary protection in an unstable patient, but permanent burial may create an unnatural appearance, discomfort, cord tension, and concerns about temperature. They should generally be regarded as a staging method or fallback rather than the default definitive reconstruction. The reconstructive ladder is therefore not a ranking from simple to sophisticated; the best method is the least burdensome option that reliably satisfies the biological and patient-centered requirements of the specific defect.[5]

Table 2

Selected evidence on outcomes of reconstruction after Fournier gangrene

Study	Design and reconstruction	Main findings	Interpretive limitation
Karian et al., 2015[5]	Systematic review; 16 studies, 425 patients; multiple closure, graft, and flap strategies	Scrotal advancement in 68 patients; algorithm favored local closure for defects <50% and graft/flap for larger defects	Older heterogeneous case series; incomplete outcome definitions and no comparative pooling
Chen et al., 2011[9]	Retrospective cohort; 31 reconstructed survivors; advancement, graft, pudendal, gracilis, and ALT techniques	Mean defect 86 cm²; overall surgical complication rate 16%	Technique selection followed defect complexity; small groups prevent fair comparisons
Mello and Helene, 2018[14]	Case series; 15 patients with 60%–100% loss; bilateral superomedial thigh flaps	Mean reconstruction at 30.6 days; adequate functional and aesthetic results reported	No control group or validated patient-reported outcome measure
Khanal et al., 2020[11]	Case series; 14 modified pudendal thigh flap reconstructions	One flap necrosis; authors reported natural appearance, cushioning, and protective sensation	Single center, short series, and qualitative function/appearance assessment
Dadaci et al., 2021[10]	Retrospective series; 29 unilateral or bilateral Limberg flaps	Seroma with dehiscence in 4 (13.7%); no infection or flap loss; acceptable cosmesis	No comparator; aesthetic result not measured with a validated scale
Öcük et al., 2022[15]	Case series; 15 superomedial thigh flaps after NPWT	Effective coverage and dead-space management; functional, aesthetic, and sensory benefit reported	Clinical judgments without a standardized comparative endpoint
Santos et al., 2022[16]	Retrospective series; 8 patients; predominantly thigh fasciocutaneous flaps	Partial necrosis in 1 of 7 flaps (14.29%); no total loss; minor revisions common	Very small sample, high diabetes prevalence, and heterogeneous procedures
Gabriel et al., 2025[7]	Retrospective algorithmic cohort; 45 patients, 36 reconstructed	Median 37.5 days to reconstruction; 15/21 contacted patients satisfied or extremely satisfied	Single-arm design and incomplete patient-reported follow-up
Alammar et al., 2026[4]	Systematic review; 107 studies, 619 patients, 625 flaps	Overall flap loss 1.6%; regional fasciocutaneous and musculocutaneous options were reliable	Evidence largely consisted of case reports and case series with heterogeneous reporting

Source: prepared by the author from the studies cited in the text.

4.12 A PRACTICAL SELECTION FRAMEWORK

A practical plan begins with four questions. First, is infection controlled and is all tissue intended for closure viable? Second, can residual scrotal skin close the defect without tension? Third, is the defect superficial or does it contain dead space, exposed urethral or anal repair, or perineal extension? Fourth, what patient factors make a longer operation, donor wound, bulky flap, or prolonged dressing course unacceptable? These questions are more reproducible than choosing a flap by percentage of surface loss alone.[2,5–7]

When viable residual scrotum closes freely, advancement is preferred because it replaces like with like. When the bed is clean and superficial but residual skin is insufficient, STSG is efficient, especially for a patient with high anesthetic risk. A thin pudendal or internal pudendal perforator flap is attractive when a larger defect requires durable, potentially sensate cover with limited bulk. A unilateral or bilateral superomedial thigh flap is useful for subtotal loss or when broader coverage is required. Gracilis muscle is added when the reconstructive problem is depth, contamination, or protection of a repair. Very large composite defects may require larger regional thigh or groin flaps and combination reconstruction.

The final choice should be shared with the patient. A younger man prioritizing sexual confidence, body image, and fertility may accept a longer perforator-flap operation to obtain thinner contour. A frail patient with renal disease and limited mobility may benefit from the shortest reliable operation. A patient with obesity may prefer a graft or thin perforator flap over a bulky medial-thigh flap, provided the wound bed is suitable. These examples represent individualized trade-offs, not evidence-based mandates.

4.13 QUALITY OF EVIDENCE AND RESEARCH PRIORITIES

Confidence in comparative conclusions is low. Indication bias is profound: small uncomplicated defects receive advancement or grafting, while larger contaminated wounds receive complex flaps. Authors often report flap survival but omit denominator-based minor complications, time to complete healing, number of procedures, donor morbidity, cost, or unplanned readmission. Follow-up is frequently short, and patients with the most severe disease may die or be lost before aesthetic or sexual assessment. These limitations can make technically demanding reconstruction appear better or worse for reasons unrelated to the flap itself.[3,4,24]

Future multicenter registries should record defect dimensions and depth, genital and perineal structures involved, comorbidities, nutritional status, number of debridements,

reconstruction timing, objective technique details, and complications using standardized definitions. Core outcomes should include complete healing, days to ambulation, pain, protective sensation, urinary and sexual function, genital body image, satisfaction, donor-site symptoms, revisions, and costs. Fertility studies should include preoperative context, semen analysis, endocrine measures, and scrotal temperature rather than relying on anatomical assumptions.

Randomized trials may be unrealistic for rare, heterogeneous wounds, but prospective comparative cohorts are feasible. Propensity methods or carefully specified defect strata could compare STSG with thin fasciocutaneous flaps and compare pudendal with medial-thigh designs. Standardized patient photographs assessed by both patients and blinded observers, combined with validated quality-of-life and sexual-function measures, would make the term “good aesthetic result” clinically interpretable.

5 CONCLUSION

Scrotal reconstruction with local and locoregional pedicled flaps after Fournier gangrene is generally reliable once infection has been controlled and the wound contains viable tissue. Residual scrotal advancement offers the best tissue match when closure is tension-free. Pudendal and perforator-based flaps provide thin, potentially sensate coverage for larger defects, while superomedial or medial thigh flaps provide robust surface area for subtotal loss. Gracilis muscle is especially valuable for dead space, contamination, and protection of deeper perineal or urethral repairs.

Complete flap failure appears uncommon; the most comprehensive flap-specific review reported a 1.6% loss rate. This should not obscure the frequency of partial necrosis, seroma, dehiscence, infection, contour bulk, scar symptoms, donor-site problems, and revision. Complications are influenced by comorbidity and wound biology as much as by flap design.

Evidence for functional and aesthetic superiority is substantially weaker than evidence for flap survival. Most studies rely on small retrospective series, surgeon judgment, and incomplete follow-up. Sexual dysfunction, urinary symptoms, pain, impaired self-esteem, and reduced quality of life remain common among FG survivors, but current data rarely isolate the effect of reconstruction. Preservation of thermoregulation and fertility is biologically plausible with thin, mobile coverage but has not been proven for any specific flap.

The most defensible clinical strategy is individualized: preserve native scrotal skin whenever possible, select the least burdensome technique that provides stable coverage, add vascularized bulk only when depth requires it, and align the plan with the patient's anesthetic risk, body habitus, function, fertility goals, and preferences. Future research should move beyond flap survival toward standardized long-term patient-reported and reproductive outcomes.

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