Redefining Abdominal Anatomy: 10 Key Elements for Restoring Form in Abdominoplasty

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Abstract

While traditional abdominoplasty methods can successfully achieve the objective of restoring a flat appearance, the results can be artificially board-like, lacking the subtle anatomical features of a three-dimensional abdomen, thus creating the potential for patient dissatisfaction. While often difficult to articulate, patient criticism is almost always distilled to the ubiquitous concern that the surgical abdomen lacks the natural features of an authentic, youthful abdomen. In an effort to provide a more anatomically accurate outcome and improve patient satisfaction, I have made a series of technical modifications to the abdominoplasty that I now perform. Ten key technical refinements, including a modified “Anatomy Defining” Progressive Tension Suture technique, were successively incorporated in 177 patients during the first 5 years of 2000-2014. All have been applied consistently in 961 abdominoplasty procedures during the subsequent 10 years, often accompanied by liposuction of adjacent lateral (non-abdominal) areas to ensure harmonious proportion. This series of refinements adds precision and detail by redefining the native anatomical nuances of the abdomen, an aesthetic objective that has been consistently achieved in BMI ranges between 20 and 35. Overall satisfaction with results was high (94%). The 10 elements described are safe, effective, and lasting.

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While traditional abdominoplasty methods can successfully achieve the objective of restoring a flat appearance, the results can be board-like, lacking the subtle anatomical features that characterize a youthful, attractive female abdomen. Previous methods have not consistently placed a primary emphasis on recreating specific anatomical features of the native abdomen. In addition, the technical tools required to attain the anatomical details present on the ideal aesthetic abdomen were limited prior to the publication of the Progressive Tension Suture (PTS) technique.¹

Numerous published studies have contributed to a more thorough understanding of the vascular anatomy of the entire abdominal unit, providing critical guidelines for more advanced techniques. By incorporating selective detailed maneuvers, three-dimensional anatomical character can be achieved safely and consistently.²,³

In my experience, anatomical authenticity is a particularly important objective in a prospective patient’s search for any cosmetic procedure, including abdominoplasty.

The surgical stigma of the traditional abdominoplasty dissuades many prospective patients from considering it as an option for improvement, except in the most profound situation, such as the major weight loss condition, where a cumbersome redundant panniculus is present.

During the initial consultation, an increasing number of my prospective patients express a desire to avoid the uniformly flat abdominal appearance which characterizes many of the abdominoplasty results they have viewed in person or online (Figure 1). In my opinion, their candid comments are a direct consequence of the abundance of digital media
available, which includes before and after photos and detailed conversations in women’s internet forums. These resources cultivate scrutinizing, sophisticated consumers whom I am seeing in consultations on a regular basis.

In 2000, Pollock and Pollock published the technique they originated (PTS), with the primary objective to reduce abdominoplasty-related clinical complications. This technique dramatically reduces seroma formation and theoretically enhances vascularity by distributing tension over the entire flap rather than at the incision line only. I began using this technique at that time, incorporating a modified anatomy-defining application as I became more proficient with the method. In addition, over the ensuing 5 years, I incorporated numerous other technical modifications aimed at improving overall aesthetic results and patient satisfaction.

PATIENT EVALUATION AND TECHNIQUE

During the physician-patient consultation of a potential abdominoplasty candidate, four elements of the abdomen require evaluation: skin laxity, excess subcutaneous fat, diastasis/hernia, and intra-abdominal fat. As part of my strategy, the abdominal flap is fully mobilized in nearly all cases; therefore, I have been reluctant to perform concomitant liposuction of the central flap.

If significant intra-abdominal fat is present, regardless of whether other factors also exist, pretreatment weight loss is necessary to provide a safe procedure and to achieve optimal aesthetic outcomes. If diastasis or skin laxity is present, an abdominoplasty of some type is recommended. The type of abdominoplasty (mini, modified, full) is based upon the specific anatomical location of skin laxity, excess fat, and diastasis. The most favorable circumstance, where liposuction alone is recommended, occurs when there is good skin tone with no more than moderate excess fat present (usually in the nulliparous young patient). The key aesthetic goals of this abdominoplasty procedure include the following:

1. low scar positioning to facilitate concealment in a modest undergarment or swimsuit;
2. uniform upper and lower fascial repair, limited to the defect present, to ensure congruent restoration;
3. differential fat thickness of the abdominal flap to more accurately replicate the native condition;
4. uniform skin tone of the entire abdominal aesthetic unit, from the costal margin and xiphoid to the symphysis pubic and inguinal crease;
5. subtle three-dimensional character that delineates the linea alba and linea semilunaris and the contour depression of the lateral abdomen/anterior waist;
6. concomitant mons treatment for skin laxity, atrophic loss of skin tone, and excess fat content within the aesthetic unit;
7. smooth soft tissue transitioning at the incision line to reduce the “step-off” effect;
8. attentive treatment of the entire torso unit, particularly the hip and waist, to ensure overall aesthetic harmony; and
9. a deeply-contoured, vertical umbilicus that accurately recreates an attractive prepartal umbilicus.

From 2000 to 2014, I performed a total of 1138 abdominoplasty procedures. Within the first five years of this period, the technical details described here were progressively employed and refined through repetition. In the ensuing 10 years, all of these elements were consistently employed in all patients. Ten key technical elements comprise this

Figure 1. (A, B) Six months after undergoing abdominoplasty with another surgeon, this 36-year-old mother of three sought a second opinion on her procedure results, which she described as unnatural and overly surgical in appearance.
abdominoplasty method, and a video demonstrating the technique can be viewed in the Supplementary Material.

**Element 1: Strategic Low Position of the Incision**

The incision is placed approximately six centimeters above the vulvar commissure as described by Lockwood and Matarasso. This allows resection of hair-bearing suprapubic skin, providing the advantage of avoiding elevation of the hairline. The scar is horizontal to 1-2 cm above the inguinal crease and ascends at a slight 20-30 degree angle to a point approximately 6-9 cm (dependent on bony anatomy and torso length) below the anterior-superior iliac spine. This design most closely follows the underwear waistband or swimsuit bottom in women’s current styles (Figure 2).

Not infrequently, low positioning of the incision necessitates vertical closure of the umbilical defect at some point between the umbilicorraphy and the suprapubic incision. Attentive Scarpa’s fascia approximation of the vertical repair, from beneath the raised flap, usually prevents an unattractive scar depression. During lower abdominal incisional repair, a three-point fixation of Scarpa’s fascia to the rectus and external oblique fascia with a 0 (polydioxanone) plus suture (PDS) suture helps reduce the tendency toward superior migration of the scar. Finally, a low incision puts the lateral femoral cutaneous nerve more at risk for injury, necessitating cautious dissection and avoidance.

**Figure 2.** Pretreatment markings demonstrated on a 34-year-old woman. The linea alba and linea semilunaris are defined. Suprapubic incision is marked 6 cm above the vulvar introitus, with the incision rising at a 20 to 30 degree angle laterally to a point approximately 6 to 9 cm below the anterior superior iliac spine.

**Element 2: Thorough Abdominal Flap Mobilization**

To facilitate the technical details of this procedure, a thorough abdominal flap mobilization is required. The flap dissection is continuous centrally to the xiphoid, preserving the superior lateral rectus perforators along the upper third of the rectus muscle. Cautious discontinuous dissection is performed along the costal margin lateral to the lateral rectus perforators, preserving segmental perforators as well. The extent of discontinuous dissection is made intraoperatively when the vascular anatomy and flap mobility can be more accurately assessed. Because the flap is thoroughly mobilized as described with this technique, liposuction of the central flap is not performed (Figure 3).

**Figure 3.** Thorough mobilization of the abdominal skin flap demonstrated on a 27-year-old female. The superior extent of the dissection is continued to the base of the xiphoid process. Above the umbilicus, it extends laterally to a point medial to the lateral rectus perforators. Discontinuous undermining is performed laterally along the upper and lower flap as needed to facilitate mobility.

**Element 3: Complete Diastasis Repair**

Ideally, in most circumstances, an accurate correction of the rectus muscle separation along its medial edge, and no more, provides the best chance for balanced harmony of the aesthetic abdominal unit. This is achieved by applying equal tension above and below the umbilicus, from the xiphoid process to the umbilicus and from the umbilicus to the symphysis pubis, utilizing a single, two-layer, running permanent monofilament suture (#1 Prolene) for each segment. Additionally, a separate purse string periumbilical repair (#1 Prolene) is incorporated in order to strengthen this weak zone and subtly invaginate the umbilicus for a more deeply contoured umbilicorraphy, described in Element 10 (Figure 4).
Once the abdominal flap is elevated, the vascularity of the deep fat is dependent upon the subdermal plexus of the superficial fat pad. Therefore, the deep fat pad below Scarpa’s fascia can be safely trimmed along the linea alba, linea semilunaris, and external oblique fascia. A thinner fat pad over the external oblique muscle deepens the waist and improves anatomical accuracy. In addition, thinning the sub-Scarpa’s fat over the external oblique exposes Scarpa’s fascia, facilitating secure placement of Anatomy Defining-Progressive Tension Sutures (AD-PTS) (2-0 PDS). This emphasizes definition along the semilunaris by simulating the zone of adherence. The lateral skin flap can then be advanced inferiorly and medially to enhance waistline definition (Figures 5 and 6).

**Element 4: Sub-Scarpa’s Fat Thinning**

Progressive tension sutures are strategically placed to enhance anatomical definition. After midline fat thinning over the linea alba via small cannula liposuction or direct excision, a running AD-PTS is utilized to further define and add tone to the midline sulcus. This usually requires 10-12 loops of 2-0 PDS in a running fashion, advancing the midline from the origin of the xiphoid process to the base of the umbilicus. The linea semilunaris is reestablished with a series of 5-6 interrupted 2-0 PDS AD-PTS on each side along the confluence of the external oblique and anterior rectus fascia. The lateral skin flap is advanced medially and inferiorly to define the anterior waist and to reduce the potential

**Element 5: Anatomy Defining-Progressive Tension Sutures**

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**Figure 4.** Umbilicorraphy involves several sequential steps, as demonstrated on a 27-year-old woman. (A) A lax periumbilical fascia is often present after upper and lower diastasis repair. A circumferential marking is demonstrated for the planned periumbilical repair. A long umbilical stalk will require both shortening and stabilization at the 1, 5, 7, and 11 o’clock positions. (B) Circumferential purse string periumbilical repair with 0-Prolene deepens the appearance of the umbilicus and balances the overall diastasis repair. The shortened umbilical stalk is secured to the rectus fascia at the 1, 5, 7 and 11 o’clock positions using 3-0 PDS. The planned area of fat resection at the umbilicorraphy inset site is demonstrated. (C) A substantial vertical fat deficit is demonstrated after umbilical detachment. (D) Completed resection of fat at the umbilicorraphy site simulates the native condition.
for lateral skin redundancy (dog ears) with an additional series of 2-0 PDS interrupted sutures (6-8) on each side. Additional interrupted 2-0 PDS progressive tension sutures (6-8) are placed centrally and inferiorly to advance the flap and reduce potential space (Figures 7 and 8).

Element 6: Vertical Closure of Umbilical Defect if Needed

In the technique described here, a priority is placed on keeping the horizontal incision very low, as described in Element 1. When inadequate skin is available to allow complete resection of skin from the suprapubic incision to the umbilicus, a vertical umbilical defect repair may be required. The vertical defect is first approximated from beneath the abdominal flap while it is still elevated. Deep internal flap repair of Scarpa’s fascia may reduce the chance that a scar contracture with a contour depression (referred to as “second belly button” by some patients) will occur.

Element 7: Mons Rejuvenation

Resection of excess fat and redundant skin are frequently both required for adequate treatment. This is initiated by sub-Scarpa’s fat resection, thinning the mons fat pad while also exposing Scarpa’s fascia. Superior mons advancement and stabilization is then accomplished by utilizing 3-5 interrupted deep 0 PDS sutures, attaching the exposed Scarpa’s fascia to the underlying rectus fascia. After mons advancement, additional resection of lax hair-bearing pubic skin may be necessary to maintain a low superior pubic hairline and to ensure equalization of skin tone of the abdominal-mons aesthetic unit (Figure 9).

Element 8: Customization of the Abdominal Skin Flap

Skin flap resection as the standard initial maneuver in an abdominoplasty may limit precise evaluation of redundancy. Over-resection of the skin flap may sometimes occur, leading to the adverse effects of excess skin tension and superior scar migration. Thorough flap mobilization, diastasis correction, and flap advancement with progressive tension sutures facilitate a truer assessment of skin laxity; for that reason, I prefer for this step to precede resection. The flap design can then be shaped along the lower incision for a precise match and tension-free repair (Figure 10).

Figure 5. Sub-Scarpa’s fat resection, as demonstrated on a 27-year-old woman. (A) Once the flap is completely mobilized, sub-Scarpa’s fat resection is performed from lateral to medial on each side. (B) This intraoperative view demonstrates exposed Scarpa’s fascia on the right side of the elevated flap after sub-Scarpa’s fat resection.

Figure 6. In order to enhance linea alba depth, midline fat resection precedes placement of AD-PTS, as demonstrated on a 27-year-old woman.
Figure 7. Anatomy defining-progressive tension sutures. (A) This schematic represents the sequencing of anatomy defining-progressive tension sutures. Restoration of the linea alba is completed first. Restoration of the linea semilunaris and advancement of the lateral skin flap proceeds from medial to lateral. (B) The intraoperative sequence for placement of anatomy defining-progressive tension sutures is demonstrated on a 33-year-old woman for the right side of the elevated flap.

Figure 8. Profile view of abdomen. (A) This is an intraoperative view of a 33-year-old woman of the linea semilunaris (LSL) marking and the vector of advancement for the lateral flap. (B) An immediate posttreatment profile view displays the effect of Anatomy Defining-Progressive Tension Sutures upon the linea alba, linea semilunaris, and the lateral skin flap; umbilical depth is also shown.

**Element 9: Precise Tissue Transition at Incision**

Soft tissue equalization at the incision line by sub-Scarpa’s fat thinning of either the upper flap or mons, subject to relative thickness, is frequently required to achieve a smooth transition at the incisional repair. A comparatively thicker abdominal flap at the incision may result in an unnatural looking step-off. The fat thickness of the inferior horizontal incision is usually much thinner than the upper flap, requiring sub-Scarpa’s fat resection of the upper flap. In addition, deep repair of Scarpa’s fascia is performed to reduce the potential for a depressed, contracted scar (Figure 11).

**Element 10: Deeply Contoured Umbilicus**

As the initial maneuver, the umbilicus is assessed for an umbilical hernia, which is especially common in the postpartum patient. On occasion an umbilical hernia may be detected intraoperatively when it wasn’t recognized.
pretreatment. When present, I utilize the subfascial technique described by Bruner et al.8 The umbilical hernia is accessed through a 2-3 cm vertical fascial incision 2 cm inferior to the umbilical base, and repaired with one or two horizontal mattress 2-0 permanent sutures. This technique is simple and reliably preserves an umbilical blood supply (Figure 12).

When redundant, the umbilical stalk is shortened by direct skin excision to a length of approximately 50% of the skin flap depth. The umbilical skin at the base is then deeply fixedated to the rectus fascia with 3-0 PDS at the 1, 5, 7, and 11 o’clock positions to create a stable, vertically-oriented foundation.

After umbilical base fixation, a periumbilical purse string suture of 0 Prolene is utilized to strengthen the weak zone between the upper and lower diastasis repair. This technique also shortens and subtly invaginates the umbilicus and surrounding periumbilical area to assist in deepening the umbilicus.

A generous vertically-oriented fat resection is performed at the umbilicorraphy inset site to replicate the native condition and enhance the appearance of depth.

A deepithelialized vertically-oriented oval, measuring 2 cm × 1.2 cm superiorly and 2 cm × 0.8 cm inferiorly, is created, overlying the stabilized umbilicus. An “X” incision is made in the dermis of this oval, creating four separate dermal flaps (superior, inferior, right lateral, and left lateral) that can be utilized to advance the oval deeply to the rectus fascia with long lasting 3-0 PDS sutures. Umbilical length is then reassessed, and shortened if needed to approximate the dermis of the deepithelialized skin edge to the umbilical dermis.

This approach is similar to that described by Pollock and Pollock,9 except that the umbilical skin edge is not included in the suture advancing the abdominal flap to the rectus fascia but approximated independently so that additional redundant umbilical skin can resected once accurately assessed as the final maneuver. The umbilicus is inset into a vertical oval skin excision, slightly wider superiorly than inferiorly, in the skin flap directly over it. Meticulous dermal edge closure with a subcuticular absorbable suture (5-0 Monocryl) reduces the chance for suture cross hatches. The combination of these independent steps assists in bringing the scar posteriorly toward the base and reduces the potential for widening and/or eversion of the umbilicorraphy (Figure 1).

Figure 9. Mons rejuvenation: view of mons from cephalad, as demonstrated on a 27-year-old woman. (A) Sub-Scarpa’s fat resection and superior advancement of the mons is frequently required to harmonize the abdominal-mons aesthetic unit. (B) Once the mons is advanced and secured, additional skin resection is often required to avoid elevation of the public hairline.

Figure 10. Skin flap customization demonstrated on a 34-year-old woman. Skin flap design and resection follows advancement with progressive tension sutures.
RESULTS

In my series, 210 consecutive abdominoplasties (207 women, 3 men) performed during a 27-month period from January 1, 2012, through March 31, 2014, with an average follow-up period of 7.6 months (range 2-30 months), were retrospectively reviewed. Age ranged from 26 to 67 with an average age of 41.3. BMI ranged from 19 to 38, with an average of 25.4 (Table 1).

In 83% (174/210) of patients, concomitant liposuction of lateral areas (hips, flanks, thighs) was performed. Because the technique described here requires full abdominal flap mobilization to the costal margin, central liposuction of the abdominal skin flap was not performed in any patient. In addition, 34% (71/210) of patients had an adjacent hip/flank skin excision for redundancy or a formal lower body lift procedure. In 30% of patients (63/210), a vertical umbilical defect repair was required to avoid a high horizontal incision. An umbilical float was performed in 2.3% (5/210) of patients.

A major complication rate of 2.3% (five patients) was seen (Table 2). All five patients developed hematomas requiring evacuation under anesthesia in the operating room. An additional patient (0.5%) required evacuation of a small hematoma under local anesthesia. In our cohort, all 210 abdominoplasty patients were treated with deep vein thrombosis (DVT) chemoprophylaxis using Xarelto for 5 days posttreatment. Since April 2014, we have switched to Eliquis because of a higher than acceptable posttreatment hematoma rate with Xarelto. There were no occurrences of major flap necrosis (≥5 sq cm), while 1.4% (3/210) of cases had minor (<5 sq cm) ischemic necrosis along the lower abdominal incision line. There were no clinically relevant seromas in our series.

In approximately 8.1% (17/210) of my patient cohort, revision of the lower abdominal horizontal scar, lateral dog ears, and/or vertical scar under local anesthesia to correct contraction/depression, protuberance, or hypertrophy was necessary to optimize aesthetics (Table 3). An additional 4.3% (9/210) of patients required umbilical revision for residual redundant skin, lack of sufficient depth, or scar constriction.

In summary, a total of 15.2% (32/210) of patients required a secondary procedure, of which 2.3% (five hematoma evacuations) were performed under general anesthesia and 12.9% (26 scar revisions and one hematoma evacuation) were performed under local anesthesia in the office (Table 4).

An unvalidated satisfaction survey request was sent by direct mail and by email through Constant Contact (Waltham, MA), an independent online survey company, to 156 consecutive abdominoplasty patients treated over the 18-month period from October 2012 through March 2014) with a minimum follow-up of 6 months. All requests allowed complete anonymity. A total of 139 patients actually received the email request, with 17 bouncing back as undeliverable. Of the 139 receiving email requests, a total of 67 patients returned completed questionnaires. An additional 23 patients returned questionnaires by direct mail in self-addressed envelopes. All surveys were tallied by an independent observer. A total of 90 patients completed questionnaires via Constant Contact or direct mail, out of a total 156 receiving them (58% response rate). A grading scale of 1-5, ranging from poor to excellent, was provided. The survey results are provided in Table 5 (a blank copy of the survey is available as Supplementary Material).

DISCUSSION

Positive advances in aesthetic surgery predominantly focus on transformation that is safe and natural, as they should. The ten elements described provide a surgical plan that is
straightforward to implement, and which has achieved predictable and improved aesthetic outcomes for my abdominoplasty patients.

The ten elements described provide a methodical strategy for most patients, regardless of potentially limiting factors generated by preexisting conditions such as higher or lower than ideal body mass index (BMI) or history of major weight loss. In my practice over the last two decades, abdominoplasty surgery has trended toward lower incisions as a direct result of patient demand. Women are very consistent in their criticism of a scar that cannot be concealed in underwear or a two-piece swimsuit. In my experience, patients overwhelmingly prefer a short vertical closure of the umbilical defect to a high abdominoplasty scar, when given a choice.

While a vertical scar from an umbilical defect repair is not ideal, a high horizontal scar seems to be more unfavorable to women when inadequate upper abdominal skin laxity precludes complete skin flap excision to the umbilicus. In my experience, a vertical scar, in the patient’s mind, is not a definitive characteristic of a “tummy tuck,” and therefore the patient is more comfortable in a two-piece swimsuit than

Figure 12. Illustrations demonstrating umbilicorrphy. (A) De-epithelialization of an asymmetrical vertical oval (~2 cm × 1 cm) over the secured umbilicus. (B) An X-incision through the dermis creates four small V-shaped dermal flaps that retract, exposing remaining umbilical fat. (C) Remaining subdermal fat is resected to expose the umbilical skin. (D) The small dermal flaps are advanced sequentially at the 12, 3, 6, and 9 o'clock positions, incorporating the umbilical stalk and the rectus fascia with 3-0 PDS. (E) After dermal advancement, the remaining excess umbilical length is shortened. (F) The skin is approximated via a subcuticular repair at the dermal epidermal interface (ie, edge of de-epithelialized skin). (G) Deep umbilical inset completed. Illustration credit: Mike de la Flor, CMI.
she would be with a high horizontal scar. Generally, when approximated well, a vertical scar is inconspicuous and less identifiable as a stigmata of abdominoplasty surgery than a high horizontal scar.

In addition, excessive skin flap removal and a high-tension closure have numerous potential disadvantages, both clinically and aesthetically. Vascular compromise can result in skin flap necrosis, with the distressing attendant physical and emotional consequences for both the patient and the surgeon. Many discriminating female patients consider a high scar aesthetically unacceptable because it fails to achieve a common goal to wear a two-piece swimsuit without the obvious stigmata of a "tummy tuck." Equally disappointing adverse aesthetic consequences of excessive skin flap removal are an unattractive elevation of the pubic hairline and altered genital anatomy. Hypertrophic scarring is also more likely.

So that all elements of this technique can be effectively implemented, a thorough mobilization of the abdominal flap is required (Figure 3). Full flap mobilization facilitates skin tone equalization between the upper and lower abdomen and allows an even, thorough distribution of AD-PTS. The advantages are:

(a) uniform skin tone can be restored over the entire abdominal aesthetic unit;
(b) zones of adherence can be recreated; and
(c) skin advancement will facilitate more accurate skin removal and maintenance of a stable low incision placement by reducing excessive tension at the incision.

Preservation of the superior row of lateral rectus perforators can be accomplished with cautious discontinuous upper flap separation. Exposure of the upper midline over the xiphoid process is necessary to adequately thin the

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**Table 1. Summary Demographic Data for Patients Undergoing Abdominoplasty Between January 1, 2012, and March 31, 2014 (n = 210)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, mean (range) yr.</td>
<td>41.33 (26-67)</td>
</tr>
<tr>
<td>Sex, no.</td>
<td></td>
</tr>
<tr>
<td>Women</td>
<td>207</td>
</tr>
<tr>
<td>Men</td>
<td>3</td>
</tr>
<tr>
<td>Follow-up, mean (range), mos.</td>
<td>7.6 (2-30)</td>
</tr>
<tr>
<td>BMI, Mean (range),%</td>
<td>25.4 (19-38)</td>
</tr>
<tr>
<td>Central liposuction</td>
<td>0 (0%)</td>
</tr>
<tr>
<td>Lateral liposuction</td>
<td>174 (83%)</td>
</tr>
<tr>
<td>Chemoprophylaxis for DVT (5 days)</td>
<td>210 (100%)</td>
</tr>
<tr>
<td>Vertical umbilical defect repair</td>
<td>63 (30%)</td>
</tr>
<tr>
<td>Umbilical float</td>
<td>5 (2.3%)</td>
</tr>
</tbody>
</table>

DVT, deep vein thrombosis.

**Table 2. Abdominoplasty Complications Within 30 Days (n = 210)**

<table>
<thead>
<tr>
<th>Complication</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Major hematoma (requiring treatment in operating room)</td>
<td>5 (2.3)</td>
</tr>
<tr>
<td>Minor hematoma (office treatment)</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Major flap necrosis (≥5 sq. cm)</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Minor flap necrosis (&lt;5 sq. cm)</td>
<td>3 (1.4)</td>
</tr>
<tr>
<td>Seroma</td>
<td>0 (0)</td>
</tr>
<tr>
<td>DVT</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Infection (minor cellulitis)</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Total</td>
<td>10 (4.7%)</td>
</tr>
</tbody>
</table>

DVT, deep vein thrombosis.

**Table 3. Abdominoplasty Scar Revision Local Anesthesia (n = 210)**

<table>
<thead>
<tr>
<th>Revision Location</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower abdominal</td>
<td>12 (5.7)</td>
</tr>
<tr>
<td>Vertical (at umbilical defect repair site)</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Dog ear excision</td>
<td>4 (1.9)</td>
</tr>
<tr>
<td>Umbilical</td>
<td>9 (4.3)</td>
</tr>
<tr>
<td>Total</td>
<td>26 (12.4)</td>
</tr>
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</table>

**Table 4. Total Re-Operation Rate**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scar revisions (local anesthesia)</td>
<td>26 (12.4)</td>
</tr>
<tr>
<td>Hematoma evacuation (local anesthesia)</td>
<td>1 (0.5)</td>
</tr>
<tr>
<td>Hematoma evacuation (general anesthesia)</td>
<td>5 (2.3)</td>
</tr>
<tr>
<td>Total</td>
<td>32 (15.2)</td>
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superior origin of the linea alba and taper the diastasis repair to avoid a potential epigastric bulge. In addition, full mobilization facilitates advancement of the upper flap, with progressive tension sutures from the costal margin to the lower incision so that an even skin tone of the entire abdominal unit can be established and toned definition.

Table 5. Abdominoplasty Satisfaction Survey

<table>
<thead>
<tr>
<th>Response</th>
<th>No. (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Natural looking</td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>71 (81)</td>
</tr>
<tr>
<td>Good</td>
<td>14 (16)</td>
</tr>
<tr>
<td>Average</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Fair</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Poor</td>
<td>0 (0)</td>
</tr>
<tr>
<td>Belly button</td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>51 (59)</td>
</tr>
<tr>
<td>Good</td>
<td>24 (28)</td>
</tr>
<tr>
<td>Average</td>
<td>5 (6)</td>
</tr>
<tr>
<td>Fair</td>
<td>5 (6)</td>
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<tr>
<td>Poor</td>
<td>1 (1)</td>
</tr>
<tr>
<td>Overall expectations</td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>69 (79)</td>
</tr>
<tr>
<td>Good</td>
<td>11 (13)</td>
</tr>
<tr>
<td>Average</td>
<td>3 (3)</td>
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<tr>
<td>Fair</td>
<td>2 (2)</td>
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<tr>
<td>Poor</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Overall results</td>
<td></td>
</tr>
<tr>
<td>Excellent</td>
<td>69 (78)</td>
</tr>
<tr>
<td>Good</td>
<td>13 (15)</td>
</tr>
<tr>
<td>Average</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Fair</td>
<td>2 (2)</td>
</tr>
<tr>
<td>Poor</td>
<td>2 (2)</td>
</tr>
</tbody>
</table>

An abdominoplasty satisfaction survey of 90 patient respondents is demonstrated. A total of 156 consecutive abdominoplasty patients received requests (58% response rate).

Figure 13. (A, C, E) Pretreatment and (B, D, F) 1-year post-treatment views of a 35-year-old woman who underwent abdominoplasty; liposuction of hips, flanks, and outer thighs; lower body lift; breast augmentation; and mastopexy.
of the linea alba and linea semilunaris can be achieved (Figure 13).

Inadequate flap mobilization may result in abdominal unit disharmony, most commonly seen in mini-abdominoplasty surgery. This occurs when there has been excessive lower abdominal skin resection and/or isolated lower diastasis repair without treatment of upper abdominal skin laxity or diastasis, leaving a relative upper abdominal protuberance that appears unnatural (Supplementary Figure 1). The isolated lower fascial repair focuses tension in an unequal manner on the lower segment of the aesthetic unit, potentially creating an unusual and unattractive convexity of the upper abdomen. In my experience, the resulting abdominal unit disharmony is a common source of patient dissatisfaction. The well-informed potential patient may describe this as a “botched tummy tuck,” decreasing their confidence in the procedure when it is recommended. Revision surgery is often required.

Diastasis is an attenuation of the intermuscular raphe with widening of the distance between the rectus abdominus muscles, most often occurring during pregnancy. There are no non-surgical corrective techniques or exercises to correct this. During surgical exposure there is an identifiable defect between the medial edges of the rectus muscles that can be outlined and repaired. Much has been written by Nahas and others about the technical details of diastasis repair.10-16 When overcorrected beyond the medial edge of the rectus muscle, van Uchelen et al.11 demonstrated recurrence to be as high as 40%. In my experience, when overcorrected, the risk of intraoperative fascial tears and intramuscular hematomas is much higher despite the use of muscular paralytics employed during this portion of the procedure. Posttreatment, when pain, spasm, and movement occurs, theoretically there may be an even higher likelihood that fascial tears, bleeding, and separation will result.

In addition, overcorrection beyond the medial rectus may not accurately recreate the native anatomy as it existed prior to pregnancy. In my opinion, adequately treated diastasis is more likely to restore a more natural state that gives a slight concavity of the upper abdomen and a slight convexity of the lower abdomen represented by a soft lazy “S” on oblique view (Figure 13).

The primary advantage of the PTS technique as originally described by Pollock and Pollock in 200017 is the successful reduction in the risk of clinically relevant seromas. My experience has paralleled that of Pollock and Pollock17 and Antonetti and Antonetti18 regarding seroma formation. There have been no clinically significant fluid collections in the 210 consecutive cases in this cohort. Preventing seroma formation and the potential sequelae avoids adverse aesthetic consequences as well.

This technique can also now be utilized to enhance aesthetic outcomes through an anatomy defining application. In its natural state, the three-dimensional character of the well-toned, attractive abdomen exhibits differential fat thickness along the different zones of the abdominal aesthetic unit.

Once the flap is elevated, the deep sub-Scarpa’s fat is entirely dependent on its vascularity through the sub dermal plexus. Therefore, it is safe to thin sub-Scarpa’s fat in a precise pattern over the linea alba, linea semilunaris, and external

Figure 14. (A, C, E) Pretreatment and (B, D, F) 1-year post-treatment views of a 29-year-old woman who underwent abdominoplasty; liposuction of hips and flanks; lower body lift; breast reduction; and breast lift.
oblique fascia, recreating a more aesthetic three-dimensional effect that characterizes the youthful, well-toned abdomen (Figure 14). Precise advancement with progressive tension sutures along the zones of adherence of the linea alba and linea semilunaris, as well as over the external oblique, further accentuates definition of these features. The anterior waist is also deepened and the soft contour depression over the external oblique is restored with sequential progressive tension sutures. In addition, strategic advancement of the flap from the costal margin to the inguinal crease and symphysis pubis with progressive tension sutures facilitates restoration of a uniform skin tone over the entire aesthetic unit. By distributing tension over the entire abdominal flap, there theoretically may be less tension at the incision line, thus a reduced tendency toward superior scar migration.

Minor visible indentations of the skin flap created by the sutures will resolve when the sutures are resorbed completely in 4–6 months. The sutures splint the flap precisely along the linea alba, the linea semilunaris, and the lateral skin flap over the external oblique for a period of 12 weeks or more while the sutures still have their integrity. Theoretically, by eliminating potential space and minor pseudobursa formation from fluid collections, and promoting scar tissue adherence along these anatomical landmarks, a stable and durable effect is achieved with long-lasting absorbable sutures (Supplementary Figure 2). Among the absorbable suture groups, PDS has the most durable profile, with 50% of its strength still present at 4 weeks and complete resorption not occurring until about 26 weeks. In my experience, progressive suture advancement and stabilization allows a more toned appearance of these anatomical landmarks than is achieved with fat thinning alone. The skin laxity of the upper abdomen can also be worked down with progressive tension sutures to improve the overall consistency of skin tone of the entire aesthetic unit.

Furthermore, the lateral flap can be more effectively advanced inferomedially to eliminate lateral redundancy (eg, dog ears). The overall effect of these independent maneuvers creates a more authentic-appearing abdomen than the one that I could accomplish previously.

It is my observation that the optimal aesthetic three-dimensional effect is realized when the abdominal flap is neither too thick (BMI > 30) nor too thin (BMI < 20). In my experience, an average flap thickness between 1.5 to 4 centimeters (BMI 20–30) provides the ideal situation for optional application of the elements described (Figure 13).

It is vascularly unsafe to thin the subcutaneous fat superficial to Scarpa’s fascia, thereby limiting the three-dimensional effect of AD-PTS in the heavy patient with a BMI > 30.

In the very thin patient with a BMI < 20, inadequate fat thickness reduces the effectiveness of AD-PTS for two reasons. First, fully mobilizing a very thin flap (< 1.5 cm) is a more tenuous proposition to accomplish in a vascularly safe manner. Second, the lack of fat reduces the differential thickness required to create the intended three-dimensional effect with AD-PTS.

A redundant, plump mons is a common source of embarrassment (Figure 14). In pregnancy, expansion with skin stretching and hormonal fat accumulation of the mons frequently accompanies the same process that is occurring on the abdomen. In this abdominoplasty technique, rejuvenation of the mons is an essential component. Matarrasso and others have emphasized mons treatment to complete rejuvenation of the aesthetic unit. This requires attentive treatment of excess fat and redundant skin when present. Skin tone equalization between the abdominal skin flap and the mons also provides a more authentic aesthetic abdominal unit. After elevation of the mons, further excision of hair-bearing pubic skin is frequently required to avoid elevation of the hairline.

Soft tissue closure at the incision is optimal when the transition between the upper flap and the lower incision is smooth, reducing the tendency toward a step-off deformity after healing. This is easily accomplished by equalizing fat thickness wherever needed. Additional sub-Scarpa’s fat thinning of the upper flap and/or mons prior to closure is usually required to create a smooth soft tissue transition. By equalizing fat thickness and including Scarpa’s fascia in the closure, a more inconspicuous scar is typically achieved. When the lower abdominal scar is not aesthetically acceptable, a revision can usually be performed in the office under local anesthesia (8.1% in this cohort).

Creating a natural and inconspicuous umbilicus has been one of the most challenging aspects of abdominoplasty in my practice. Numerous umbilicorrhapsy methods have been described over the years with varied effectiveness. The central purpose for any technique should be the creation of a natural, inconspicuous umbilicus. To accomplish this, a recreation of the native condition is necessary. In a recent computer analysis of Playboy models, Lee et al. demonstrated prevalence of the vertically shaped umbilicus, and concluded that this is an important parameter of the “beautiful umbilicus.” The goal of my technique has been to create a deep vertical oval shape, which coincides with the parameters of the “beautiful umbilicus” described by Lee.

Many post-partal women with diastasis also have an accompanying umbilical hernia. Clinical diagnosis pretreatment isn’t always successful, therefore close inspection intraoperatively is advisable. Failure to repair an inconspicuous and undiagnosed umbilical hernia may become obvious posttreatment, and will adversely affect the appearance of depth and possibly require secondary repair. The subfascial repair described by Bruner et al. is easy, reliable, and preserves native vascularity to the umbilical stalk.

The umbilicorrhapsy technique described here attempts to recreate the native condition as accurately as possible. Inspection of the umbilical defect beneath the raised abdominal flap demonstrates a striking absence of fat in a
spacious, vertically-oriented pattern (Figure 4C). Generous fat removal at the umbilicorrhapy site in a matching pattern facilitates a deep umbilical inset. Under-resected fat at the inset site will encroach upon the stalk and limit the desired appearance of depth (Figure 1).

Shortening of the stalk, secure stabilization with durable absorbable sutures (PDS), and advancement of the abdominal dermal X-flaps to the rectus fascia at the umbilical base are also all important steps in the creation of a deep vertical umbilicus (Figure 12). A long umbilical stalk and/or one that is inadequately stabilized may result in redundancy and eversion (Figure 4A).

Despite the details employed in the technique described here, there is still a 4.3% revision rate to improve umbilical aesthetics in my cohort. The thin patient (flap thickness <1.5 cm) is the most challenging for achieving the deep vertical umbilicus and, therefore, these patients should be advised accordingly.

In my experience, obtaining the most authentic abdominal contour correlates strongly with the pretreatment condition when applying these elements. The heavier patient, especially one with an excessive intraabdominal fat component, is a particularly challenging endeavor. Critical evaluation and cautious recommendations with appropriate description of expectations is always prudent. For most patients with a BMI less than 35, a dramatic authentic effect and significant contour improvement can be achieved with the safe and reliable steps detailed here. All of the elements are applied routinely with each patient, yet variation in the overall achievement in aesthetic goals is more dramatic in those closer to ideal body weight, as one would expect. Nevertheless, a positive aesthetic effect is still consistently seen in all patients under a BMI of 35. (Figures 13 and 14 and Supplementary Figure 1).

Lockwood,24 Matarasso,19 and others have emphasized the importance of rejuvenating the entire torso/thigh aesthetic unit. Lockwood unambiguously advised, “Be artistic. Think outside the box. … How can we judge our success in body contouring if we don’t look at the entire aesthetic unit?”24

Harmonized contouring of the body should be considered for every patient who requests or is a candidate for abdominoplasty. In our cohort, 83% had adjacent lateral hip, flank, and/or outer thigh liposuction and 34% had some type of skin excision procedure of the hip/flank region. The abdomen is only one component of the thoraco/abdominal/thigh aesthetic unit. Hormonal fat redistribution and skin expansion associated with pregnancy occurs along the lower torso and hip/buttock region as well as the abdomen andmons. Coordinated treatment of adjacent areas will complement and enhance the authenticity of abdominal shaping (Supplementary Figure 3). Consider the artificial contrast of a well-contoured, toned abdomen adjacent to a thick waistline or a redundant, bulging mons. Such anatomy seldom exists naturally and will likely create annoying clothes fitting issues for women. Consideration of lipocontouring of the flanks and hips, possibly with a lifting procedure of the hips, buttocks, and outer thighs and/or fat grafting of the lateral gluteal and gluteal areas is complementary as an adjunct to abdominoplasty in many patients. Aesthetic results are not effectively analyzed in the typical scientific sense. Patient perception is an important criteria for analysis. The quality of aesthetic results is often measured by patient satisfaction through referrals. A satisfied patient will often say so and refer other patients. An unsatisfied patient will also say so and negatively impact referrals.

A satisfaction survey was sent by direct mail and by email with a request for completion online through Constant Contact (Table 5). Anonymity was ensured for all patients to encourage candor. Nonresponse bias is always a consideration with satisfaction surveys, yet the 58% response rate compares favorably to recent aesthetic surgery surveys published in the Aesthetic Surgery Journal.21,25 A standardized validated satisfaction survey for body contouring surgery similar to the Breast-Q for breast surgery would be valuable for future analyses.26

In my experience, patients frequently criticize the “unnatural belly-button” and the “surgical, flat as a board” appearance of many tummy tucks they have seen. These are frequently their primary hesitation with the abdominoplasty procedure. One of my objectives has been to create a more authentic-appearing abdomen so that patients would be more satisfied with their results. The survey demonstrated a 97% (81% excellent, 16% good) satisfaction rating to the question: “How natural looking is the appearance of your abdomen?” A slightly less positive response was elicited to the question, “How would you rate the appearance of your belly-button?” with 87% (59% excellent, 28% good) rating it favorably. I believe that the overall high level of satisfaction with results, reported at 93% (78% excellent, 15% good) provides support that this objective is being met.

CONCLUSIONS

Ten key elements of a well-executed abdominoplasty provide a unified, anatomically accurate recreation of the abdomen. This technique relies heavily on extensive use of progressive tension sutures placed specifically to enhance the native anatomy (AD-PTS).

The incorporation of these elements 10 years ago has led to a perceptible improvement in the aesthetic quality of my abdominoplasty results. Overall satisfaction was high (93%). In particular, better anatomical accuracy is supported by the high level of patient satisfaction (97%) regarding the natural appearance of their results, as consistently demonstrated in the patient photos included.
Supplementary Material
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