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A Novel Approach to Abdominoplasty: TULUA Modifications (Transverse Plication, No Undermining, Full Liposuction, Neoumbilicoplasty, and Low Transverse Abdominal Scar)

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Abstract

Background Lipoabdominoplasty can be associated with complications, particularly tissue necrosis, wound dehiscence, epigastric bulging, high transverse scar, low positioning of the umbilicus, and seroma.

Methods Modified abdominoplasty characterized by (1) transverse elliptical plication of the lower abdominal wall, (2) no undermining of the flap above the navel, (3) unrestricted liposuction, (4) umbilical amputation and neoumbilicoplasty by skin graft, and (5) low transversely placed abdominal scar (TULUA) was performed for 42 patients. These procedures were elective and performed primarily to remedy epigastric skin redundancy associated with obesity or when supraumbilical undermining was considered inappropriate.

Results The results were objectively scored as excellent for 20 patients, good for 21 patients, and fair for 1 patient. A normal-appearing umbilicus was attained in all cases except one. The lower transverse scars were generally concealable (6.3 ± 1.4 cm from the anterior vulvar commissure), and epigastric bulging was avoided. Although four patients experienced seromas at the tail ends of incisions, no skin necrosis, wound dehiscence, or other major complications such as venothromboembolism occurred, and there were no fatalities. In four patients, postoperative magnetic resonance imaging demonstrated measurable and significant changes attributable to plicature compared with equivalent control points ($p < 0.000001$), which persisted over time.

Conclusions The TULUA procedure offers potential advantages in terms of vascular safety, sensory recovery, position and quality of the umbilicus, and transverse scar location, with aesthetic outcomes that generally eliminate epigastric bulging. A sizeable patient population stands to benefit from this approach, especially when obesity, smoking, secondary revisions, umbilical or hypogastric hernias, and massive weight loss are clinical considerations for abdominoplasty.

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Keywords Abdominal wall, blood supply · Surgery, umbilicus · Surgery abdominal fat · Surgery abdominal muscles · Lipectomy · Methods, suture techniques cicatrix · Surgery retrospective studies

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The main challenges of abdominoplasty are vascular safety, avoidance of residual redundant fat and skin,

creation of a concealable transverse scar, and achievement of satisfactory umbilical placement and appearance [1]. To address these issues, a modified abdominoplasty method was devised. This approach is characterized by transverse (vs vertical) plication, no undermining above the navel (vs wide or limited epigastric flap dissection), full and unrestricted liposuction including epigastrium and sometimes circumferential; umbilical amputation with immediate neoumbilicoplasty by skin graft, and low abdominal placement of the transverse scar (TULUA) [2].

Methods

A retrospective, nonconsecutive case review of adult women was conducted. At the author's discretion, 42 patients were selected for this procedure from 238 patients who underwent lipoabdominoplasty between January 2005 and December 2012. The remaining 196 patients underwent conventional lipoabdominoplasties during the same period. Modifications of TULUA were largely indicated to remedy epigastric skin redundancy associated with obesity or when supraumbilical undermining was considered inappropriate or dangerous in terms of flap viability. Although the indications were arbitrary, the selection of patients was made intuitively to include those for whom epigastric undermining was deemed unsafe. All 42 patients who underwent TULUA modifications were included in this study.

All the subjects were informed of the procedure in detail and provided written consent for surgery. Professional ethical standards and institutional protocols were uniformly upheld in keeping with the principles of the World Medical Association Declaration of Helsinki.

The mean age of the 42 patients who underwent TULUA was 47 ± 12 years (range 22–64 years). The mean follow-up period was 53 weeks (range 3–389 weeks). Of the 42 patients, 32 underwent primary procedures and 10 underwent secondary abdominoplasties. The mean body mass index (BMI) was 30 ± 3.6 (range 22–38), with 22 patients qualifying as obese (BMI > 30). For 10 patients, excessive epigastric skin and fat were the primary indications. Clinically detectable diastasis of the upper abdominal muscle and epigastric hernias were contraindications of the technique (Table 1).

Table 1 Indications for TULUA (Transverse plicature, no Undermining, unrestricted Liposuction, neo-Umbilicoplasty, Abdominoplasty)

Primary cases	32
Revisional abdominoplasties	10
Obesity	22
Smoker	3
Epigastric skin excess	10

Surgical Technique

Demarcation was similar to that for conventional abdominoplasty. With the patient under general anesthesia, tumescent infiltration (3,000–8,000 ml) of normal saline and epinephrine (1:500,000) was extended to the abdomen and additional areas (back, chest, and medial thighs).

Unrestricted deep and superficial liposuction (5-mm cannula) of the upper abdomen, flanks, and mons pubis, combined with circumferential liposuction in some cases, was then performed. A low transverse skin incision was made 6–7 cm from the anterior vulvar commissure based on previous demarcations and carried down to the fascia by dissection of hypogastric fat and skin, progressing over the aponeurosis to the umbilicus. Above-navel dissection was never performed.

A horizontal ellipse was drawn on the abdominal fascia from one anterior iliac spine to the other and from the umbilicus to the pubis. Under muscle relaxation and with mild flexing of the operating table, transverse plication was achieved through layered suturing (0 polypropylene; intermittent and then running suture for reinforcement). The downwardly displaced umbilicus was amputated, and the remaining umbilical wall defect was sutured.

As is customary, elliptical dermolipectomy was performed. The wound was closed in layers using additional liposuction, with lateral extension of the incision as needed to reduce dog ears. Suction drainage was left in place postoperatively for 7 days.

After skin closure, the ideal umbilical position in the midline was determined. The H:V ratio was established for placement of the navel during surgery, where V (veneris) is the distance from the anterior vulvar commissure to the transverse incision and H (hypogastrium) is the distance from the incision to the neoumbilicus. This ratio also served as one of the indices scored in the assessment of patient results. The ideal position of the umbilicus is approximately twice the distance of the incision to the vulvar commissure (10–14 cm). An inverted U-shaped incision was made at the site of the new umbilicus, and fat surrounding the new opening was excised, forming a 2.5-cm-wide depression. A triangular full-thickness skin graft (1 cm across) was firmly fixed to the abdominal fascia and then to the dermis of the incised skin using 2–0 polyglycolic acid and 3–0 plain catgut sutures (Fig. 1).

Preoperative, intraoperative, and periodic postoperative photographs were taken. Patient data were collected including age, BMI, intraoperative measurements, complications, and scored results. Outcomes were rated by the author as excellent, good, fair, or poor using a cumulative score of 0 to 18 points for six variables, each rated from 0 to 3 points (Table 2).

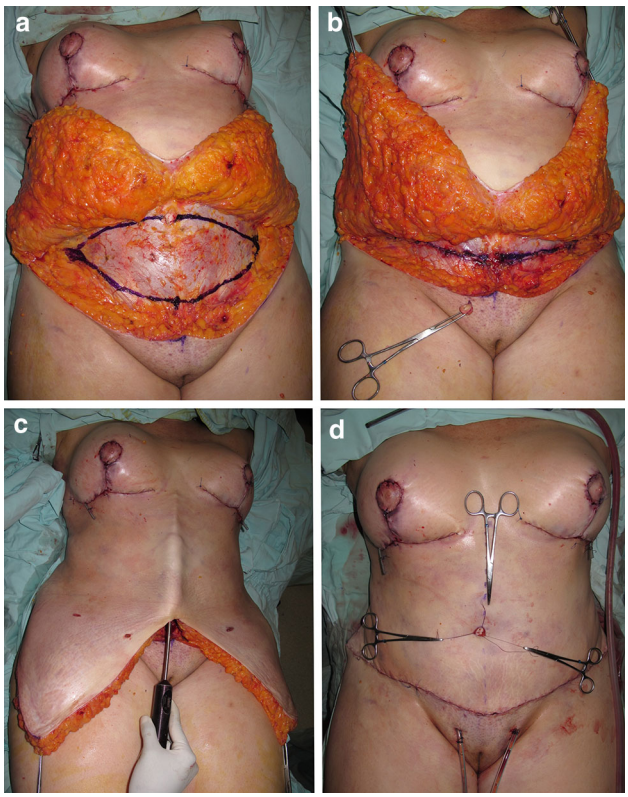

Fig. 1 Modifications of TULUA (Transverse plicature, no Undermining, unrestricted Liposuction, neo-Umbilicoplasty, Abdominoplasty). **a** A transverse ellipse is drawn between the anterior iliac spines and from the umbilicus to the pubic bone. **b** After transverse plication, the epigastric flap slides gently down, allowing tension-free closure. The amputated umbilicus is held by Allis clamps. **c** No undermining of the epigastric flap is performed. Full and unrestricted liposuction facilitates additional molding and downward movement. **d** Transverse closure is placed 5–7 cm from the anterior vulvar commissure, with full-thickness skin graft used for neoumbilicoplasty

During the postoperative period, magnetic resonance imaging (MRI) (MR BRIVO 355. 1.5 Tesla; General Electric, Fairfield, CT, USA) was performed without contrast in four arbitrarily selected patients at different times after surgery (range 56–312 weeks). Conventional T1- and T2-weighted and FIESTA (*F*ast *I*maging *E*mploying *S*teady s*T*ate *A*cquisition) sequences provided views of the abdominal wall in axial, coronal, and sagittal slices. For objective assessment of any postoperative change in transmural thickness, measurements of plicated areas were compared with control points (muscle and fascia only) in the same median and paramedian sagittal slices and at the level of the umbilicus and plicature in axial slices (K-Pacs Software, v 1.5.0 2007, Image Information Systems Ltd., Plauen, Germany).

Results

The average total liposuction aspirate volume (predominantly fatty) was 4,250 ml (range 1,000–8,000 ml). A lipoaspirate volume for the abdomen only was not obtained. The average weight of elliptically resected skin and fat was 1,375 g (range 540–5,000 g).

The mean transverse dimension was 31 ± 2.34 cm (range 24–34 cm), and the height of the elliptical plicature was 10 ± 2.15 cm (range 6–13 cm). The average total area of plication was 236 ± 56 cm^2 (range 118–338 cm^2) (Table 3).

The V distance (anterior vulvar commissure to transverse incision), measured at various intervals postoperatively was 6.3 ± 1.4 cm in 38 patients and less than 7 cm in 30 patients. The H distance (umbilicus to incision) was approximately twice the V distance, giving an overall H:V ratio of 1.9 ± 0.5.

On a scale of 0 to 18, the patient outcomes were acceptable. The worst score was 6 points (fair), whereas 20 patients were rated as excellent and 21 patients as good. An example of an excellent outcome is shown in Fig. 2.

The MRI images confirmed a relative increase (2.28-fold) in the thickness of muscle and fascia in 12 measured areas of plication (mean, 13.51 ± 2.9 mm) compared with equivalent control points (mean, 5.92 ± 2.29 mm; $p < 0.000001$). In one patient, these changes persisted for 6 years after surgery, suggesting permanent abdominal wall modification (Table 4, Fig. 3).

No mortalities occurred, and none of the patients experienced venothromboembolism, flap necrosis, or wound dehiscence. Although partial viability of the grafted neoumbilicus and delayed umbilical healing were observed in 10 of the 42 patients, only one neoumbilicus failed to achieve a normal score. Four patients experienced seromas at the tail ends of incisions, which were drained by repeated sterile syringe puncture (2–5 times), with complete remission. No seromas of the hypogastrium occurred. None of the patients needed reoperation, but one patient required red blood cell transfusion.

Discussion

The addition of liposuction to abdominoplasty is advantageous but increases vascular risks and thus is subject to limitations and stipulations [3–6]. Extended undermining to the xiphoid level and the costal margins has been replaced by limited epigastric dissection in a central tunnel, thereby preserving segmental intercostal vessels [7] and epigastric artery perforators, improving safety [8–12].

Nevertheless, the threat of necrosis remains, especially if a wide flap dissection is incorporated, and wound closure is under tension. It seems reasonable that greater safety might be conferred by abandoning undermining of the epigastrium to preserve more vascularity.

Furthermore, transverse plication of the abdominal fascia from the navel to the pubis enables smooth skin flap

Table 2 Clinical outcome scoring of 42 TULUA (Transverse plicature, no Undermining, unrestricted Liposuction, neo-Umbilicoplasty, Abdominoplasty) patients[a]

Score indices	0	1	2	3
Epigastric bulging (wall)	Flat epigastrium	Bulging in sitting position	Bulging in standing position	Surgical revision required or performed
	$n = 39$	$n = 3$	None	None
Epigastric skin redundancy	No redundancy	Demonstrated by pinch test	Visible without pinch	Surgical revision required or performed
	$n = 41$	$n = 1$	None	None
Hypogastrium/veneris (H/V) ratio (38 measurements, 1.9 ± 0.5)	Ideal H/V: 1.5–2.0	–	High umbilicus H/V > 2.0 Low umbilicus H/V < 1.50	Surgical revision required or performed
	$n = 23$	–	High: $n = 11$ Low: $n = 4$	None
Umbilical shape	Inconspicuous	Some deformity	Abnormal or absent	Surgical revision required or performed
	$n = 41$	None	$n = 1$	None
Transverse scar position (38 measurements, 6.3 ± 1.4 cm)	5–7 cm from anterior vulvar commissure	7.1–10 cm from anterior vulvar commissure	>10 cm, not concealed by underwear.	Surgical revision required or performed
	$n = 30$	$n = 7$	$n = 1$	None
Aesthetic appearance	Aesthetically pleasing	Irregularities, redundancies, retractions, without skin necrosis	Skin loss, extensive scarring, aesthetically unpleasant	Surgical revision required or performed
	$n = 37$	$n = 4$	$n = 1$	None

H hypogastrium, *V* veneris

[a] Overall scoring of outcome: excellent (0 points), 20 cases; good (1–5 points), 21 cases; fair (6–9 points), 1 case; poor (≥10 points), 0 cases

advancement, reducing suture line tension. A downward displacement is facilitated by liposuction tunnels and the traction exerted when the fascia folds upon itself, affording a tension-free wound closure with an adequately low-lying scar. This approach may be beneficial in terms of vascularization, thus reducing the risks of wound dehiscence, scar expansion, and seroma.

Abdominal wall management, which almost always involves midline plication, also is in need of revision. Alternative methods (oblique; semilunar; H-, L-, or J-shaped; and transverse plications) intended to improve waistline contours and abdominal tension, routinely call for wide flap dissection, which can have an adverse impact on irrigation. Only a few vertical and anchor plications with limited undermining have been reported [13–15].

A semilunar plication of the hypogastrium, as described for mini-abdominoplasty [16], allows full liposuction but draws the umbilicus downward. This crescenteric plicature can be converted to an ellipse during TULUA for complete abdominoplasty with doubling of the plicature area. This avoids flap elevation above the navel with no detriment to neoumbilical placement and maintains safety in terms of vascularization.

Table 3 Patient data and operative parameters. 42 female TULUA (Transverse plicature, no Undermining, unrestricted Liposuction, neo-Umbilicoplasty, Abdominoplasty) patients

	Mean ± SD	Maximum	Minimum
Age (years)	47 ± 12	64	22
Follow-up (weeks)	53 ± 83.7	389	3
BMI (kg/m^2)	30.1 ± 3.6	38.3	22.0
Lipoaspirate (ml)	4,250 ± 2,020	8,000	1,000
Dermolipectomy specimen (g)	1,375 ± 1,109	5,000	540
Transverse dimension of plicature (cm)	31 ± 2,34	34	24
Vertical dimension of plicature (cm)	10 ± 2.15	13	6
Area of plicated ellipse (cm^2) ($\pi \times r_1 \times r_2$)	235.7 ± 55.8	337.7	118

SD standard deviation, *BMI* body mass index

The described transverse plicature (30.7 ± 2.3 × 9.8 ± 2.1 cm) incorporates nearly twice the visual area of other lipoabdominoplasties with vertical plications (usually 30–34 cm × 4–7 cm). A transverse plication may generate

Fig. 2 Patient 12, age 30 years, with a body mass index (BMI) of 32.8 kg/m^2 and a TULUA (Transverse plicature, no Undermining, unrestricted Liposuction, neo-Umbilicoplasty, Abdominoplasty) score of 0 points (excellent). *Left:* Preoperative anterior and lateral views. Obesity was the chief indication for TULUA lipoabdominoplasty. Liposuction (3,700 ml of lipoaspirate) and tissue resection (2,000 g) were performed. *Right:* Postoperative photographs at postsurgical week 17. Note the overall improvement of the *upper* and *lower* abdomen, without epigastric compensatory bulge and with proper positioning of the umbilicus and the scar. The umbilicus shape was judged to be good

more tension, which might be sufficient to correct overall laxity of the abdominal wall, giving an appropriately flat appearance without compensatory epigastric bulging (as demonstrated in this report).

The TULUA approach to abdominoplasty does not dissect the upper abdomen and does not afford direct correction of upper diastasis, which may be considered a defect of the technique. However indirect traction of the muscles by lower horizontal plication flattens the upper abdomen, extending the effect to the entire anterior abdominal wall. This effect is enhanced by unrestricted epigastric liposuction and absence of the medial mobilization of the skin and subcutaneous tissues observed in most vertical plicatures. As a result, the overall clinical effect is epigastric bulge correction with improvement of the upper and lower abdomen (Fig. 4). In addition, MRIs of four patients arbitrarily selected for imaging after TULUA showed no compensatory bulge of the upper abdomen or epigastric hernia, whereas permanent measurable changes were observed in the plicated zone at the hypogastrium. Furthermore, clinical objective scoring specifically addressed wall bulge or laxity, and no significant protuberance, hernia, or diastasis was found.

Evaluation of the durability and physiologic changes attained with transverse plicature in the abdominal wall needs further assessment. Comparative studies of pre- and postoperative MRIs as well as intraoperative measurements can be conducted prospectively in a consecutive series of TULUA cases to assess the permanence of plicature [17].

Although this study did not include quantification of the abdominal wall tension or measurement of the intraabdominal pressure after transverse plicature, surface measurements of the elliptical plicated area were performed. Visually, this area of plicature was larger than that achieved with vertical plicature. This suggests that transverse plicature is at least as good as vertical plicature for

Table 4 Magnetic resonance imaging (MRI) of transmural thickness at plicated and control points in TULUA (Transverse plicature, no Undermining, unrestricted Liposuction, neo-Umbilicoplasty, Abdominoplasty) ($n = 4$)

	MRI slice	Wall thickness plicature (mm)	Wall thickness control (mm)
Patient 1 (64 weeks after surgery)	Sagittal midline	10.50	2.23
	Sagittal paramedian	13.38	6.68
	Axial	13.36	8.20
Patient 2 (56 weeks after surgery)	Sagittal midline	18.01	6.00
	Sagittal paramedian	13.12	6.98
	Axial	10.00	5.00
Patient 3 (58 weeks after surgery)	Sagittal midline	16.00	2.05
	Sagittal paramedian	13.00	7.00
	Axial	16.00	8.03
Patient 4 (312 weeks after surgery)	Sagittal midline	8.95	3.10
	Sagittal paramedian	17.90	7.86
	Axial	12.00	8.00
Average wall thickness		13.51 ± 2.9	5.92 ± 2.29

One-tailed t test for paired samples ($p < 0.000001$)

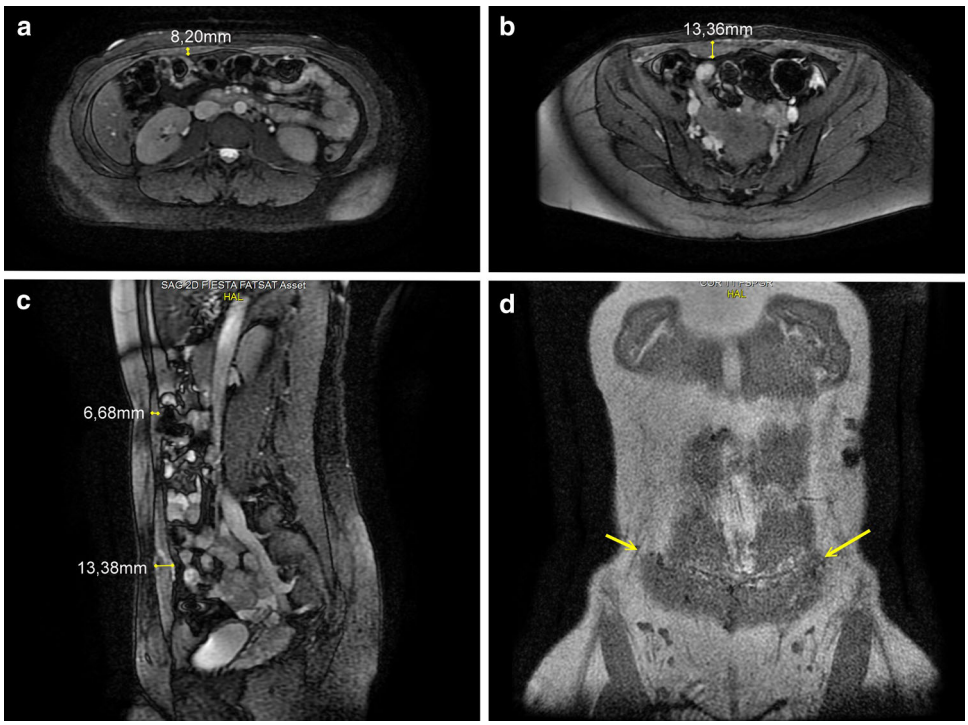

Fig. 3 Patient 1 with postsurgical magnetic resonance imaging (MRI) and FIESTA sequence at week 64. **a** Axial slice (umbilical level) with muscle and fascia 8.2 mm thick and no compensatory bulging or diastasis. **b** Axial slice (level of plicature) with significant change in transmural thickness due to plication. **c** Sagittal slice with plicature clearly visible and measurements confirming surgical modifications. **d** Coronal slice with plicature visible 1.2 years after surgery as indicated by *arrows*

correcting abdominal muscle laxity and might even be better. Further studies to compare abdominal wall tonometry, intraabdominal pressure variations, and total area of plication between TULUA and conventional lipoabdominoplasties will be conducted in the near future [18, 19].

Some concern has been raised about the potential physiologic consequences of the vertical muscle shortening produced by transverse plicature. However, transverse plication is not a new procedure and has been described in abdominoplasty without mention of major effects on abdominal function or the development of new symptoms or related disease [16, 20]. On the other hand, it can be argued that vertical shortening is a theoretical advantage because it improves contouring, thus increasing abdominal wall tension, intraabdominal pressure, and maybe even muscle strength and muscle efficiency due to biomechanical improvement of function [21–23].

Excess skin and fat of the epigastrium is a common problem after conventional lipoabdominoplasty when epigastric liposuction is omitted or dissection is limited to a central tunnel. While muscles in the midline are sutured, tissues may be pulled to the center of the upper abdomen, resulting in redundant sagging skin, vertical folds, and bulging (Fig. 5). Thinning of the epigastrium through liposuction and transverse plicature-related downward traction prevented such redundancy in this series (Fig. 6).

A new umbilicus is created during TULUA abdominoplasty. The advantages of this strategy are that no flap detachment is needed and the surgeon has total freedom to position the neoumbilicus optimally [24, 25]. Although no formula exists to determine the ideal umbilical height,

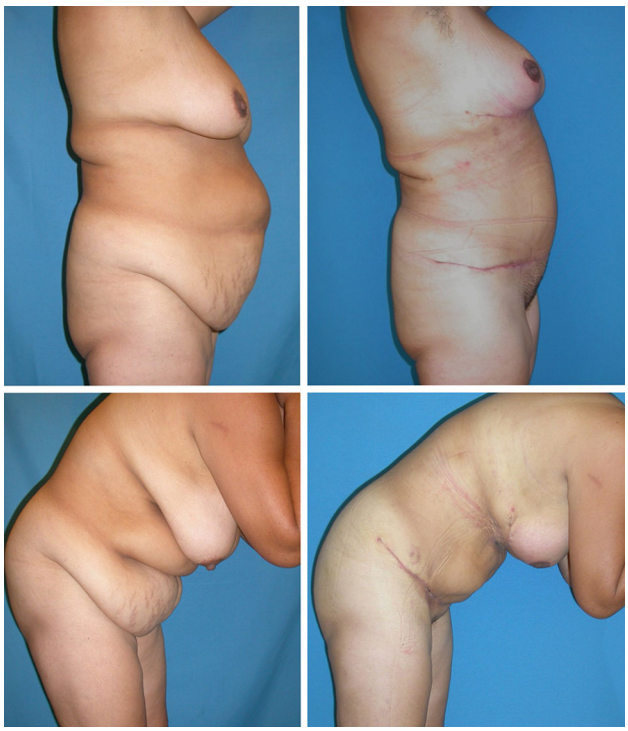

Fig. 4 Patient 22, age 42 years, with a body mass index (BMI) of 36 kg/m^2 and epigastric bulge correction. *Left:* Preoperative view. *Right:* View 9 weeks after the TULUA procedure involving liposuction of the anterior abdomen (3,000-ml lipoaspirate), resection (1,850 g), and transverse abdominal wall plicature (34 × 8 cm; 215.7 cm^2). Note the correction of the epigastric bulge without epigastric direct plicature. In the *lower* row of photos, the patient is standing while the trunk is anteriorly flexed to demonstrate the amount of epigastric correction attained

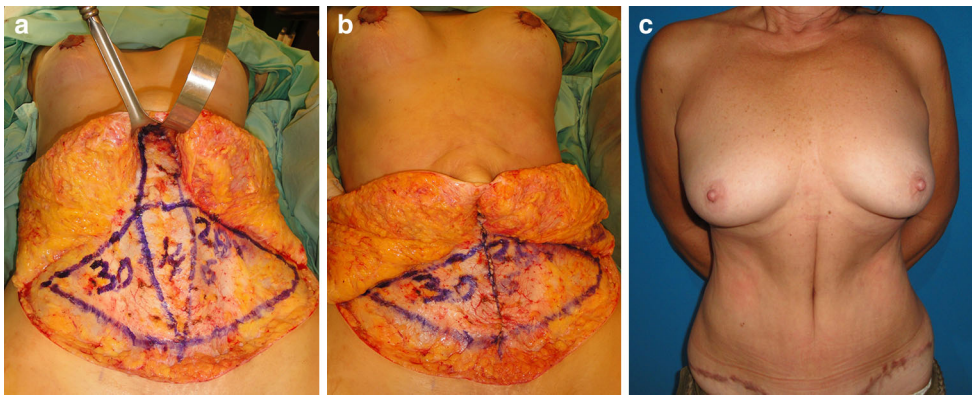

Fig. 5 Vertical plicature compared with transverse plicature, including examples of conventional vertical plicature. **a** A central epigastric tunnel was dissected during conventional lipoabdominoplasty. The vertical plicature (28 × 6 cm, outlined) appears minor compared with the hypothetical (not performed) transverse plicature (30 × 14 cm). **b** Tissues are pulled to the midline after conventional vertical plicature, creating skin and fat redundancy at the epigastrium and in the periumbilical areas. **c** Epigastric skin redundancy in a different patient with a vertical fold attributed to limited central epigastric undermining and vertical plicature

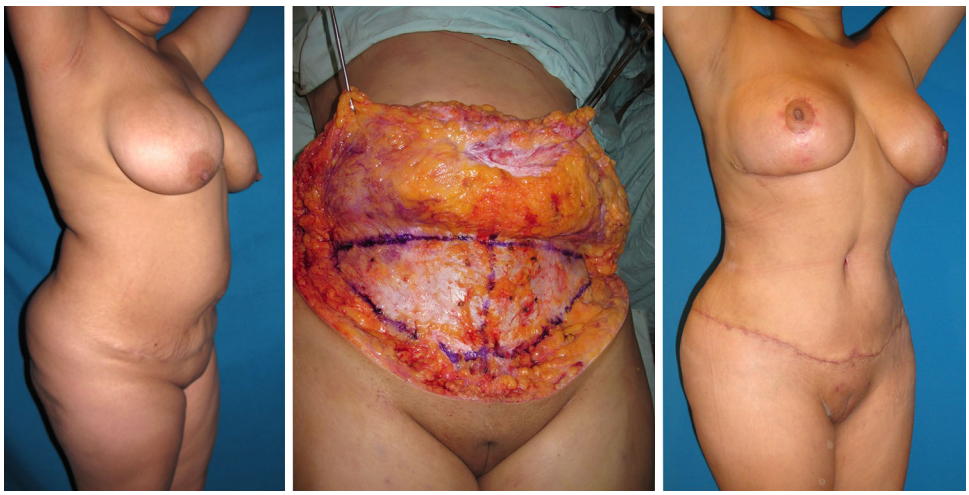

Fig. 6 Epigastric bulge correction using TULUA modifications in a secondary revision case involving patient 38, age 32 years, with a body mass index (BMI) of 31 kg/m^2. *Left:* A previous conventional abdominoplasty had been performed elsewhere. Residual epigastric bulge was the main complaint and indication for revisional surgery. *Center:* During TULUA, a transverse plication (34 x 8 cm = 213 cm^2) was generated. No epigastric dissection or upper abdomen plicature was performed. Liposuction (lipoaspirate, 4,000 ml) and resection (960 g) were performed. *Right:* View 4 weeks postoperatively. The secondary epigastric bulge has been corrected, and the overall *upper* and *lower* abdomen is improved. Umbilical shape, position, and proportionality were judged to be good (V = 6 cm, H/V = 1.8). The overall result was scored as excellent

some sources recommend using a line passing through the highest point of the iliac crests or a fixed distance from the pubic bone [26–28]. However, these are fixed bony reference points, and the structures displaced in a flexed operative stance are entirely mobile. Umbilical location might be better determined by proportionality in the span from the mons pubis to the hypogastrium [29] or the xiphoid [30–32]. Provided proportional harmony exists, any minor navel displacement probably can be tolerated [16, 33].

In a previous publication by the author [34], analysis of 40 photographs of nulliparous females with normal BMI generated H:V ratios of 1.5–2.5. This parameter was used during surgery, serving as the primary basis for umbilical repositioning in this series, as well as an index of patient outcome. Freedom to position and shape the new navel is a theoretical asset. In the current series, 11 patients displayed relatively high umbilical placement, with H:V ratios higher than 2, possibly due to intraoperative misjudgment of the new umbilicus position, which has been avoided in later cases (outside this report), or due to rebound stretching of the fascia, which could be a significant drawback of this technique although the MRI results suggest ample longevity of the plication.

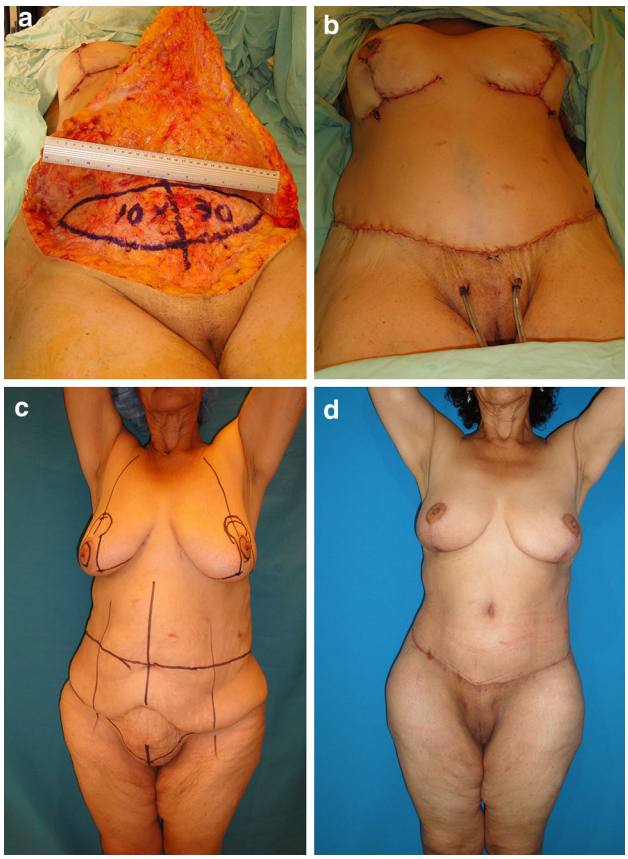

Fig. 7 Postbariatric TULUA abdominoplasty in patient 3, age 64 years, with a body mass index (BMI) of 25 kg/^{2}. **a** Plicature (30 × 10 cm, outlined) after unrestricted liposuction (3,000 ml) of the abdomen and flap elevation not beyond the level of the umbilicus. **b** Transverse plicature draws the epigastric flap downward, avoiding excess tension at the suture line and allowing proper scar placement (1,000-g lipectomy specimen). The entire abdominal surface is now ready for new umbilicus reconstruction at the best possible position. **c** Preoperative markings. **d** View at postsurgical week 96: V = 6 cm (vulvar commissure to incision), H:V ratio = 1.8, overall score = 0 points (excellent)

Fig. 8 The TULUA procedure as an aid to correct poor results of previous abdominoplasty for patient 33, age, 60 years, with a body mass index (BMI) of 26.6 kg/m^2. **a** The dissatisfied patient wanted to lower her abnormally high transverse scar after conventional abdominoplasty. **b** Liposuction was performed to mobilize the epigastric flap, with direct dissection halted at the umbilicus. A modified transverse plicature is outlined, and closure of the umbilical amputation defect is planned. **c** View at postsurgical week 116. The transverse scar position is much *lower* (V = 6 cm), but the neoumbilicus appears high (H/V = 2.2). Additional scarring due to prior umbilical closure is seen. The overall score is 4 points (good). **d** Neoumbilicoplasty with skin graft. The intraoperative umbilical was set high, with further upward migration after surgery

To reconstruct a new umbilicus, several techniques can be used concomitantly with current TULUA modifications [35–37]. In described cases, a neoumbilicoplasty was made by applying a small skin graft over the fascia to reconstruct the bottom of the umbilical depression and an inverted U incision sutured also to the abdominal aponeurosis to form the walls of the new navel with mentioned good results. However, a more precise outcome evaluation in terms of the shape and appearance of the new umbilicus deserves attention and can be investigated in a further study. Preceding descriptions of the umbilicus configuration will be useful in creating an objective scoring system [38, 39].

Adequate planning of the transverse low incision, treatment of redundant mons pubis with liposuction, and a wound closure free of tension enabled low scar placement in the current series, as demonstrated quantitatively by the large number of patients with V shorter than 7 cm.

Objective descriptions of abdominoplasty results are scarce. Salles et al. [40] in 2011 and Saldanha et al. [41] in 2013 quantitatively evaluated their results according to a scale that included five parameters (abdominal volume, lateral contour, skin laxity, umbilicus, and scar), each scored as 0, 1, or 2 points.

Aesthetic outcomes were quantitatively assessed in the TULUA series using a new scoring system that further included linear and proportional measurements to avoid bias or subjectivity. Although more consistent evaluation can be offered when independent evaluators assess results, this series demonstrated outcomes as good as those attained by the author using conventional abdominoplasties, with

the possible added advantages of vascular safety, epigastric bulge correction or avoidance, and total freedom in umbilicus placement.

The current series did not include consecutive cases, but patients were selected for surgery at the author's discretion, which might be considered a major limitation of this report. However, all cases managed by the TULUA procedure were included in the series, and an objective scoring system was developed to evaluate the outcomes in order to avoid bias. Although the modifications described in this report may be applied routinely in any instance of abdominoplasty, the TULUA technique is intended for difficult circumstances less suitable for conventional abdominoplasty such as obesity, smoking, postbariatric surgery, and secondary revisions (Fig. 7). Thus, although there currently are no scientific criteria for inclusion, more detailed indications will be defined as we gain more experience using this technique over time (Table 1). Patients with umbilical hernias and other wall defects of the lower abdomen also may benefit from this technique. Moreover, equivalent success should be achievable for males.

Although most of the cases in this study were primary operations, evaluating the usefulness of the procedure may be complicated by the inclusion of some secondary cases. In fact, TULUA was beneficial in 10 cases of reoperation to correct deformities left by previous abdominoplasties such as fat and skin redundancy in the upper abdomen, a low umbilicus, and a high transverse scar. In such cases, further epigastric dissection and vertical plicature are either not indicated or difficult to perform and possibly harmful. In our study, horizontal plicature and tunnels of liposuction helped in secondary skin resection and in lowering of the previous scar, whereas free positioning of the entirely new umbilicus was an additional benefit (Fig. 8).

However, TULUA does have some potential disadvantages. It does not specifically address muscular diastasis in the midline. The durability and physiologic effects of transverse plication are uncertain, and the process of partial skin grafting could result in a less than ideal umbilicus. The neoumbilicus also tends to migrate superiorly, possibly due to progressive elongation of the transverse plicature. Finally, excessive tissue may accumulate at the corners of the transverse incision, requiring additional concurrent treatment of dog ears, and postoperative changes at the waist have yet to be examined quantitatively.

Conclusions

A set of modifications to abdominoplasty, namely, transverse plication, no upper abdomen flap detachment, unrestricted liposuction, neoumbilicoplasty with skin graft, and low transverse scar placement were performed safely in 42 primary and secondary cases of lipoabdominoplasty with good results and minor complications. In theory, the TULUA procedure can be used for every patient seeking abdominoplasty, but it currently is recommended only for specific cases that are not suitable for conventional abdominoplasty.

The TULUA approach has several possible advantages including preservation of vessels and nerves, thus potentially maintaining vascular and sensory integrity; low scar placement; reduced tension at the suture line and possibly less scar expansion; limited dead space, thus reducing the chance of seroma; lack of epigastric skin/fat accumulation; and complete freedom in the selection of a new umbilical position. The element of vascular safety despite liberal use of liposuction allows further molding of the flap in critical areas such as the epigastrium, subcostal areas, and the waistline, thus avoiding second-round revisions (downstaging) as recommended elsewhere [42].

The recent impetus to simplify abdominoplasty has led to a number of innovative approaches and technical modifications [43–48]. In line with this trend, the TULUA technique might improve surgical outcomes and facilitate patient recovery.

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