Use of Progressive Tension Sutures in Components Separation: Merging Cosmetic Surgery Techniques with Reconstructive Surgery Outcomes

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Summary: Components separation is a widely used technique for defect size reduction in abdominal wall reconstruction, and ultimately helps achieve gold standard primary fascial reapproximation in many cases. Even with perforator-sparing techniques, oftentimes there are undermined skin flaps to varying degrees that can lead to complications such as seromas. In this article, the author describes the previously published technique of "progressive tension sutures" reported in the cosmetic literature and extrapolates it to reconstructive abdominal surgery with statistically significant decreases in drain output. This technique also enables recruitment of skin to the midline to afford tension-free reapproximation and excision of redundancy, thereby discarding the most random portion of the skin flaps. (*Plast. Reconstr. Surg.* 130: 851, 2012.)

Components separation, originally described by Young in 1961[1] and repopularized by Ramirez in 1990,[2] revolutionized the way abdominal wall defects were reconstructed using totally autogenous methods. Although synthetic mesh had been introduced in the 1950s and was widely used, this novel autogenous technique helped reduce the need for mesh except in the larger hernias and, even when it was used, helped reduce the size of the defect. The components separation technique has been used by many surgeons since its introduction, and several subsequent studies and algorithms published have validated its utility in abdominal wall reconstruction.[3-9] This technique has gained additional popularity in recent years with the advent of biological materials which, combined with components separation, are able to achieve definitive reconstruction in many patients, even those with significant hernias and loss of domain or in those who have had contamination and previous infection—challenging situations for prosthetic meshes, to be sure.[10-15]

As with any surgical procedure, experience and newer understandings of anatomy modify the original description to optimize outcomes and minimize complications. There have been several such modifications for components separation, including the "minimally invasive approach" with limited incisions and undermining, the laparoscopic approach, and the perforator-sparing modification—all designed to increase the vascularity to the abdominal skin flap and avoid complications such as infections, dehiscence, and flap necrosis.[16,17] These modifications have been based on an increased understanding of underlying vascular anatomy, especially with respect to the perforators that travel to the skin, and newer technologies.

One modification to the traditional technique that has not been described in the literature, but which I routinely perform in my abdominal wall reconstruction practice, is based on an extrapolation of a concept in the plastic surgery literature originally described by Baroudi and Ferreira[18] and popularized by Pollock and Pollock—"progressive tension sutures."[19,20] This concept has been applied mainly to cosmetic abdominoplasties, where it is used to decrease dead space, minimize shear forces that create seromas, and allow for earlier drain removal and even avoidance of drain placement at all. The

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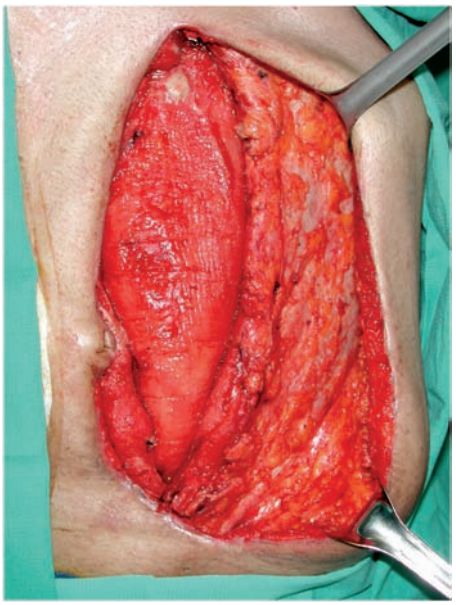

Fig. 1. Elevation of skin flaps just above the anterior abdominal fascia. Of note, perforator-sparing techniques should be used if possible. In this example, a non–perforator-sparing technique was used because of prior surgery that disrupted perforators.

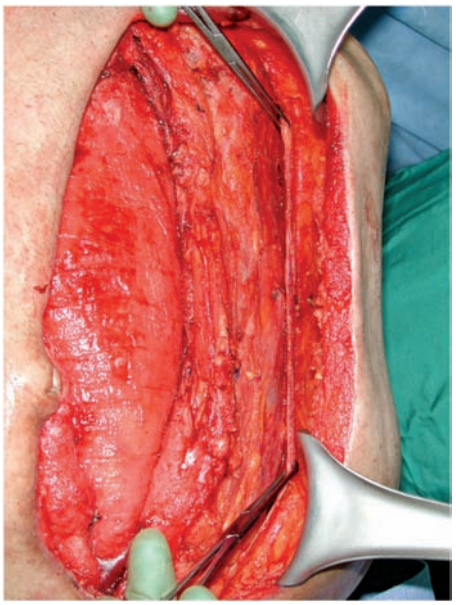

Fig. 2. After identification of the linea semilunaris through inspection, palpation, and electrocautery confirmation (which causes a muscle twitch and subsequent indentation along the semilunar line), an external oblique aponeurotomy is made 1 to 2 cm lateral to the linea semilunaris and the external oblique is raised from the internal oblique. Note the usual thinness of the external oblique.

original article was published in 2000, and most recently, a follow-up of 500 consecutive drainless abdominoplasties performed by Pollock and Pollock using this technique demonstrated zero seromas, validating the concept.[21] This concept differs from traditional "quilting sutures" in that it advances the skin flap toward the incision, not just suturing the flap down to the underlying fascia. This "progressive advancement" allows for a tension-free closure which, aside from being a fundamental concept to plastic surgery repairs, is of increased importance in the abdominal wall reconstruction patient where large abdominal hernias/defects require definitive soft-tissue closure—a challenging situation in many patients, particularly those with massive hernias, loss of domain, and a relative paucity of abdominal skin. The technique is as follows:

1. Remove the skin graft/lyse bowel adhesions from gutter to gutter/resect the hernia sac.
2. Develop the skin flaps to the anterior axillary line, or further if needed, at a level just above the anterior abdominal fascia (the case example used here is a non–perforator-sparing approach, although this technique can certainly be applied to the perforator-sparing approach, which is my preferred technique) (Fig. 1).
3. Identify the semilunar lines by inspection, palpation (intraabdominal bimanual palpation of the lateral rectus border), and, if needed, electrocautery confirmation by

Fig. 3. Execution of components separation with criterion standard midline fascial reapproximation, in this case with no. 2, nonburied, figure-of-eight, interrupted sutures.

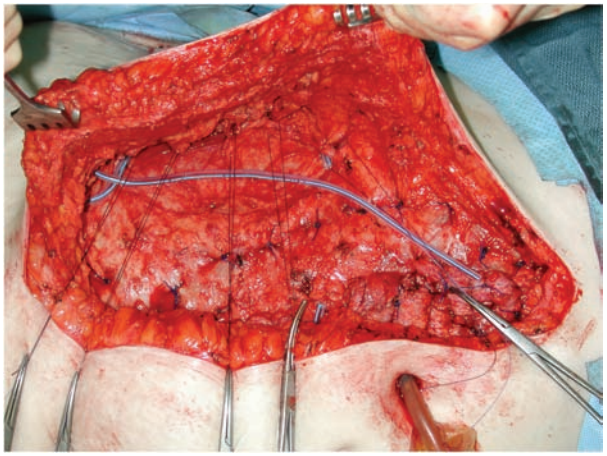

Fig. 4. Placement of one row of progressive tension sutures of 2-0 Vicryl (Ethicon, Inc., Somerville, N.J.) in an interrupted fashion, extending from the subcostal margin (*right side of photograph*) to the inguinal ligament (*left side of photograph*). The down bite is more medial on the anterior abdominal fascia, whereas the up bite is more lateral on the skin flap and engages a small amount of Scarpa fascia. These are tagged at first so as not to decrease exposure and subsequently are tied down.

tapping the cautery on the external oblique muscle, which causes a "divoting" along the semilunar line.

4. Release the external oblique aponeurosis fully and completely from the underlying internal oblique, including over the subcostal margin.
5. Perform dissection through the loose areolar plane to perform a components separation (Fig. 2).
6. Mobilize the rectus/external oblique complex to the midline bilaterally.
7. Place prosthetic or biological material for reinforcement and/or bridging, if applicable.
8. Perform closure of midline fascia after components separation (as much as possible) (Fig. 3).
9. Place drains.
10. Place progressive tension sutures to secure the skin flap to the underlying fascia. This is done with two to three packs of 2-0 polyglactin sutures on CT-1 pop-off needles. These are placed from lateral to medial in vertical rows that extend from the subcostal margin to the inguinal ligament. They are placed by catching one end through the abdominal wall fascia and the other through the undersurface of the flap to incorporate a small bite of the Scarpa fascia. These are tagged and subsequently tied only once the entire vertical row of sutures has been placed, which facilitates ease of placement and exposure. The flap is advanced again and the next row of sutures is placed. Traditionally, this has been accomplished in five vertical rows: two in the lateral gutters, two paramedian, and one in the midline (assuming primary fascial closure). Ultimately, the redundant skin and subcutaneous tissue is excised sharply, if needed, and the midline incision is closed using three-point 2-0 polyglactin sutures to obliterate the midline dead space and complete the closure, obviously making sure to avoid incorporation of the previously placed drains during the placement of all progressive tension sutures (Figs. 4 and 5).
11. Perform final skin closure (Fig. 6).

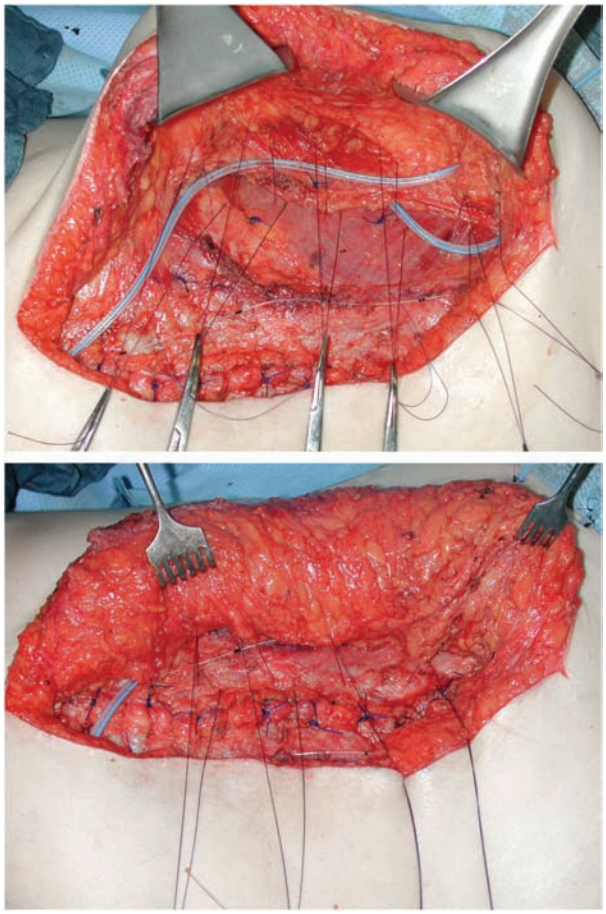

Fig. 5. (*Above*) Broad view of progressive tension suture placement in a vertical row. A drain has been placed. (*Below*) After advancement of the skin flap, another vertical row is placed.

Although this technique clearly lengthens the operative time, the difference is only marginal—on the order of 15 to 20 minutes. The advantages,

Fig. 6. Tension-free midline layered skin reapproximation after placement of progressive tension sutures and excision of redundancy.

however, are clear and have greatly enhanced my practice and patient satisfaction, especially when traditional complications such as seroma formation can be mitigated and when drains can be discontinued faster.

A further, more recent modification I have made uses the same concept but attempts to expedite the process through the use of running continuous barbed sutures. This was originally described in cosmetic abdominoplasties in 2010 by Rosen.[22] This is accomplished in the same vertical five rows, working from lateral to medial, and uses no. 0 unidirectional barbed polydioxanone sutures. The advantages are the elimination of knot bulk, use of monofilament sutures, closer apposition of the skin flap to the underlying fascia because of the use of a running continuous suture, and decreased time to execute this maneuver (Fig. 7).

It should be noted that this technique can be used even if midline fascial closure cannot be achieved. However, progressive tension sutures are not placed in the bridging material (prosthetic or biological) to avoid potential complications such as inadvertent bowel injury from iatrogenically incorporating bowel into the suture bite. Whether fascial closure is achieved or whether a bridge is used, drains are still placed to remove any fluid produced postoperatively, especially if a biological material is placed as a bridging underlay or overlay, to ensure apposition

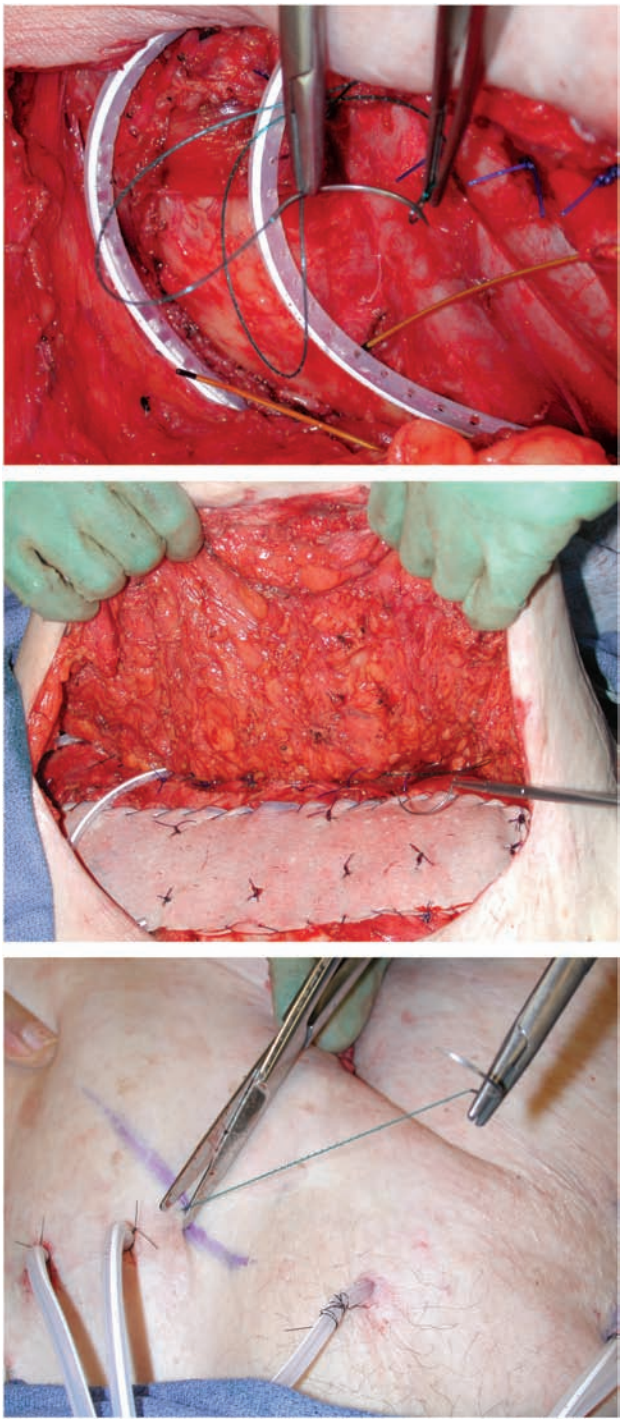

Fig. 7. (*Above*) A running barbed suture is used as a modification of the original technique to improve efficiency. The first suture bite, with elimination of knot bulk, is shown. (*Center*) After completion of one vertical row of running progressive tension suture technique with barbed suture seam and advancement of skin flap. Sandwich reinforcement (underlay/overlay) with non–cross-linked porcine acellular dermal matrix has been performed after primary fascial reapproximation and drain placement. (*Below*) Knotless completion of running barbed progressive tension suture.

Table 1. Average Drain Output: Progressive Tension Suture Group versus Control*

	No.	Day 1	Day 2	Day 3	Cumulative
PTS	9	103 ± 110.9	104.4 ± 115.2	168 ± 184.1	375.8 ± 313.9
Non-PTS	5	420 ± 249.1	335 ± 82	232 ± 103.2	987 ± 389
p†		0.0436	0.0011	0.4233 (NS)	0.0198

PTS, progressive tension suture; NS, not significant.
*Data are presented as average ± 1 SD drain output in cubic centimeters.
†Calculated using a two-tailed *t* test assuming unequal variances.

of the material to vascularized tissue to optimize incorporation.

Currently, a full clinical study is being conducted to prospectively collect and track outcomes and document this technique and its advantages in the peer-reviewed literature. Preliminary retrospective review of this technique over the 3 months before the start of the prospective data collection for future publication has demonstrated statistically significant decreases in drain output versus controls where progressive tension suturing is not performed (Table 1).

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