Esthetic and functional evaluation of abdominal contouring using lipoabdominoplasty versus lipoabdominoplasty with TULUA procedure: a comparative clinical study

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Background
Lipoabdominoplasty techniques may be followed by a wide range of complications such as flap necrosis, wound dehiscence, surgical site infection, epigastric bulging, malpositioned umbilicus, high transverse scar, and seroma formation. Villegas in 2014 introduced Transverse Plication, No Undermining, Full Liposuction, Neoumbilicoplasty, and Low Transverse Abdominal Scar (TULUA) abdominoplasty to improve the esthetic outcome and to avoid the many associated complications mentioned.
The aim of this study was to compare the esthetic and functional outcomes between the traditional lipoabdominoplasty and TULUA abdominoplasty.
Patients and methods
In this prospective comparative clinical study, 60 adult women with excess subcutaneous abdominal fat and skin laxity after repeated pregnancies with mild to moderate degree of diastasis of recti were included. The patients' ages ranged between 28 and 55 years, and their BMI scores were 25–35 kg/m^2. Group A (30 patients) underwent lipoabdominoplasty, whereas group B (30 patients) underwent TULUA abdominoplasty. The patients were followed up for a minimum of 6 months, where the comparative study included esthetic results regarding the abdominal contouring using clinical outcome scaling system in addition to functional aspects assessing anatomical features, changes in anterior abdominal wall, and finally, the complication rates between both techniques.
Results
The average volume of liposuction of the abdomen was 2400 ml in group A, whereas in group B, the average volume was 3500 ml. The mean surface area of vertical plicature measured intraoperatively was 211.93±54.66 cm^2 in group A, whereas in group B, the mean transverse plicature surface area was 369.47±84.22 cm^2. The increase in intra-abdominal pressure after plication and skin closure in group A was 7.93±1.26 cmH_2O, whereas in group B was 9.87±1.01 cmH_2O, being higher, with a highly significant difference. Flap sloughing was seen in four cases (13.3%), wound dehiscence in two cases (6.6%), and seroma in three cases (10%) for group A, whereas no cases reported flap necrosis, wound dehiscence, or seroma that need to be aspired in group B. The esthetic outcomes were evaluated using a five-point Likert scale system through three indicators. For group A, the overall result was 4.50±0.87, umbilical appearance was 4.61±0.73, and scar quality was 4.35±0.82. On the contrary, group B showed overall result of 4.53±0.71, umbilical appearance of 4.52±0.82, and scar quality of 4.43±0.87.
Conclusions
TULUA procedure is a safe, reproducible shift in abdominoplasty and is associated with fewer complications.

Keywords:
abdominal contouring, lipoabdominoplasty, modified lipoabdominoplasty, TULUA

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Introduction

Abdominoplasty has undergone slow and continuous changes over the past decades [1]. The modern abdominoplasty techniques that have been described share three characteristics: restricted tunneled dissection of the abdominal flap, vertical fascial plication of the recti muscles, and excision of the excess skin and fat beneath [2].

Performing adjuvant liposuction through the abdominoplasty procedure has truly raised the rate of

satisfaction regarding the abdominal wall thickness and enhancing the waistline [3].

Liposuction added to abdominoplasty has aroused a comprehensive argument about its effects on the vascularity and viability of the flap [4].

There are many local complications other than flap necrosis associated with lipoabdominoplasty, particularly wound dehiscence, surgical site infection (SSI), epigastric bulging, high transverse scar, malpositioned umbilicus, and seroma formation [5]. Villegas in 2014 described the TULUA abdominoplasty characterized by full and unrestricted liposuction to the abdomen, low abdominal placement of the transverse incision, no undermining above the navel, transverse plication of recti muscles, and umbilical amputation with immediate neoumbilicoplasty by skin graft at the same session [6]. The aim of this study was to compare between lipoabdominoplasty and TULUA abdominoplasty esthetically and functionally.

Patients and methods

Following ethical standards and institutional protocol board approval, the study was done over a 3-year period from March 2019 to April 2022. A total of 60 women were included seeking abdominoplasty operation with abdominal fat and skin excess with mild to moderate diastasis of the recti muscles after pregnancy diagnosed clinically and through abdominal ultrasound. Participants were divided into two groups: group A (30 patients) underwent lipoabdominoplasty and group B (30 patients) underwent TULUA abdominoplasty. The age of the patients ranged from 28 to 55 years old, and BMI scores were 25–35 kg/m^2.

Smokers, patients who had a history of vascular diseases and diabetes (American Society of Anesthesiologists ≤II), those who had previous abdominal surgeries, and those who had umbilical or paraumbilical hernias all were included in the study. The indications for TULUA were arbitrary. Patients with severe supraumbilical diastasis, BMI less than 25 or greater than 35 kg/m^2, severe medical illnesses greater than or equal to American Society of Anesthesiologists III, or patients with unrealistic prospects were excluded from the study.

All candidates signed an informed written consent, and the minimum follow-up was 6 months. Photographs were taken preoperatively, intraoperatively, and 6 months postoperatively; these images aided in objective evaluation of outcomes as the esthetic assessment was assessed based on the last documented photographs during the follow-up.

Preoperative assessment and marking

Waist–hip ratio (WHR) was measured and documented preoperatively. A midline and two lateral lines corresponding to the rectus abdominal muscles' lateral edge were marked. In addition, the areas planned for liposuction of the abdomen were marked too while the patient is standing. Then, the patient bents over, and determination of the length of abdominoplasty incisions was done by placing the ends of the pannus' skin creases, and by putting a mark on either side. Following the marking, the patients lightly elevated their pannus and joined these lateral marks, with the midline position ~7–9 cm above the anterior labial commissure for group A patients in the natural suprapubic crease (the upper margin of the pubic hairline), whereas for group B, the horizontal suprapubic line was drawn 6–8 cm from the anterior labial commissure, and then a gentle oblique line was drawn parallel to the inguinal crease superiorly in the direction of the anterior superior iliac spine.

Operative procedure

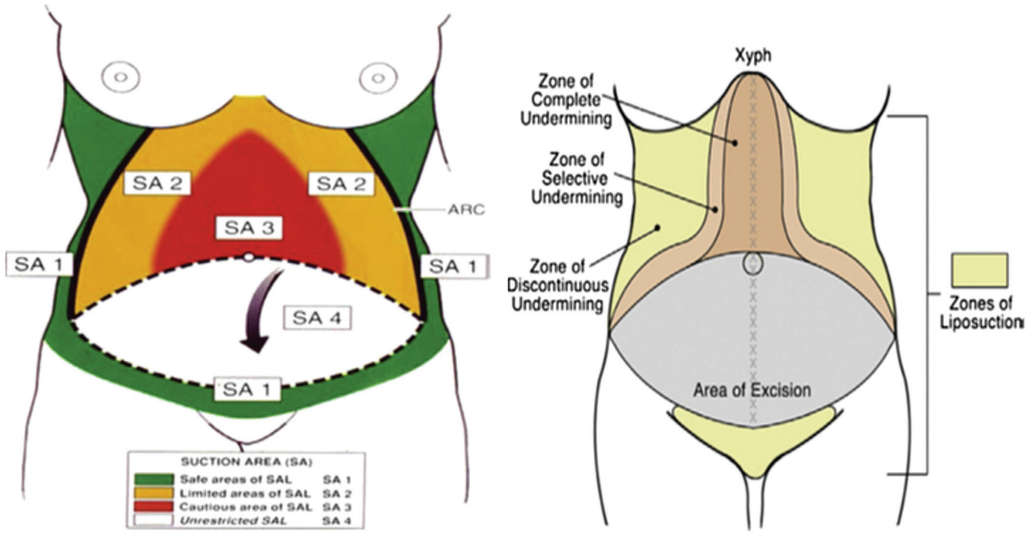
General anesthesia with endotracheal intubation and muscle relaxant was used in all patients. Tumescent solution for infiltration was prepared for both groups using the following formula: 10 ml of 1% lidocaine and 1 ml of 1 : 1000 epinephrine per liter of normal saline.

Group A: lipoabdominoplasty (n=30 patients)

Suction-assisted lipectomy was done for deeper planes at the epigastrium region between the two outer lines referring to rectus muscles' lateral borders. Then, liposuction of the flanks and lumber regions was performed (Fig. 1). The pinch test was used for assessment of the central flap thickness and flanks over the cannula and for evaluation of the regularity. The thickness of the flap following liposuction is required to be 3–4-cm thick and the lateral areas to be 2.5 cm thick for the flap vascularity safety.

Incision of skin and subcutaneous fat was done reaching the plane above the rectus sheath till the umbilicus is freed. Tunneled dissection and undermining of the abdominal flap were made extending to the xiphoid process (Fig. 1). Then, vertical plication of the rectus abdominal muscle was made from the xiphoid process to the suprapubic region using PDS 1 loop (Ethicon INC /USA). After flexion of the operating table, resection of excess skin was done cautiously to minimize flap

Figure 1



(Left) diagram showing the safety zones of liposuction in lipoabdominoplasty. (Right) diagram showing zones of undermining in lipoabdominoplasty.

tension. The umbilicus is then exteriorized through an incision in the flap and sutured. The wound is closed in three layers after two closed suction drain application through the mons pubis.

Group B: TULUA abdominoplasty (n=30 patients)

Unrestricted deep and superficial suction-assisted lipectomy was done for all abdominal zones of the epigastrium, subcostal, flanks, and mons pubis. A low transverse skin incision was done reaching down to the fascia, with dissection over the rectus sheath reaching to the umbilicus. The dissection was halted above the umbilicus.

A horizontal ellipse was drawn as described by Villegas, 2014, on the abdominal fascia from one anterior iliac spine to the other and from the umbilicus to the pubis to determine the area planned for plication. While the muscles were under relaxation, mild flexion of the operating table was done, and transverse plication was then carried out through double-layered suturing (0 polypropylene; interrupted and then reinforcement running suture). Amputation of the downward displaced umbilicus was done. As elliptical dermolipectomy was done, one or two surgical drains were applied, and the wound was closed in layers. After skin closure, determination of the neoumbilical position in the midline was defined through the H : V ratio (1–1.5), where V (veneris) is the distance from the anterior labial commissure to the transverse incision and H (hypogastrium) is the distance from the incision to the neoumbilicus. An inverted U-shaped incision was made at the site of the new umbilicus, and the inferiorly based flap was sutured to the rectus sheath. A full-thickness skin graft was tightly fixed to the rectus sheath using 2–0 monocryl sutures and then to the dermis of the incised skin using 3–0 monocryl sutures with application of tie over to the graft (Fig. 2).

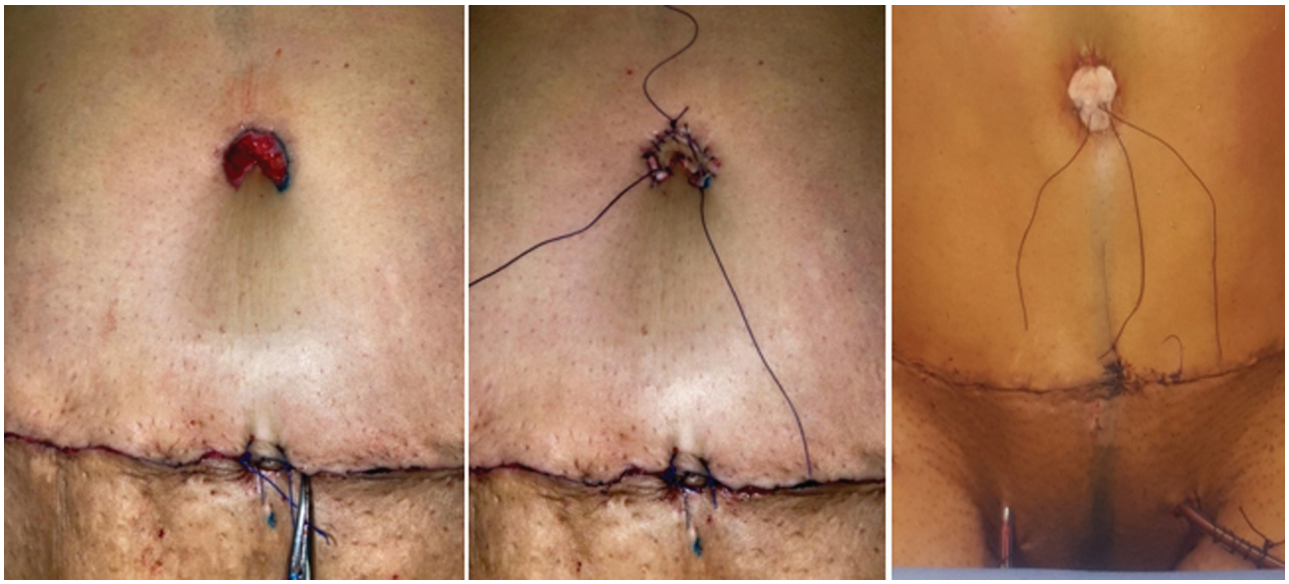
Postoperative care

The patients were urged to ambulate as soon as possible. Semisitting position was recommended to reduce the tension over suture. They were administered with antibiotics, antiedema medications, and analgesics. The drains were observed daily and removed once less than 30 ml/day output. First dressing on the graft for group B patients was done 7–10 days after surgery. Any seroma formation after drain removal was assessed by clinical examination or ultrasound if needed, and aspiration was done under complete aseptic conditions. The use of the abdominal binder was recommended for 4 weeks.

Evaluation

The data of the patients were collected including age, BMI, the total liposuction aspirate volume of the abdomen, the scar placement from the anterior labial commissure, and intraoperative measurements for the area of plicature using the equation of ellipse surface area $\pi \times r1 \times r2$ (Villegas) ($r1$: half the distance of the vertical limb of the ellipse and $r2$: half the distance of the transverse limb of the ellipse). Flap vascularity intraoperatively was assessed in two cases in each group using intravenous fluorescein dye (fluorescein

Figure 2



Left: an inferiorly based U-shaped flap sutured to the rectus sheath, (center) application of a full-thickness skin graft tightly fixed to the rectus sheath. Right: application of tie over to the graft.

sodium) (20 mg/kg) (USP 10% w/v white stone lab. mJasola<New Delhi-India). Wood's lamp was used with the room light off to evaluate the fluorescence of the flaps after its inset of both sides.

Changes in the intra-abdominal pressure (IAP) before and after plication and skin closure intraoperatively were also recorded using the three-way Foley bladder catheter (injection of 350 ml of saline solution through the third port of the Foley catheter after the bladder's contents had been evacuated and the urinary output port had been closed). The IAP in centimeters of water was determined using a central venous pressure catheter. It is important to declare that the neutral (0) value of the water column must be at the level of the pubis. Waist enhancement was analyzed also between the two study groups through the WHR changes documented preoperatively and 6 months after surgery for each case.

Regarding the changes in the anterior abdominal wall after TULUA procedure, MRI (1.5 Tesla machine; Achieva and Ingenia Philips Medical System, Eindhoven, Netherlands) was done for randomly selected three cases from group B 6 months postoperatively in the T1 axial, T2 axial, sagittal, and coronal planes. Cuts were taken at the umbilical level to give data on muscle and fascial thickness. Another cut was taken at the midpoint from the umbilicus to the symphysis pubis corresponding to the level of plicature.

Complications were recorded including flap viability, SSI wound dehiscence, and seroma formation. An external observer (a resident physician of the Surgery Department) evaluated esthetic outcomes for both groups blindly on a five-point Likert scale during a personal interview with the patients. Based on images of patients before and after surgery, three indicators were used: overall result, umbilicus appearance, and quality of the scar.

Furthermore, clinical outcomes of TULUA cases were objectively scored as excellent, good, fair, or poor using a cumulative outcome scoring made by Villegas 2014, of 0–18 points for six independent factors, each rated from 0 to 3 points.

Statistical analysis

Statistical analysis was done using the Statistical Package for the Social Sciences (IBM Corp. Released 2017. IBM SPSS Statistics for Windows, Version 25.0; IBM Corp., Armonk, New York, USA). Shapiro–Wilk test was used to evaluate normal distribution of continuous data. All continuous variables were presented as mean and SD values. Categorical results were described as numbers of cases and percentages. Categorical variables were compared using the χ^2 test or Fisher's exact test. Student's *t*-test was used to compare a continuous variable between two study groups. A P value less than 0.05 was considered statistically significant.

Results

The mean age of patients in group A was 39.80±4.09 (34–46 years old), whereas in group B was 41.93±4.87 (35–50 years old). The mean BMI for group A was 32.18 kg/m^2±1.99 (28.5–35 kg/m^2) and was 33.39 kg/m^2±3.69 (28.5–35 kg/m^2) for group B, as shown in Table 1.

The average total liposuction aspirate volume of the abdomen was 2400 ml (ranging from 1500–3500 ml) in group A, whereas in group B was 3500 ml (ranging from 2300–4600 ml). During the procedure, liposuction was done only to the abdomen without any other areas of the body to standardize the WHR changes. The transverse incision in group A was done at the pre-existing lower abdominal crease 7–9 cm (mean: 8.2 cm) from the anterior labial commissure, whereas in group B, the incision was as low enough at about 6–8 cm (mean: 7.07) above the anterior labial commissure. The mean surface area of plicature measured intraoperatively was 211.93±54.66 cm^2 in group A, whereas in group B, the transverse plicature surface area was 369.47±84.22 cm^2, as shown in Table 1.

The mean IAP before plication was 4.47±1.17 cmH_2O and the mean immediate IAP after plication and closure of skin was 12.40±0.97 cmH_2O with an increase of 7.93±1.26 cmH_2O for group A, whereas while for group B, the mean IAP preoperative was 4.70 ±1.12 cmH_2O, and the mean immediate IAP after plication and closure of skin was 14.57±0.77 cmH_2O, with a highly significant increase of 9.87±1.01 cmH_2O, as shown in Table 2.

In group A, flap sloughing was seen in four cases (13.3%), wound dehiscence occurred in two cases (6.6%), SSI occurred in two cases (6.6%), and seroma formation was documented in three cases (10%), whereas group B, no flap sloughing, no wound dehiscence, and no seroma formation that need drainage occurred, and only one (3.3%) case presented with SSI during the follow-up visits, as shown in Table 3. None of the patients (0%) in any of the two groups had hematomas, deep venous thrombosis (DVT), or any other major complications.

Translocated umbilicus in group A showed good results except for one (3.3%) case that expressed a shifted umbilicus, and one (3.3%) case that underwent concomitant umbilical hernial repair expressed sloughing to the umbilicus during the follow-up visits. Another case of group A with intraoperative intravenous fluorescein dye test that underwent concomitant umbilical hernial repair showed poor umbilical vascularity intraoperatively, besides the central flap showed less fluorescence, and decision was made to amputate the original umbilicus and to do a neoumbilicus in another session.

Neoumbilicus in group B also showed good results to be central and of good appearance; grafts were taken in 17 cases (56.7%). Flat umbilicus was seen in two cases (6.7%), as shown in Table 4.

The changes in WHR before and 6 months after surgery showed non-significant changes between the two study groups, where the mean WHR for group A was 0.86±0.03 preoperatively that decreased 6 months

Table 1 Demographic information, lipoaspirate volume, scar placement, and surface area of plicature

	Group			
	Traditional (*n*=30) Mean/*N*±SD/%	TULUA (*n*=30) Mean/*N*±SD/%	*P*	Significance
Age	39.80±4.09	41.93±4.87	0.081‡	NS
BMI	32.18±1.99	33.39±3.69	0.122‡	NS
Lipoaspirate volume	2.40±0.86	3.55±0.59	0.0001‡	HS
Scar placement (cm)	8.20±0.41	7.07±0.35	0.001‡	HS
Surface area to be plicated cm^2 ($\pi \times r1 \times r2$)	211.93±54.66	369.47±84.22	0.0001‡	HS

HS, highly significance.

Table 2 Changes in intra-abdominal pressure before and immediate after plication intraoperatively

	Group (*n*=60)			
	Group A (*n*=30) Mean/*N*±SD/%	Group B (*n*=30) Mean/*N*±SD/%	*P*	Significance
Intra-abdominal pressure before plication	4.47±1.17	4.70±1.12	0.432*	NS
Intra-abdominal pressure after plication	12.40±0.97	14.57±0.77	0.001*	HS
Change in intra-abdominal pressure after plication	7.93±1.26	9.87±1.01	0.001*	HS

HS, highly significance.

Table 3 Complications of the two study groups

	Group (*n*=60)			
	Group A (*n*=30) Mean/*N*±SD/%	Group B (*n*=30) Mean/*N*±SD/%	*P*	Significance
Flap vascularity				
Good	26±86.7%	30±100.0%	0.024**	S
Slough	4±13.3%	0		
Wound dehiscence	2±6.6%	0	0.49**	NS
SSI	2±6.6%	1±3.3%	1.0**	NS
Seroma	3±10.0%	0	0.23*	NS
Hematoma	0	0	0.496**	NS
DVT	0	0	0.496**	NS
Deaths	0	0	0.496**	NS

S, significance; SSI, surgical site infection. *Chisquare test. **Fisher exact test.

Table 4 Umbilical outcome for both groups

	Group(*n*=60)			
	Group A (*n*=30) Mean/*N*±SD/%	Group B (*n*=30) Mean/*N*±SD/%	*P*	Significance
Umbilicus				
Translocation	29±96.7%	0	0.001*	HS
Neoumbilicus (inverted U flap+FTSG)	1±3.3%	30±100%		
Graft take for neoumbilicus	1±3.3%	17±56.7%	0.001*	HS
Shifted umbilicus.	1±3.3%	0	1.0**	NS
Flat umbilicus	0	2±6.7%	1.0**	HS
Umbilicus slough	1±3.3%	0	1.0**	NS

HS, highly significance; FTSG, full thickness skin graft.

Table 5 Waist/Waisthip ratio changes before and 6 months after surgery

	Group (*n*=60)			
	Traditional (*n*=30) Mean±SD	TULUA (*n*=30) Mean±SD	*P*	Significance
Waist–hip ratio before	0.86±0.03	0.85±0.04	0.09*	NS
Waist–hip ratio after 6 months	0.78±0.01	0.76±0.05	0.19*	NS
Decrease in waist–hip ratio	0.07±0.02	0.08±0.04	0.94*	NS

after surgery by 0.07±0.02, whereas in group B, the mean WHR was 0.85±0.04 preoperatively, which decreased by 0.08±0.04, as shown in Table 5.

Results of group A (Figs 3 and 5) as well as group B (Figs 4 and 6) were assessed by the esthetic outcomes score through the three indicators. For group A, the esthetic outcomes score showed that the overall result was 4.50±0.87, umbilical appearance was 4.61±0.73, and scar quality was 4.35±0.82, whereas for group B, it showed overall result was 4.53±0.71, umbilical appearance was 4.52±0.82, and scar quality was 4.43 ±0.87, as shown in Table 6.

Outcomes of TULUA cases were objectively rated by the clinical outcome scoring made by Villegas, 2014. On a scale from 0 to 18, the patient outcomes were rated: 17 cases (56.7%) were rated as excellent, 10 cases (33.3%) as good, two cases (6.7%) as fair, and one case (3.3%) as poor.

Discussion

The traditional lipoabdominoplasty concept involves both abdominal flap thinning and tightening as much as the blood supply will allow, which frequently resulted in a featureless, operated-look abdomen as well as unnatural abdominal contouring [7].

Lipoabdominoplasty was reported by Matarasso [8]. He performed liposuction to the abdominal flap with wide undermining and classified these areas of liposuction regarding the blood supply of the abdominal wall.

Figure 3

A 42-year-old patient, with BMI of 37 kg/m^2 with epigastric bulge. (up) Preoperative views. (Down) Seven months after lipoabdominoplasty involving liposuction (2300-ml lipoaspirate), vertical abdominal wall plicature (311 cm^2). Noting the epigastric dome still present.

Liposuction when added to abdominoplasty increases the risk of necrosis, especially to the elevated flaps. This necrosis is attributable to multiple etiologies; the triad of wound closure under tension, undermining of the lateral flaps, and the addition of aggressive liposuction in an inappropriate zones and planes are considered important factors [9]. Saldanha *et al.* [10] described a technique of limited tunnel dissection of the upper abdomen in which they demonstrated decreased complications when liposuction was combined with full abdominoplasty, but the concern about the aggressiveness of liposuction in the central epigastrium during lipoabdominoplasty is still present.

Hypothetically, TULUA preserves vascularity of abdominal flap because there is no flap undermining, preserving the intercostal vessels and epigastric system perforators. Moreover, liposuction can be done without restriction in all planes and zones of the abdomen. Abdominal flaps' downward displacement is facilitated by the tunnels formed by the liposuction as well as the traction created when the transverse plication of the anterior rectus sheath causes it to fold in on itself, presenting less tension on wound closure with less liability for any scar expansion [11].

The incidence of skin necrosis in tunneled limited dissection above the navel varies between 3% and 4.4%, maintaining a sufficient number of perforating vessels [12]. The technique of dynamic laser-fluorescence-video angiography was used by Mayr *et al.* [13], to assess the abdominal flap perfusion following abdominoplasty using a wide dissection and flap undermining. They have shown that the

Figure 4

(a and b) A 42-year-old smoker female patient with BMI 29 kg/m^2, waist–hip ratio 0.80, presented with umbilical hernia underwent traditional lipoabdominoplasty. (c) Intravenous (IV) (fluorescein sodium) dye was used showing minimal central perfusion of the flap. Decision was made to amputate the nonvascularized umbilical stalk after hernia repair for fear of minimal perfused flap. (d) One month postoperatively showing the flap sloughing. (e and f) Patient underwent scar revision and neoumbilicus 6 months after the first session showing better outcome and waist–hip ratio 0.76.

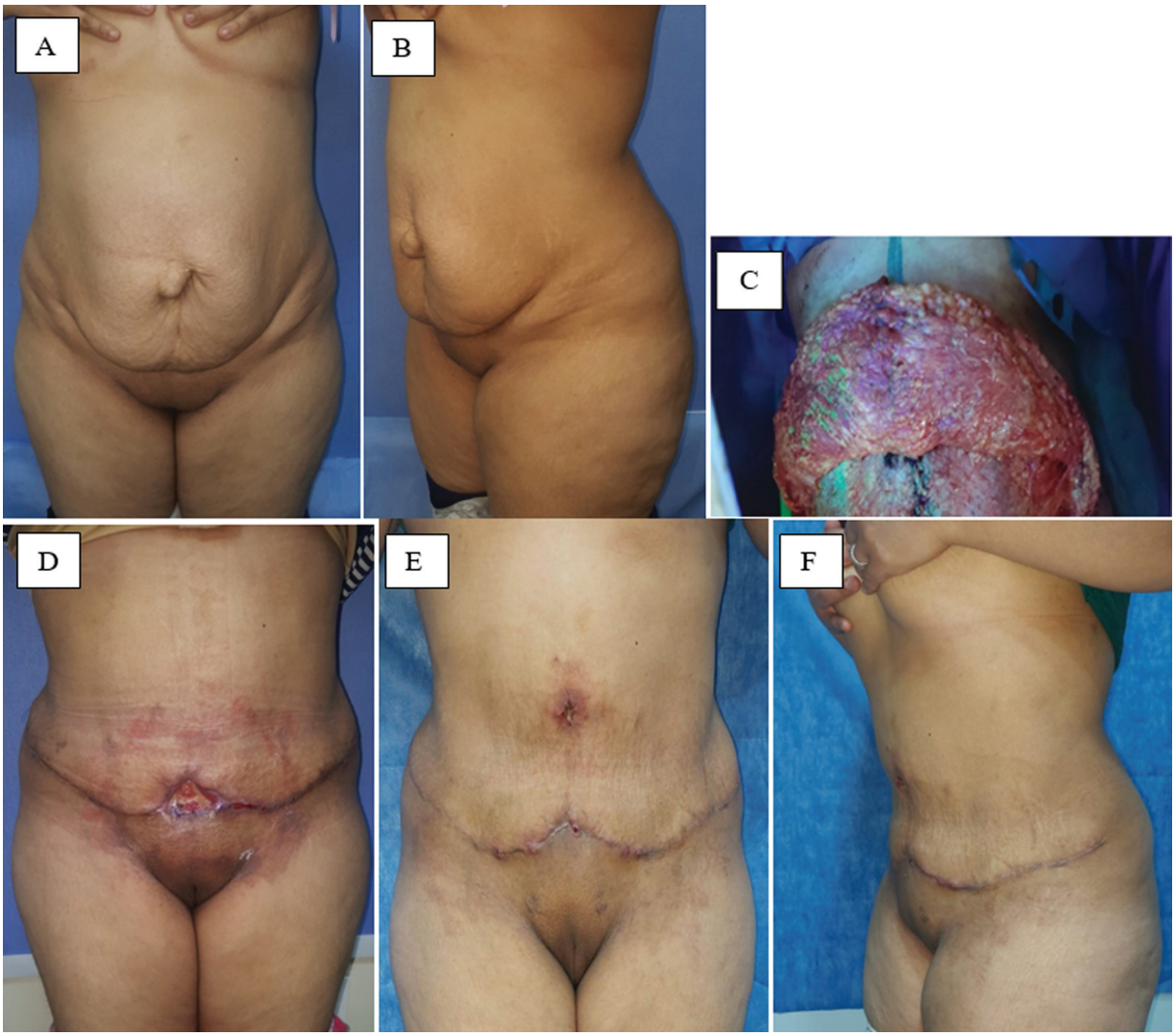
infraumbilical area mean perfusion index was 17.2% of the perfusion of the skin surrounding that was not enrolled in surgery. This clarifies that the flap loss after the abdominoplasty procedure usually occurs in the lower midline, and it ranges from minor (2–3 cm) to major (up to the umbilicus) [14].

According to our work, no flap necrosis occurred in the TULUA group. On the contrary, flap necrosis occurred in four cases (13.3%) that underwent lipoabdominoplasty with supraumbilical undermining. We used fluorescein sodium intravenous injection for monitoring flap vascularity intraoperatively as well as early postoperative clinical flap monitoring.

One of the common drawbacks that may happen during liposuction in lipoabdominoplasty is the epigastric bulging, as 'dome like' in the form of redundant sagging skin and vertical folds. This is typical when epigastric liposuction is minor, or the dissection is relatively restricted to a central tunnel. In contrast, the symmetrical full liposuction to the epigastrium and downward traction related to the transverse plicature in the TULUA approach prevented such redundancy; this safe liposuction can create a thin flap with a thickness of around 2 cm [15].

The lower scar placement gives better esthetic look. The transverse incision in lipoabdominoplasty group was done at the pre-existing lower abdominal crease 7–9 cm from the anterior labial commissure, whereas in the TULUA group, the incision was as low enough at about 6–8 cm above the anterior labial commissure. To give a better esthetic scar look, Klinger and colleagues, performed a 3 cm utmost the abdominal flap debulking

Figure 5



A 45-year-old diabetic patient with a BMI of 32 kg/m^2. Waist–hip ratio of 0.89 underwent TULUA abdominoplasty, with transverse plication performed. Liposuction (lipoaspirate, 3000 ml) down: 6 months postoperative, with waist–hip ratio 0.77.

on the Scarpa's fascia plane to match the thickness of the pubic flap. They also stated that anchoring the pubic flap to the muscular fascia beneath precludes upward displacement of the scar [16].

Daronch *et al.* [17] stated that wound dehiscence rate in lipoabdominoplasty was 6.9%, which nearly matched with our results in group A, with two cases (6.6%). Wound closure based on less tension in TULUA cases, as supported by the muscular fascia approximation by the transverse plication and superficial fascial system continuity, preventing any wound dehiscence. Our series reported no dehiscence in group B, which also matched a multicenter study by Villegas *et al.* [15] on 845 patients who underwent TULUA abdominoplasty.

Vertical plication used in the traditional lipoabdominoplasty is indeed more anatomical and enhances repair of the recti diastasis and hernias above the navel as well; the mean surface area of vertical plicature in our study was smaller compared with the TULUA group, where the plication is not anatomical, but it facilitates umbilical or infraumbilical hernias as well. This plication shortens and straightens the rectus muscles, imbricating them inward to the abdominal wall cavity. Moreover, the inferomedial borders of the external oblique muscles coincide with the ellipse of plicature. An improvement of the waistline was produced by the downward and medial advancement of the external oblique muscle [18].

Liposuction combined with abdominoplasty results in a better abdominal contour, enhances the waistline as

Figure 6

A 32-year-old diabetic patient, with BMI of 32 kg/m^2, waist–hip ratio of 0.89 underwent TULUA abdominoplasty, lipoaspirate of 3000 ml down: 6 months postoperative, with waist–hip ratio 0.77.

well as the distal ends of the line of closure [19]. Gkionoul *et al.* [20] suggested that the use of digitalized reference values concerning the female WHR should be updated to 0.7 instead of 0.75 and was evaluated to be the most attractive by many authors. According to our work, liposuction was only done to the abdomen without another concomitant regions, and also no fat grafting was done to standardize the WHR changes measured preoperative and 6 months after surgery. The decrease in WHR for both techniques showed nonsignificance. This may prove that the advancement of the external oblique produced by the transverse plication in the TULUA abdominoplasty does not affect WHR as predicted.

The umbilicus is crucial in abdominal contouring. It defines the medial abdominal sulcus and shares in the formation of the convexity of the inferior abdomen. It lies anatomically within the midline roughly between L3 and L5 vertebrae at the level of the superior iliac crests, according to Eycleshymer *et al.* [21]. Ideally, the distance from the umbilicus to the anterior labial commissure is 18–21 cm. In accordance, the appearance of umbilicus changes with age and is affected by the abdominal fat thickness, fluctuations in weight, number of pregnancies, hernia, and scars [22].

Based on an assessment of 40 images of nulliparous females of normal BMI, Villegas *et al.* [23], established

Table 6 Aesthetic outcomes Likert scale of the two study groups

	Group A: lipoabdominoplasty	Group B: TULUA abdominoplasty	*P* value
Overall result	4.50±0.87	4.53±0.71	0.53
The appearance of the umbilicus	4.61±0.73	4.52±0.82	0.42
Scar quality	4.35±0.82	4.43±0.87	0.51

Overall result – 1: very bad, 2: poor, 3: medium, 4: good, and 5: excellent. Umbilical appearance – 1: surgical revision required, 2: abnormal or absent, 3: some deformity, 4: inconspicuous, and 5: accepted. Scar quality – 1: very poor, 2: poor, 3: medium, 4: good, and 5: excellent.

H : V ratios of 1.5–2.5 for the positioning of the neoumbilicus. This parameter was actually not used in our series; patients preferred their normal umbilical site, so the H : V ratios was made to be 1–1.5, serving as the primary basis for the neoumbilicus site, as well as an index for the umbilical results to the modified clinical outcome scoring published by Villegas.

During the TULUA technique, the inverted U inferiorly based flap must not be too thin, so that flap necrosis can be provided. Moreover, care must be taken to avoid excessive thinning of the midline just above the neoumbilicus, and sufficient fatty tissue should be left around the area where the neoumbilicus will be reconstructed so as to keep the neoumbilical depth and to avoid a flat neoumbilicus. This was actually seen in two cases (6.7%) in the TULUA group in our study.

One crucial point to be considered in the TULUA technique is that the umbilicus is a skin graft, so changes in sensitivity may present as it takes place with most of the grafts. It is important to note that in traditional abdominoplasty, a decline or loss of sensation of the abdominal wall especially in the hypogastrium and mesogastrium regions could occur as a result of the dissection of the thoracic-abdominal nerves when the cutaneous flap is lifted. In fact, patients only oriented by the esthetic result of the navel gave less importance to whether or not they had sensitivity in the umbilical area [24]. Other point in favor of the technique of the neoumbilicus in the TULUA procedure is the inverted U-shaped flap and the graft fixation through a concealed sutures in contrast to the translocated umbilical scar that may also be hypertrophic in the traditional lipoabdominoplasty.

The abdomen behaves as a hydraulic system with a normal IAP of about 0–5 mm Hg (0–6.7 cmH_2O) [25]. In 2002, the first IAP study in plastic surgery was published by Talisman and colleagues. In this study, an analysis was performed preoperatively and on postoperative days 0 and 1 on 18 patients who underwent abdominoplasty. The study did not consider only the IAP values but also possible hints of a pathologic condition [26].

Through our work, we monitor the IAP before plication as a reference, and then another reading was taken after plication and skin closure intraoperatively. Our results showed a significant increase in the TULUA group. The IAP increase is mainly attributed to the surface area planned for plication and flap tension after resection. However, racial and nutritional characteristics need to be considered. One of the causes of the decrease in IAP values postoperatively is the elasticity of the skin and muscle. The accommodation of the abdominal viscera and the reduction in the inflammatory reactions produced by the surgery (metabolic and endocrine response to trauma) also could be factors in the decrease postoperatively as well [27].

In 2011, Najera *et al.* [28] published a series of 200 patients, pointing to the seroma rate variations between lipoabdominoplasty and abdominoplasty, where lipoabdominoplasty showed a higher seroma rate by 31.2%, whereas it was 16% only in abdominoplasty. Several methods have been suggested to lower the risk of seroma formation. One of them is the preservation of Scarpa's fascia while lifting the abdominal flap, leaving it attached to the anterior abdominal muscles' fascia [17].

Another proposed alternative by Baroudi and Ferreira [29] used sutures to seal the dead space between the muscles fascia and the Scarpa's fascia to reduce the possibility of liquid accumulation. In a similar vein, fibrin glue has been suggested for the use in abdominal flap adhesion to the muscles beneath and collapsing the dead space [30,31].

In TULUA abdominoplasty, there is no supraumbilical dissection and the transverse plication closes the dead space that leads to decrease in the risk of seroma formation; nonetheless, we use one or two suction drains for 1 week for all patients. Interestingly, no case presented with seroma in group B that need aspiration. On the contrary, three cases (10.0%) of group A experienced postoperative seroma. These cases typically were heavy smokers, with high BMI and noncompliant regarding the abdominal binder. Seroma faded after 3–4 times aspiration at the

outpatient clinic, more lymphatic massaging, and tightening the compression garments.

Conclusion

TULUA modification is a safe, reproducible shift in abdominoplasty. It is a technique that presents a higher esthetic abdominal contouring in line with current beauty standards. In addition, this technique is safe with full high-definition liposuction that encourages esthetic surgeons to sculpt a more athletic and more natural-look abdomen.

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Conflicts of interest

There are no conflicts of interest.

References

1 Matarasso A, Matarasso DM, Matarasso EJ. Abdominoplasty: classicprinciples and technique. Clin Plast Surg 2014; 41:655–672.

2 Ousterhout DK. Combined suction-assisted lipectomy, surgical lipectomy, and surgical abdominoplasty. Ann Plast Surg 1990; 24:126–132.

3 Swanson E. Prospective outcome study of 360 patients treated with liposuction, lipoabdominoplasty, and abdominoplasty. Plast Reconstr Surg 2012; 129:965–978.

4 Saldanha OR, Federico R, Daher PF, Malheiros AA, Carneiro PRG, Azevedo SFD, Saldanha Filho OR, Saldanha CB. Lipoabdominoplasty. Plast Reconstr Surg 2009; 124:934–942.

5 Cárdenas-Camarena L. Lipoabdominoplasty with abdominal definition. Aesthetic Plast. Surg 2016; 11:111–125.

6 Villegas FJ. A novel approach to abdominoplasty: TULUA modifications (transverse plication, no undermining, full liposuction, neoumbilicoplasty, and low transverse abdominal scar). Aesthetic Plast Surg 2014; 38:511–520.

7 Trussler AP, Kurkjian JT, Hatef DA, Farkas JP, Rohrich RJ. Refinement in abdominoplasty: a criticaloutcomes analysis over a 20 year period. Plast Reconstr Surg 2010; 126:1063–1074.

8 Matarasso A. Liposuction as an adjunct to a fullabdominoplasty. Plast Reconstr Surg 1995; 95:829–836.

9 Dutot MC, Serror K, Al Ameri O, Chaouat M, Mimoun M, Boccara D. Improving safety after abdominoplasty: a retrospective review of 1128 cases. Plast Reconstr Surg 2018; 142:355–362.

10 Saldanha OR, Pinto EB, Matos WNJr, Lucon RL, Magalhães F, Bello EM. Lipoabdominoplasty without undermining. Aesthet Surg J 2001; 21:518–526.

11 Villegas F. TULUA lipoabdominoplasty: no supraumbilical elevation combined with transverse infraumbilical plication, video description, and experience with 164 patients. Aesthet Surg J 2021; 41:577–594.

12 Neaman KC, Armstrong SD, Baca ME, Albert M, Vander Woude DL, Renucci JD. Outcomes of traditional cosmetic abdominoplasty in a community setting: a retrospective analysis of 1008 patients. Plast Reconstr Surg 2013; 131:403e–410e.

13 Mayr M, Holm C, Hofter E, Becker A, Pfeiffer U, Muhlbauer W. Effects of aesthetic abdominoplasty on abdominal wallperfusion: a quantitative evaluation. Plast Reconstr Surg 2004; 114:1586–1594.

14 Rogliani M, Silvi E, Labardi L, Maggiulli F, Cervelli V. Obese and nonobesepatients: complications of abdominoplasty. Ann Plast Surg 2006; 57:336–338.

15 Villegas F, Blugerman G, Cucchiaro J, Cárdenas-Camarena L, Uebel CO, Schavelzon D, *et al.* TULUALipoabdominoplasty: transversal aponeurotic plication, no undermining, and unrestricted liposuction. A multicenter study of 845 cases. Plast Reconstr Surg 2021; 148:1248–1261.

16 Klinger M, Klinger F, Giannasi S, Bandi V, Vinci V, Catania B, *et al.* Aesthetic and functional abdominoplasty:anatomical and clinical classification basedon a 12-year retrospective study. Plast Reconstr Surg Glob Open 2021; 9:e3936.

17 Daronch OOT, Marcante RFR, Neto AAP. Major and minor risk factors for postoperative abdominoplasty complications: a case series. Chin J Plast Reconstr Surg 2022; 4:56–62.

18 Villegas-Alzate FJ. A paradigm shift for abdominoplasty: transverse hypogastric plication without supraumbilical dissection, unrestricted liposuction, neoumbilicoplasty, and low placement of the scar (TULUA). In: Di Giuseppe A, Shiffman MA, editors. Aesthetic Plastic Surgery of the Abdomen. Cham, Switzerland: Springer 2016. 171–193

19 Boudreault DJ, Sieber DA. Getting the best results in abdominoplasty: current advanced concepts. Plast Reconstr Surg 2019; 143:628e.

20 Gkionoul N, Govsa F, Bicer A, Ozer MA, Pinar Y. Physical attractiveness: analysis of buttocks patterns for planningbody contouring treatment. Surg Radiol Anat 2019; 41:133–140.

21 Eycleshymer AC, Schoemaker DM, Potter P, Smith C, Jones T. A Cross-Section Anatomy. New York, NY: Appleton -Century-Crofts; 1911. p. 36.

22 Aly A, Rotemberg SC, Cram A. Abdominoplasty (Chapter 122). In: Guyuron B, Eriksson E, Persing JAMD, Chung KC, Disa J, ArunGosain A, Kinney B, Rubin JP, editors. Plastic Surgery: Indications and Practice. Edinburgh: Saunders Elsevier 2009. p. 1609–1926.

23 Villegas F. Abdominoplasty without flap dissection, full iposuction, transverse infraumbilical plication and neoumbilicoplastywith skin graft. (T.U.L.U.A). Can J Plast Surg 2011; 19(A):95.

24 Saldanha OR, Federico R, Daher PF, Malheiros AA, Carneiro PR, Azevedo SF, *et al.* Lipoabdominoplasty. Plast Reconstr Surg 2009; 124:934–942.

25 Kirkpatrick AW, Roberts DJ, De Waele J, Jaeschke R, Malbrain ML, De Keulenaer B, *et al.* Intra-abdominal hypertension and the abdominal compartment syndrome: updated consensus definitions and clinical practice guidelines from the World Society of the Abdominal Compartment Syndrome. Intensive Care Med 2013; 39:1190–1206.

26 Talisman R, Kaplan B, Haik J, Aronov S, Shraga A, Orenstein A. Measuringalterations in intraabdominal pressure during abdominoplastyas a predictive value for possible postoperativecomplications. Aesth Plast Surg 2002; 26:189–192.

27 Graça Neto L, Araújo LR, Rudy MR, Auersvald LA, Graf R. Intraabdominal pressure in abdominoplasty patients. Aesth Plast Surg 2006; 30:655–658.

28 Najera RM, Asheld W, Sayeed SM, Glickman LT. Comparison of seroma formation following abdominoplasty with or without liposuction. Plast Reconstr Surg 2011; 127:417–422.

29 Baroudi R, Ferreira CA. Seroma: how to avoid it and how to treat it. Aesthet Surg J 1998; 18:439–441.

30 Di Martino M, Nahas FX, Barbosa MV, Montecinos Ayaviri NA, Kimura AK, Barella SM, Novo NF, Ferreira LM. Seroma in lipoabdominoplasty and abdominoplasty: a comparative study using ultrasound. Plast Reconstr Surg 2010; 126:1742–1751.

31 Pilone V, Vitiello A, Borriello C, Gargiulo S, Forestieri P. The use of a fibrin glue with a low concentration of thrombin decreases seroma formation in postbariatric patients undergoing circular abdominoplasty. Obes Surg 2015; 25:354–359.