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# ICG-directed scrotal flap design for adult-acquired buried penis repair


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**Summary** Indocyanine green (ICG) lymphography is a validated tool used to map superficial lymphatic patterns. Patients with adult-acquired buried penis (AABP) secondary to penile engulfment by surrounding soft tissues often have abnormal lymphatic drainage of the genital region and experience high rates of postoperative lymphedema after surgical correction. To evaluate clinical utility of preoperative and intraoperative lymphography in surgical AABP repair, we performed a multicenter observational study of 15 patients presenting for surgical correction of AABP. Nine of these patients underwent preoperative nuclear lymphoscintigraphy, six of whom demonstrated stage one or greater lower extremity lymphedema. All patients underwent intraoperative lymphography via intradermal injection of ICG dye into the inferior abdominal fat pad, medial thighs, penile shaft, and scrotum. This revealed significant lymphatic congestion with dermal backflow in all patients, with variable patterns of genital and adjacent soft tissue involvement. In all patients, drainage of the posterior scrotum was completely or partially preserved. After injection and interpretation of lymphography, dissection and soft tissue removal were performed. The boundaries of the posterior scrotal flap were determined based on the preservation of observed linear scrotal lymphatics and exclusion of tissue displaying characteristics of lymphatic congestion. These findings reveal that lymphedema is highly prevalent in patients with AABP and should be addressed during the treatment. Drainage of the posterior scrotum toward the perineum is commonly preserved, validating the importance of preserving this tissue for scrotal reconstruction.


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Adult acquired buried penis (AABP) is a condition in which the penile shaft and glans become entrapped in the suprapubic fat pad or peripenile cicatrix.[1] Clinically, AABP is marked by a progressive reduction in visible penile length, eventually leading to complete concealment of the penis. This severely impacts urinary function, sexual activity, and overall quality of life.[2] Unlike congenital buried penis, AABP typically results from excessive adipose tissue accumulation associated with systemic obesity. However, it may also arise secondary to genitourinary lymphedema following cancer therapy, surgical interventions, or congenital lymphatic disorders.[3] Surgical correction of AABP remains essential, as conservative approaches such as weight reduction are insufficient to reverse the accumulation of excess skin, subcutaneous tissue, and chronic inflammation of the penile and/or scrotal skin.[4]

Various reconstructive strategies are used for AABP repair, including penile skin excision with grafting, complex scrotoplasty using adjacent perineal and medial thigh skin, and escutcheonectomy with or without abdominal panniculectomy. Common complications include reburying, poor wound healing, and development of lower extremity lymphedema.[5-7] The true prevalence of pre- and post-operative lymphedema in the AABP population is currently unknown but may play a significant role in buried penis etiology and the subsequent development of complications. The complexity of pre-existing scrotal lymphedema in these patients presents a unique challenge to plastic surgeons and urologists.[8-11]

Over the past several decades, case reports, case series, and small cohort studies describing management of genitourinary lymphedema have indicated that lymphatic reconstruction results in better outcomes than excision alone.[12] Assessment of genital lymphedema using indocyanine green (ICG) lymphography has shown promise, although detailed mapping of superficial lymphatic drainage patterns in the scrotum, penis, suprapubic fat pad, and medial thighs remains limited.[13-16] Using ICG as a lymphatic mapping tool to guide lymphatic reconstruction in patients with genital lymphedema has also been described in limited series.[17,18] Recent studies have elucidated multiple beneficial roles of lymphatic mapping in preoperative and intraoperative planning for AABP, including guiding flap design to reduce the risk of lymphatic injury and identifying lymphovenous bypass (LVB) targets.[3]

Here, we describe our innovations to the AABP repair surgical technique in which intraoperative ICG lymphography was used for lymphatic mapping of patients with AABP prior to flap creation to facilitate reconstruction after tissue removal. We outline a standardized and easily reproducible protocol for scrotal ICG injection to guide precise flap planning and facilitate effective scrotal reduction while preserving vital lymphatic structures.

## Materials and methods

### Study population and recruitment

We conducted a prospective multicenter, multi-surgeon observational pilot study on patients undergoing surgical correction of AABP. Local regulatory approval was obtained from each IRB (STUDY23100173 and STUDY00007221). Consecutive patients presenting to the reconstructive urology clinic for surgical correction of symptomatic AABP requiring, at minimum, a complex scrotoplasty were screened. Patients with allergies to iodine and ICG were excluded, as were any patients with contraindications to anesthesia administration or surgical correction. Consent was obtained prior to surgical intervention.

### Data collection

Data abstracted from the patient's electronic health record (EHR) included basic demographic information, bariatric history (if present), urologic history, prior workup and/or treatment for lymphedema, surgical parameters, and postoperative data including complications and unanticipated presentations for acute office-based care. All patients were followed for a minimum of three months postoperatively.

### Lymphoscintigraphy

Prior to surgical intervention, lymphoscintigraphy was performed in patients with clinical signs of lower extremity or genitourinary lymphedema based on the preoperative physical examination performed by the urologic surgical teams. These studies were performed to determine the extent of preexisting lower extremity edema and extent of scrotal lymphedema, when present. Lower extremity examination findings that prompted referral for lymphoscintigraphy included unilateral or bilateral lower extremity swelling, dermal thickening, and nonpitting edema. Isolated scrotal edema, penile edema, or adverse skin changes out of proportion to those expected based on their body habitus/AABP also prompted referral for lymphoscintigraphy. For these studies, four equal aliquots of radiotracer were injected into the intradermal tissue of the first and second interdigitary spaces of the bilateral feet. A total of 1 mCi radiotracer was administered per patient. Images were obtained in the anterior-posterior projection at 0, 90, 180, and 270 min. Uptake velocity, node visualization, channel pattern, and presence of dermal backflow were all assessed by an attending radiologist and abstracted from the EHR. Lymphoscintigraphy grade and laterality was reported as previously described.[19,20]

### Fluorescent lymphatic mapping

All members of the team were instructed on appropriate injection techniques during the initial procedure at each site by experienced plastic surgeons. Following induction of anesthesia and skin preparation, lymphatic mapping was performed. Briefly, 25 mg of ICG was dissolved in 10 mL sterile water to a final concentration of 2.5 mg/mL. This solution was injected intradermally in 0.1-0.2 cc aliquots along the abdomen at the level of the umbilicus, top of the prepuce, ventral penile base, anterior scrotum, posterior scrotum, and superior thighs (Figure 1). Injections were then performed by members of the plastic surgery and urology teams. Injection sites were covered with Ioban drapes to minimize dye streaking over the skin surface.

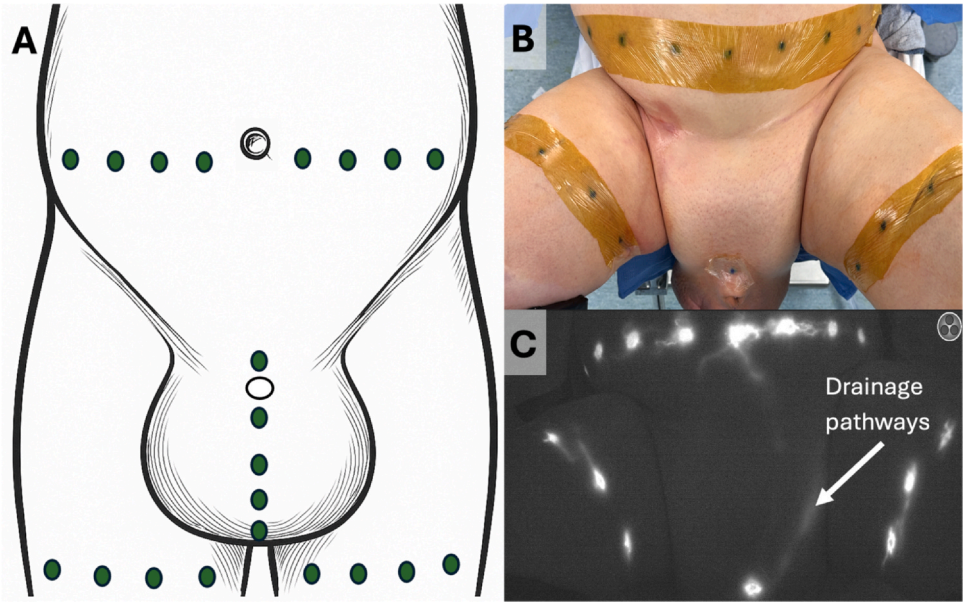


**Figure 1** ICG injection pattern used for intraoperative lymphography depicted as a schematic (A) and in visible (B) and near-infrared (C) imaging of a representative patient.

Lymphatic drainage was assessed using the SPY-PHI handheld imager (Stryker Corp) 5 min after injection to capture early linear flow patterns, when present. Device settings were determined on a case-by-case basis by the operators at each site. Typical workflow included focusing handheld device between 10–40 cm from each injection site in overlay mode. Following focus in overlay mode, the SPY mode was then used to facilitate a high-resolution assessment of lymph drainage. Overlay mode and re-focus were performed as needed based on the field size to facilitate assessment across all injection sites. The degree of lymphatic abnormality was initially assessed intra-operatively to guide tissue resection margins and flap boundaries. The dermal backflow pattern characterization was then retrospectively reviewed post-operatively by a lymphatic expert and reported as previously described based on dermal backflow patterns (linear, splash, stardust, and diffuse).[21] Discrepancies in categorization prompted consensus review. Regions displaying significant heterogeneity were classified according to their two most prevalent patterns.

### Posterior scrotal flap design with ICG

After injection and real-time interpretation of the lymphographic findings by members of the plastic surgery and/or urology teams, AABP repair was undertaken. Degloving of diseased penile skin and resection of the epidermis, dermis, and suprapubic fat pad were undertaken as clinically indicated.

After the penis was exhumed and the surrounding tissue resected, the lymphatic drainage of the scrotum was again assessed using the SPY-PHI wand. The anterior and lateral margins of the posterior scrotal flap were designed to include tissue displaying linear or splash dermal backflow patterns contiguous with the proposed posterior lymphatic pedicle. Redundant medial and anterior scrotal tissue with evidence of lymphatic congestion were excluded, when possible, to reduce scrotal volume while preserving sufficient tissue for a tension-free reconstruction. Final boundaries were determined intraoperatively by consensus from the urologic and plastic surgery (when present) teams.

Scrotal dissection was then undertaken. The epidermis and dermis were incised sharply, and the subdermal tissue and dartos fascia were incised with electrocautery to the level of the tunica vaginalis. Care was taken to avoid injury to the cord structures and tunica vaginalis. The lateral edges of this posterior flap were then sutured to the skin abutting the medial thigh in two layers. The anterior edges were brought to the base of the penis as previously described (Figure 2).[22]

## Results

### Population demographics

A total of 15 patients across two clinical sites were recruited for the study. The demographic information of these patients can be found in Table 1. The mean age of these patients was 58.3 years (range 40–75 years). Nine patients (9/15, 60%) identified as White. The average BMI at the time of surgery was 41.6 $\pm$ 7.6 kg/m$^2$. Among the presenting patients, 2/15 had a history of gastric bypass surgery for weight loss, 5/15 used a GLP-1 agonist for weight loss, and 2/15 used both gastric bypass surgery and a GLP-1 agonist. Eleven had a preoperative diagnosis of lymphedema based on clinical findings. One patient had a history of a glansectomy and bilateral inguinal lymph node dissection for penile cancer. Minimum follow-up was three months.

### Lymphoscintigraphy

Among the 15 patients recruited for the study, 9 (60%) underwent lower extremity lymphoscintigraphy based on clinical exam findings. Six of these patients (67%) had evidence of lower extremity lymphatic abnormalities, including 4 with unilateral or bilateral stage 2 or 2+ lower extremity lymphedema and 2 with unilateral or bilateral stage 1 lower extremity lymphedema.

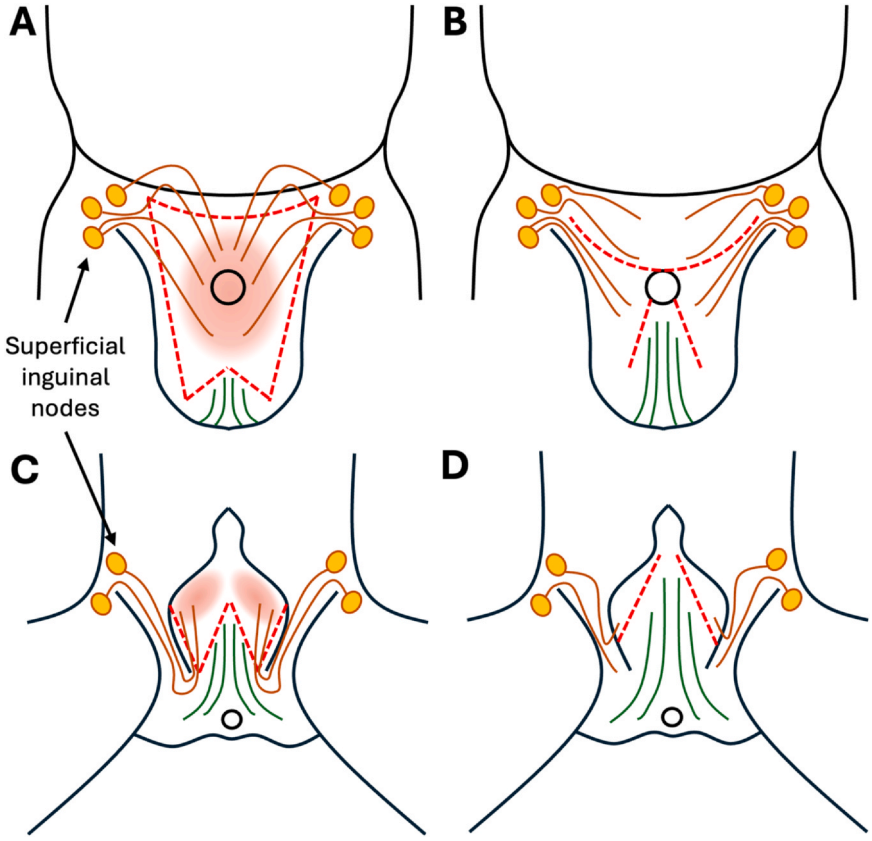


**Figure 2** Illustration of the visualized lymphatic drainage of the scrotum superimposed upon the margins (red dotted lines) of the flaps used for scrotal reconstruction after AABP repair. Panels A and C represent preoperative congested lymphatic drainage to the superficial (yellow/brown) inguinal nodes with relatively preserved posterior scrotal drainage (green.) Panels B and D represent post-reconstruction schematics in which the posterior scrotum was used as a bridging lymphatic flap.

**Table 1** Clinical and demographic background of the patients included in the study.

| Patient Information (n=15) | |
|---|---|
| Age (range), years | 58.3 (40-75) |
| Body Mass Index (range), kg/m$^2$ | 41.5 (27-58) |
| Race (%) | |
| White - Non-Hispanic | 60 |
| White - Hispanic | 13 |
| Black | 27 |
| Prior Weight Loss Intervention (no.) | |
| Surgical Only | 2 |
| Medical (GLP-1 Agonist) Only | 5 |
| Surgical and Medical | 2 |
| Surgical Element (%) | |
| Escutcheonectomy | 100% |
| STSG | 87% |
| Scrotoplasty | 80% |
| Abdominal Panniculectomy | 67% |
| Urethroplasty | 15% |
| Thigh pouches | 7% |
| Glans resurfacing | 7% |
| Hydrocelectomy | 7% |
| Umbilical Hernia Repair | 7% |

## Surgical information

All patients underwent surgical intervention for AABP. The procedures performed included removal of the suprapubic fat pad (escutcheonectomy), abdominal panniculectomy, scrotoplasty, split thickness skin grafting of the penile shaft, and other adjunctive procedures (Table 1). All patients required scrotoplasty as a component of their reconstruction, consistent with the prespecified inclusion criteria, and were reconstructed using the W-plasty technique.[22]

## ICG lymphography

All patients exhibited evidence of aberrant lymphatic drainage with abnormal dermal backflow in the genitals or adjacent tissues. The regions affected did not have a clear correlation to any patient clinical parameters, including BMI, prior bariatric history, or AABP etiology. A visual representation of each patient's pattern of lymphatic congestion can be found in Figure 3. Intraoperative ICG lymphography facilitated identification of consistent posterior scrotal drainage in all patients (Figure 4).

When considering scrotal flap boundaries, real-time interpretation of the images by the operating urologist and, in early cases, the collaborating plastic surgery team was performed.

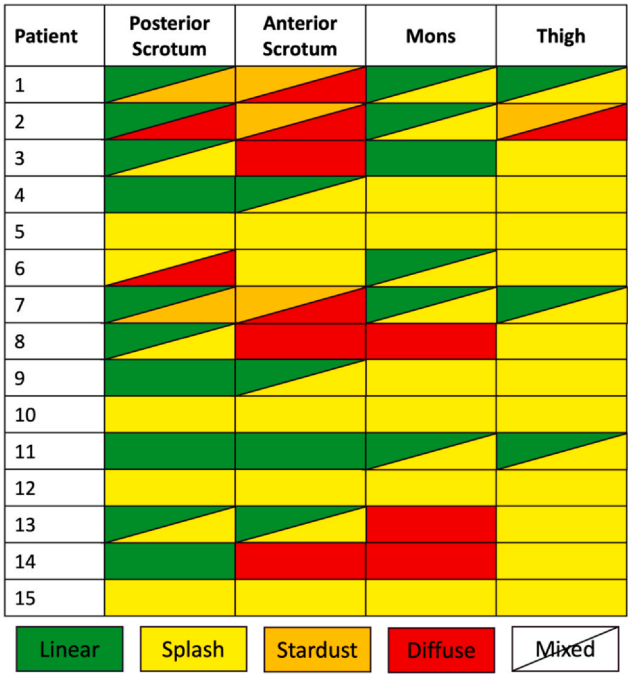


**Figure 3** Summary of lymphography findings based on patient and anatomic region. Regions displaying significant heterogeneity were classified according to their two most prevalent patterns, depicted as a diagonal line.

When anatomically feasibly, efforts were made to preserve tissue with organized lymphatic drainage and exclude congested tissues. This workflow is highlighted in Table 2.

## Complications and surgical outcomes

No patients experienced apparent complications from ICG injections, including injection site bleeding, pain, or local/systemic allergic reactions. Three of the 15 patients (20%) experienced postoperative incision dehiscence requiring outpatient management with enhanced wound care, consistent with prior published rates of low-grade complications. The patient with a history of prior glansectomy and inguinal lymph node dissection experienced isolated postoperative penile lymphedema managed with a compression wrap. No other patients demonstrated worsening lymphedema or re-burying of the penis postoperatively at their three month follow-up.

## Discussion

### Diagnosis of lymphedema in patients with AABP

The role of lymphedema as a cause or consequence of subcutaneous tissue accumulation in patients with AABP is hitherto poorly defined. In our clinical workflow, we used preoperative lower extremity lymphoscintigraphy as an established clinical tool to characterize preexisting lymphatic disruption in patients for whom a clinical suspicion existed. Although this study was not powered to elucidate the rates and risk factors of global lymphatic disruption in the AABP population, our lymphoscintigraphic findings in 6 of 9 patients tested support more intentional characterization of lower extremity lymphedema in these patients.

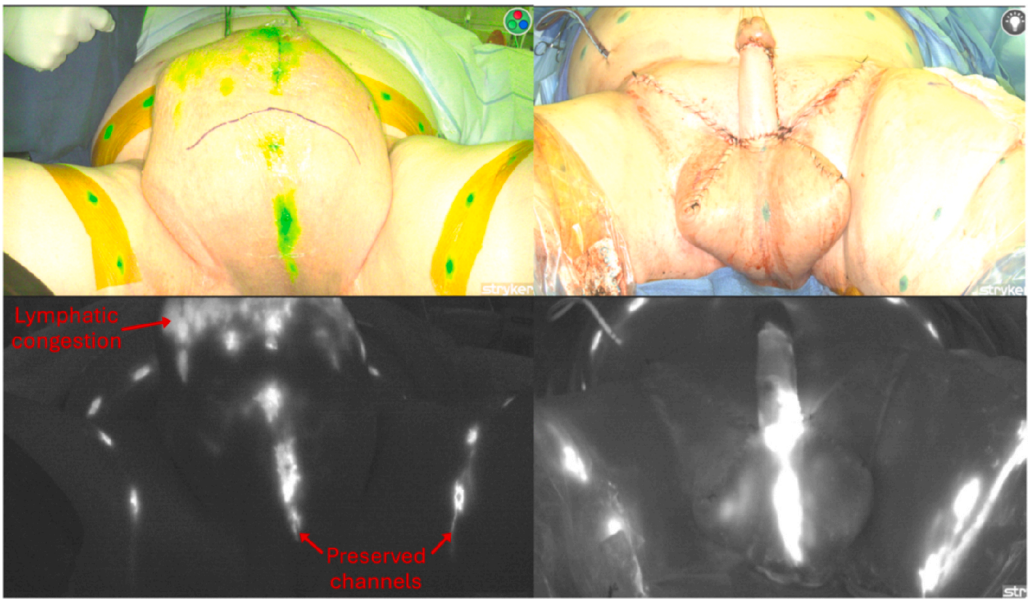


**Figure 4** Representative visible and near-infrared images of a representative patient before (left) and following (right) AABP repair with escutcheonectomy, complex scrotoplasty, and split-thickness skin grafting of the penile shaft. The surgical line in the top left figure represents the superior boundary of the fasciocutaneous flap used for covering the reduced scrotal contents. This flap comprises the inferior remnant of the scrotum and perineum and is drained by the lymphatic pedicles seen and preserved in the two lower fluorescent images.

**Table 2** Outline of intraoperative tissue management workflow following lymphographic assessment.

| Lymphography-guided tissue management | |
|---|---|
| Linear | Preserve *in situ* or use as flap |
| Splash | Preserve unless removal would improve cosmesis or facilitate local flap use from tissue with a linear pattern |
| Stardust | Resect, unless removal would require creation of unplanned flaps or grafts that adversely affect function or cosmesis |
| Diffuse | Resect unless no local flaps or grafts are available for substitution |

Despite being a known risk factor for the development of lymphedema and AABP, the degree of obesity in the patients examined herein did not correlate with a specific lymphatic drainage patterns on ICG in our study.[23,24] In fact, no correlation of drainage patterns with any suspected etiology of medical/surgical history element was noted. Interestingly, all patients who underwent intraoperative ICG lymphography demonstrated evidence of genitourinary and medial thigh lymphedema, even in the 40% that did not have clinical suspicion of lower extremity lymphedema and the 20% that had lymphoscintigraphy studies read as unremarkable. This discrepancy was unexpected and the clinical significance is uncertain.

### Intraoperative feasibility and implications for reconstruction

The use of intraoperative ICG to identify vascularized and/or appropriate lymphatic tissue for reconstruction is not novel. However, we believe this is the first study describing a standardized approach to intraoperative lymphatic mapping guiding lymphatic preservation during AABP repair. This study demonstrated real-time interpretation of intraoperative ICG to identify healthy lymphatic drainage to facilitate appropriate flap boundary selection. Furthermore, we demonstrated that intraoperative ICG lymphography during AABP repair can be standardized at two high-volume centers with reproducible findings. After several sessions, urologic providers at both sites could obtain and interpret studies reliably. Preexisting familiarity with the ICG platform may flatten the learning curve for other surgeons seeking to adopt lymphatic mapping as part of their reconstructive approach. Furthermore, the general availability of intraoperative near-infrared angiography should make this technique generalizable to interested providers.

Although the study herein was not designed to examine postoperative outcomes, this approach offers a compelling biologic rationale for postoperative lymphedema reduction and, potentially, recurrence of AABP.[25,26] In this limited series, relative sparing of lymphatic channels in the inferior scrotum extending posteriorly was consistently observed. This anatomic pattern directly supports—and helps systematize—the previously-described use of a posterior scrotal flap for scrotal reconstruction after excision of excess and/or diseased skin.[22] We hypothesize that delineation of flap margins to spare organized lymphatic channels may enhance venous/lymphatic outflow and wound healing.[27,28] These preserved channels may also foster lymphangiogenesis and re-establish functional connections in adjacent tissues. Furthermore, intraoperative lymphography could also identify lymphatic channels as possible targets for LVB, further highlighting the benefits of this multidisciplinary management approach.[29]

### Limitations

This study has some limitations that should be considered when applying the findings to contemporary patient care. The generalizability of our findings given the heterogeneity of our small cohort's surgical, oncologic, and bariatric history is limited. Therefore, all findings should be considered hypothesis-generating. Observer bias stemming from the subjective nature of lymphographic interpretation should also be considered. Notably, neither the sample size nor the follow-up regimen used in this study were designed to quantify surgical outcomes resulting from this procedural adjunct. Therefore, no conclusions relating to surgical outcomes can be drawn from the data presented herein.

### Future directions

Future studies using independent review of lymphographic images while controlling for factors known to affect lymphatic physiology will facilitate a deeper and more objective understanding of lymphedema in patients with AABP. Commentary on subpopulations with prior abdominal or genitourinary surgeries, those with prior pelvic radiation, and those with differing metabolic and bariatric histories should be considered in the future. This will be vital to identify patient populations that may benefit the most from intraoperative assessment or preoperative referral to a lymphedema specialist during surgical planning. A direct comparison of multiple genital lymphatic mapping methods, including ICG lymphography, lymphoscintigraphy, and magnetic resonance lymphangiography, would aid in the refinement of the reconstructive workflow for at-risk patients undergoing genital reconstruction and should be considered in the future.

Importantly, future work should also focus on quantitative pre- and postoperative lymphedema characterization to discern the effect of image-guided reconstructive planning on anatomical, functional, and patient-reported outcomes.

## Conclusions

Impaired lymphatic drainage of the external genitalia and adjacent soft tissue was universally observed in patients with AABP regardless of the underlying etiology. This consistent finding, coupled with the feasibility and safety of intraoperative ICG lymphography, suggests that close clinical attention should be paid to comorbid lymphedema in this patient population. Further, our findings provide a foundation on which future studies on real-time delineation of lymphatic pathways guiding flap design can be built. Future studies on surgical outcomes following implementation of ICG-guided

flap design is needed to understand if this approach reduces iatrogenic lymphedema in this high-risk cohort.

## Ethical approval

Local regulatory approval was obtained from each institutional IRB (Pitt STUDY23100173, Medstar STUDY00007221).

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## Declaration of Competing Interest

None declared.

## Declaration of Generative AI and AI-assisted technologies in the writing process

The authors did not use generative AI or AI-assisted technologies in the development of this manuscript.

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