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# Combined Double-breasted Full-thickness Abdominal Flap Plication and Acellular Dermal Matrix in Prune-belly Syndrome Reconstruction

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**Background:** Reconstruction of the abdominal wall in patients with prune-belly syndrome (PBS) following previous intra-abdominal procedures is a challenging problem with a high incidence of revision due to persistent bulging or herniation. The abdominal wall flaccidity not only produces a severe psychological and aesthetic discomfort for the patient but often determines functional disabilities, including inability to cough properly, impaired bowel and bladder function, and delay in posture and balance.

**Methods:** The authors describe three cases of reconstruction of abdominal wall using a modified double-breasted abdominoplasty fascial plication with additional acellular dermal matrix interposition and review the literature for innovations in the use of abdominal repair for reconstruction of these difficult cases.

**Results:** Three children with PBS at a mean age of 7.3 years achieved successful reconstruction of the abdominal wall, using the modified double-breasted abdominoplasty fascial plication with acellular dermal matrix interposition. Patients underwent previous procedures, including orchiopexy in two patients and bilateral nephrectomy in one patient. No postoperative complications have been found, apart from superficial skin dehiscence along the abdominal incision treated conservatively in one child. At mean follow-up of 42 months (range 28–56 months), no patient presented incisional hernia, persistent or recurrent fascial laxity with abdominal bulging. All patients achieved significant aesthetic and functional improvements, including children's ability to cough, spontaneous gain of abdominal tonus, balance, and ambulation.

**Conclusion:** Modification of the original vertical, two-layer plications of the deficient abdominal interposing biological mesh has the purpose of improving strength, aesthetics, and function of the abdominal wall in pediatric patients with PBS. *(Plast Reconstr Surg Glob Open 2024; 12:e5744; doi: 10.1097/GOX.0000000000005744; Published online 19 April 2024.)*

## INTRODUCTION

Reconstruction of the abdominal wall in patients with prune-belly syndrome (PBS) is a challenging task for plastic surgeons. Also referred to as Eagle-Barrett syndrome,[1] it is a rare congenital condition occurring in approximately one in 40,000 live births, with an incidence of 3.6 per 100,000 live births in the United States.[2–6] First described by Frolich in 1839 in a patient with congenital absence of abdominal wall musculature,[7] it occurs primarily in boys and occasionally in girls with a milder presentation.[8] The three main features of patients with PBS are abdominal-wall flaccidity with different stages of abdominal musculature hypoplasia, urologic anomalies, and bilateral cryptorchidism.[4,9–12] It is not uncommon that these patients present some degree of pulmonary dysfunction, skeletal deformities, cardiac anomalies, and gastrointestinal manifestations.[13–16] The etiology of PBS remains unknown, with a wide variety of theories being proposed.[10,15–18] The poor cosmetic abdominal appearance is often associated with psychosocial consequences

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and compromise of self-image for these children. Indeed, the abdominal musculature hypoplasia may produce physical limitations, including delays in sitting and walking, increase in upper respiratory infections secondary to an impaired cough mechanism, inability to entirely empty the bladder and evacuate the bowels, and severe constipation secondary to ineffective valsalva ability.[2,19–21]

Although most efforts have been focused on procedures to correct cryptorchidism and the urinary anomalies, there is a growing body of literature claiming the need for surgical repair of the abdominal wall to improve strength, function and cosmesis.[10,11,22] Several surgical techniques have been described over the years to reconstruct the abdominal wall in patients with PBS.[9,23–34] Most of the techniques proposed rely on either excision or plication of the abdominal wall weakness.[24–29]

Despite favorable results being described by these techniques, buldging occurrence remained significant and was seldom evaluated at a long-term follow-up.

We describe a modified abdominal wall reconstruction technique that combines the double-breasted abdominoplasty fascial plication to the use of a biological mesh of acellular dermal matrix (ADM), with the purpose of reinforcing the neo-abdominal wall, to reduce the risk of bulging occurrence and herniation.

**Takeaways**

**Question:** How to perform reconstruction of the abdominal wall in patients with prune-belly syndrome.

**Findings:** We achieved successful reconstruction of the abdominal wall using the modified double-breasted abdominoplasty fascial plication with ADM interposition.

**Meaning:** Biological mesh interposed to the double-breasted fascial plication for abdominal reconstruction is a valuable tool in the treatment of pediatric PBS patients, achieving a good cosmetic and functional outcome.

## PATIENT AND METHODS

A total of three children with PBS with a mean age of 7.3 years underwent reconstruction of abdominal wall using a modified double-breasted abdominoplasty fascial plication with additional ADM interposition between September 2017 and January 2019. All had undergone previous procedures, including orchiopexy in two children and bilateral nephrectomy in one patient (Table 1). This article conforms to the Declaration of Helsinki. Informed consent was obtained from the patients included in the study.

### Surgical Technique

Preoperatively, the patient's abdomen is assessed in the upright position first, next in horizontal decubitus, and during the Valsalva maneuver.

With the patient in the supine position under general anesthesia, a nasogastric tube is routinely inserted. A longitudinal ellipsoid marking starting just below the xiphoid process to above the pubis is drawn on the anterior abdomen (Figs. 1 and 2). Markings are made according to abdominal flaccidity and skin redundancy by test-pinching the redundant skin to the midline. After markings, the ellipsoid skin area is de-epithelialized with the umbilicus circumcised (Fig. 3). Once the skin is superficially removed, multiple (two or three) paramedian stab wound incisions are made from close to the midline to more laterally at the level of the umbilicus to assess the thickness and the presence of all tissue components from the dermal layer all the way deep to the peritoneum. A unilateral curved paramedian vertical incision is then performed to the fascia on the most redundant side, extending from the xiphoid to the pubic area, 3–4 cm from the midline measured at the level of the umbilicus. Next, dissection proceeds laterally. If the tissue-layers are present and can be separated, the dissection proceeds, mobilizing the dermis and subcutaneous components from the musculo-aponeurotic fascia until the anterior axillary line bilaterally.

If the abdominal layers are not present and therefore do not seem splittable, still maintaining adequate blood supply, as it happens most frequently, the same curvilinear paramedian incision is performed from the dermis down to the parietal peritoneum in one single layer. This allows us to define two full-thickness abdominal flaps.

At this point, once suitable exposure of the peritoneal cavity is achieved, releasing intra-abdominal adhesions between the parietal peritoneum and the bowel, intra-abdominal or urologic procedures may be performed if required. After completion, an overlapping double-breasted abdominoplasty fascial plication is performed bringing the wider abdominal fascia flap into the abdomen across the midline and secured laterally to the inner (peritoneal) side of the contralateral fascial flap with 3-0 Prolene suture (Ethicon, USA) (Figs. 4–5). Next, ADM SurgiMend (TEI Biosciences, Boston, Mass.), is placed and secured with 4/0 PDS suture (Ethicon, USA) to the wider abdominal fascia flap (Fig. 6). The ADM inserted

**Table 1. List of Three Patients with PBS Who Underwent Abdominal Wall Reconstruction Using the Modified Double-breasted Abdominoplasty Fascial Plication with ADM Interposition**

| Patient No. | Age | Previous Procedures (Age at the Time of the Procedure) | Abdominal Wall Findings | Complications Abdominal Wall Reconstruction | Follow-up (Mo) |
|---|---|---|---|---|---|
| 1 | 7 | • Bilateral ureteroneocystostomy (5) | Laxity with lack of musculature | — | 56 |
| 2 | 8 | • Bilateral orchiopexy (3)<br>• Appendicovesicostomy (5) | Severe muscle/fascia deficiency | Infection cellulitis | 28 |
| 3 | 7 | • Bilateral orchiopexy (2)<br>• Bilateral nephrectomy (5) | Muscle absence in medial/inferior portions | Superficial skin dehiscence in the abdominal midline | 42 |

**Fig. 1.** A 7-year-old boy presenting with PBS.

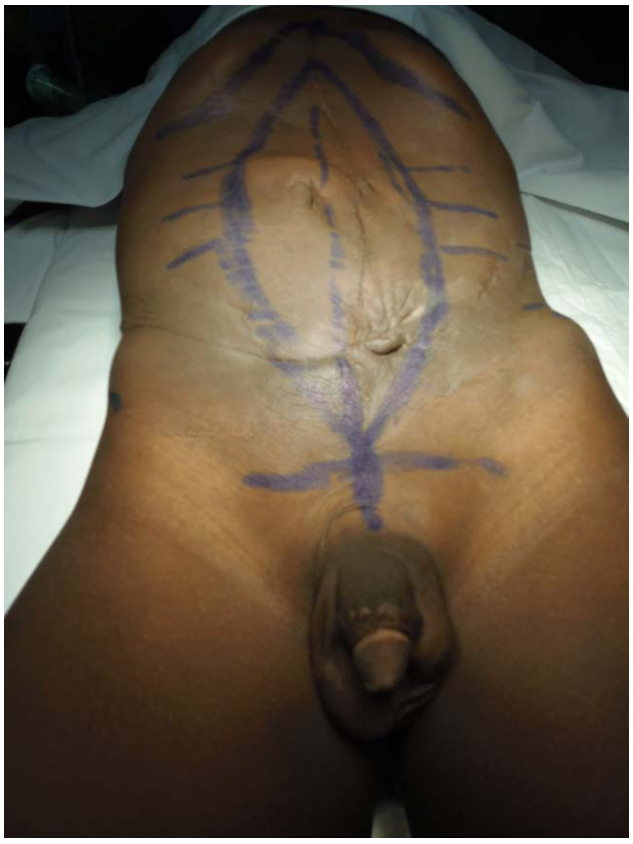

**Fig. 2.** Preoperative markings. A longitudinal ellipsoid is outlined starting just below the xyphoid process to above the pubis on the anterior abdomen.

was an unmeshed single sheet between the two flaps for optimal integration with dimensions of 10×20 cm. The mesh is covered superficially by the controlateral abdominal fascial flap that is previously scarred on the peritoneal side (Figs. 7–8). The distal margin of the superficial flap is then secured with the same 3-0 PDS sutures to the base of the underlying flap right at the margin of the deepithelialized area. With this maneuver, a sort of vascularized pocket is created between the two flaps for optimal mesh integration (Figs. 9–10). Two subcutaneous 5-mm Jackson-Pratt drains are left among the new abdominal wall and the pubic skin. The abdominal incision is finally closed with resorbable monofilament sutures for the approximation of the subcutaneous tissue and nonresorbable monofilament 4-0 sutures for the skin. Postoperatively, an abdominal binder is placed and recommended for 12 weeks. Postoperative antibiotic is administered, and the drains are usually removed by the fifth to sixth postoperative day, considering the fact that ADM was inserted. The criterion for drain removal was serum below 50 mL in 24 hours. One patient was discharged with no drains and the other two with drains.

## RESULTS

We performed abdominal wall reconstruction using the modified double-breasted abdominoplasty fascial plication with ADM interposition in three children with PBS (Table 1). No severe postoperative complications have been detected despite significant abdominal tightening. No pulmonary complication, such as atelectasis, occurred due to intra-abdominal pressure increase. There was no need for prolonged postoperative intubation.

Postoperative pain was managed according to standard protocols used for pediatric patients. There were no seromas or wound infections; however, one child experienced superficial skin dehiscence along the abdominal incision, treated conservatively. At a mean follow-up of 42 months (range 28–56 months), no patient presented incisional hernia or persistent or recurrent fascial laxity with abdominal bulging.

Postoperatively, all patients achieved significant improvement of aesthetic and tonus of the abdominal wall. Functional improvements regarding children's ability to cough, spontaneous gain of abdominal tonus, balance, and ambulation were also noted. No patient has required additional interventions to repair bulging or sagging of the abdominal wall.

## DISCUSSION

We report the successful use of biological mesh combined with double-breasted plication technique in abdominal wall reconstruction in the pediatric PBS population. Abdominal wall reconstruction can produce significant benefits to these patients, including reduction of flaccidity and improvement of appearance, removing most of the

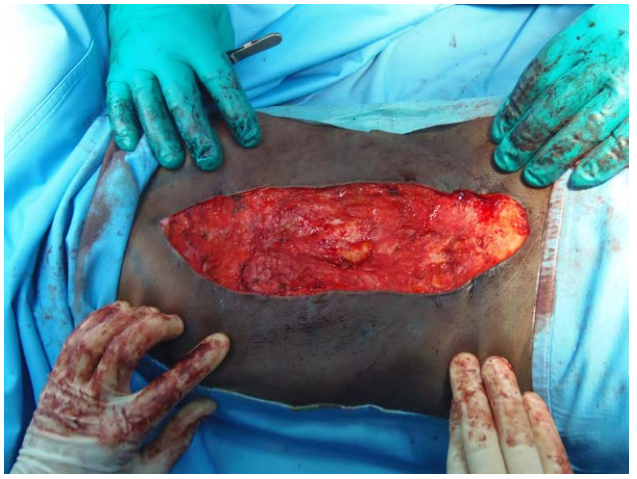

**Fig. 3.** The ellipsoid skin area is superficially removed and de-epithelialized.

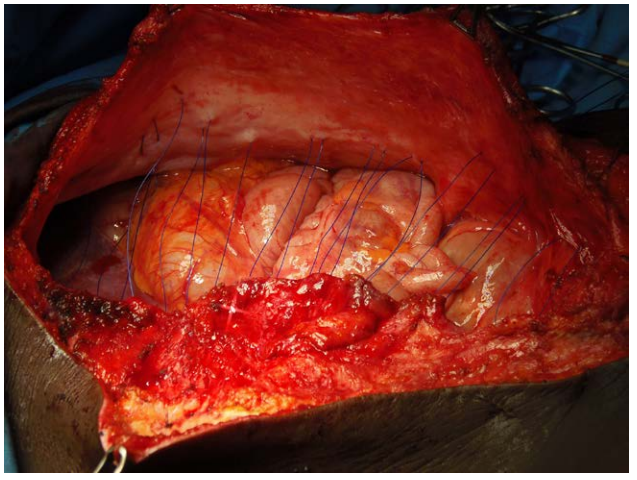

**Fig. 4.** Intraoperative view after full-thickness abdominal flap harvesting and preparing for double-layered suturing. The deep flap is secured first with nonabsorbable sutures. The mesh will be secured in a pocket between the two flaps.

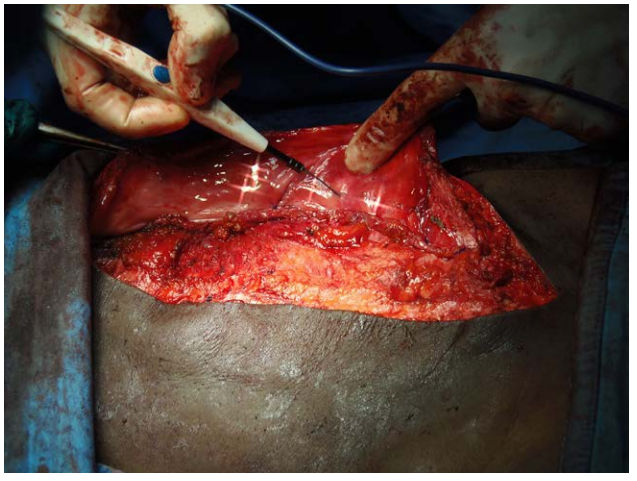

**Fig. 5.** The superficial flap is scarred on the peritoneal side.

**Fig. 6.** The ADM is placed over the deep flap and sutured at the basis of the superficial flap first.

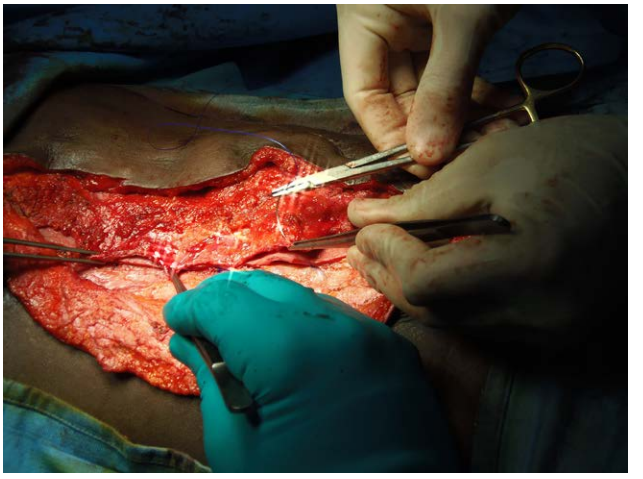

**Fig. 7.** The superficial flap is advanced over the ADM and sutured at the basis of the deep flap to achieve a triple layer.

**Fig. 8.** Appearance before skin closure.

**Fig. 9.** Postoperative view of the same child at 2-year follow-up, showing settled scars and a stable correction of the abdominal wall.

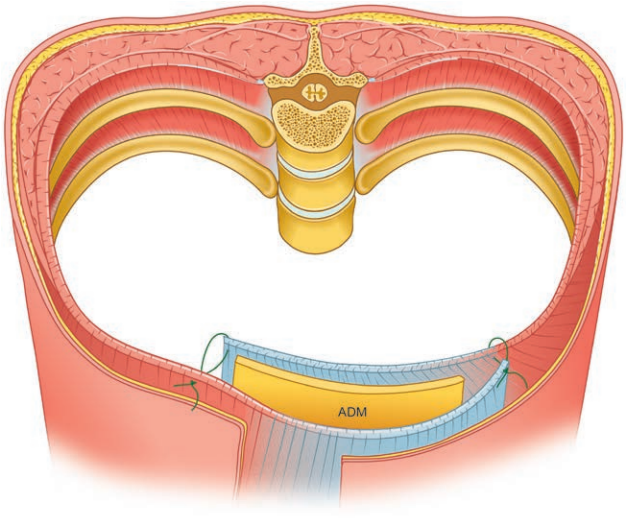


**Fig. 10.** Anatomical drawing showing the details of our technique: The mesh is secured in a pocket between the two full thickness abdominal flaps.

skin wrinkles. From the functional point of view, it provides an improvement in cough and in the body posture, and, indeed, it may also help in bladder emptying and bowel functions.[35,36]

Historically treated with external compressive bandages,[37] over the years, surgical management of abdomen flaccidity focused on decreasing abdominal wall distention due to congenital absence of abdominal muscles using local excision techniques and then fascial imbrications and plications.[9,23–34] Randolph et al reported abdominal wall reconstruction using U-shaped transverse incision, with full thickness excision of the redundant lower abdominal layers and advancement of the upper abdominal wall fascia musculature toward the pubis.[23]

In 1986, Ehrlich et al,[24,25] and more recently, Lesavoy et al[30] described an innovative fascial-plication technique through a midline incision, overlapping musculofascial flaps with medial advancement in a double-breasted fashion. Monfort et al described a technique of elliptical resection of redundant median skin and subcutaneous tissue from the xyphoid to the pubis, bilateral vertical fascial incisions with longitudinal advancement, and plication with umbilical preservation.[26,27]

In contrast, Denes et al[31,34] included elliptical skin removal with the umbilicus attached to the largest inner fascial flap and then passed through the smaller outer fascial flap and secured to skin edges.

In 1998, Furness et al described the Firlit technique for patients who do not require intra-abdominal surgery, consisting of a simple midline extraperitoneal fascial plication of the musculofascial layer with excision of the skin and subcutaneous layers and preservation of the umbilicus.[29]

In 2005, Franco reported a modification of the Firlit technique, consisting of laparoscopic suture to reinforce the abdominal wall medially.[38] Levine et al reported the laparoscope-assisted abdominal wall reconstruction.[32] Recently, Lopes et al described a robotic abdominoplasty for abdominal wall lateral bulging in adult patients with PBS.[39]

Our approach includes elliptical resection of the wrinkled abdominal skin. Then, through a paramedian incision, only one fascial incision is performed to release some abdominal adhesions, mobilizing the musculo-aponeurotic fascia. The addition of biological mesh (ADM) interposition between the two-fascial-layer overlapping plication of the abdominoplasty provides excellent reinforcement of the mid-abdomen with a triple-layered suture.

A review of the published literature has shown approximately 20% frequency for reoperations due to persistent or recurrent flaccidity or incisional hernia in patients with PBS.[33]

Using biological mesh, areas of weakness are supported by a further layer, avoiding bulging recurrence. In recent years, a large increase of novel biological materials has been reported to assist hernia closures in complex and infected operations.[40] In this series, SurgiMend was chosen over other biologics given the senior author's familiarity with its use in abdominal wall surgery and also in breast reconstruction and its relatively large body of data.[41–43] Using the biological mesh interposed to the double-breasted fascial plication, all three pediatric PBS patients achieved a good cosmetic and functional outcome and no one presented hernia complication or abdominal bulging recurrence.

Recently, Berjeaut et al described a case of prune perineum syndrome, a rare condition requiring both abdominal and pelvic surgery to correct malformations and improve the life quality of these children.[44]

The technique described for the reconstruction of the anterior abdominal wall in patients with PBS is designed to provide a triple layer to support the deficient anterior abdominal wall. Noticeably, the corporal image and self-esteem of these children improved dramatically, but also abdominal strength with improved upright body posture and ability to participate in common peer-related activities, even in sports. There are limitations to this study, such as a small number of patients, partly reflective of difficulty to recruit these patients.[45–47] Further studies with a longer follow-up time and a large number of patients will be more conclusive.

## CONCLUSIONS

Our small series builds on previous reports in this difficult patient population. Although additional studies with larger subject pools would assist in solidifying the observations seen in this study, initial findings suggest that ADM combined with double-breasted plication for abdominal reconstruction is a valuable tool in the treatment of these complex patients.

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## DISCLOSURE

*The authors have no financial interest to declare in relation to the content of this article.*

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