

## Body Contouring

# Ultrasound-Guided Female Equilibrated Minimal Muscularization and Enhancement (U-Femme)

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## Abstract

**Background:** High-definition liposculpture (HDL) has undergone significant evolution since its initial description, with the goal of achieving more natural outcomes and a muscular-defined appearance. The introduction of intramuscular fat grafting has enhanced contouring capabilities, with its applications extending to various muscle groups. Subperiosteal fat grafting efficacy and safety are well-established in facial surgery.

**Objectives:** Describe the technique of combining ultrasound (US)-guided subperiosteal lipoinjection of the anterior superior iliac spine (bikini bridge) plus intramuscular fat grafting of the internal oblique muscles with HDL.

**Methods:** A retrospective cohort study was conducted across different specialized plastic surgery centers. Adult patients who underwent bikini bridge and dynamic definition liposculpture were included. All patients were informed of the innovative use of the technique and consented to participate. Descriptive statistical analysis was performed to summarize the variables.

**Results:** A total of 105 consecutive patients were included for analysis. Patients were mostly females (86.7%) plus 14 male patients (13.3%) who were in the gender reassignment process. Mean age was 34.3 years (standard deviation [SD] 8.7 years) and the median BMI was 22.9 kg/m<sup>2</sup> (SD 2.74 kg/m<sup>2</sup>). All patients underwent fat grafting the iliac spines + the oblique muscles as an additional procedure to HDL. Median volume of fat injected was 15 cc (interquartile range 12 cc) for the iliac spines and 40 cc for the internal obliques. No major complications were reported.

**Conclusions:** The US-guided intramuscular and subperiosteal fat grafting of the abdomen is a safe and reproducible procedure, resulting in a harmonious and athletic appearance with natural-looking outcomes, high satisfaction, and a very low rate of complications.

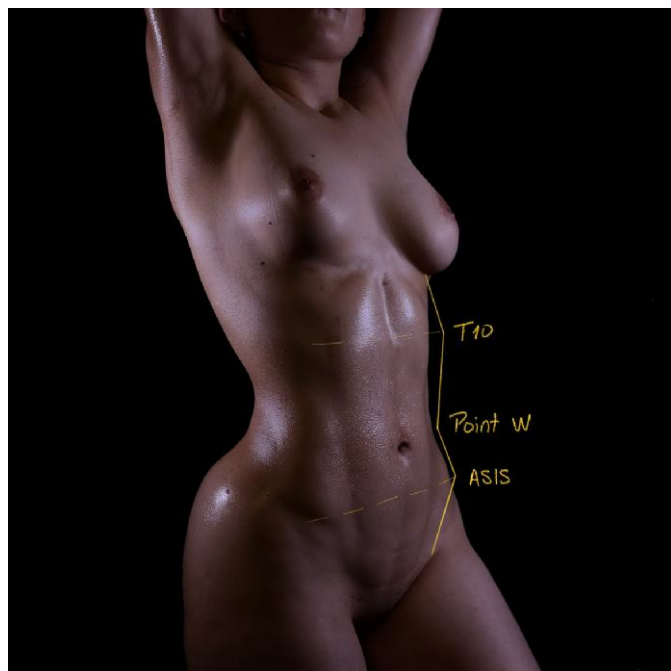
## Level of Evidence: 4 (Therapeutic)

Liposuction has undergone significant advancements in surgical technique, objectives, and safety standards in the past decades.<sup>1</sup> This switch in objectives and outcomes can be partially explained by a new subgroup of normal-weighted patients seeking body contouring procedures to achieve athletic definition. Hoyos et al<sup>1</sup> described high-definition liposculpture (HDL) and dynamic definition (HD2) liposculpture to enhance a more natural and athletic appearance with a muscular strength look, through the highlighting of muscle dynamics, transition zones, lights, and shadows, in addition to the incorporation of fat grafting.<sup>2</sup> Several authors have highlighted the benefits of lipoinjection and outcomes in different muscle groups, consistently demonstrating favorable safety profiles, and contributing to improved final aesthetic results.<sup>3-11</sup> The use of

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**Figure 1.** Feminine facets of the abdomen: this case involves a 27-year-old female who underwent dynamic definition liposculpture and fat grafting of the buttocks. Photograph is 6 months after surgery. Additionally, she underwent rib remodeling surgery to reduce the waistline diameter. The feminine facets of the abdomen were enhanced through the following procedures: (1) Carving the prominence of the rectus abdominis muscle at the T10 level, where the ribcage typically reaches its maximum anterior projection. (2) Liposuction and rib remodeling surgeries were utilized to define a prominent indentation at the waistline (Point W). (3) Finally, the prominent anterior superior iliac spines were augmented with fat grafting, with further improvement through grafting of the internal oblique muscle.

autologous fat as a filler in aesthetic and reconstructive surgery has been growing in the past decades, being considered an optimal filler, due to its convenient availability, versatility, biocompatibility, and realistic and long-lasting final appearance.<sup>12</sup> The incorporation of intramuscular fat grafts into body contouring procedures has allowed the harmonization of the appearance, adding bulk and dynamism to specific targeted muscle groups.

The use of fat grafting in the abdomen was initially described by Steinbrech and Sinno<sup>8</sup> in 2016, to obtain an athletic and muscular “6-pack” appearance of the abdomen, through subcutaneous fat grafting under direct observation. In 2017, Danilla<sup>5</sup> reported the application of intramuscular fat grafting of the rectus abdominis in patients with skin laxity undergoing lipoabdominoplasty, obtaining improved results and more natural outcomes. Later on, in 2020, Viaro et al<sup>6</sup> described an improvement in this technique, using ultrasound (US) to guide the fat grafting of the rectus abdominis muscle in patients undergoing HDL. An additional aspect of this improved technique was the possibility of using it in patients without skin laxity. Real-time US guidance is also highly valuable as it helps the precise localization of muscles and anatomical structures, hence ensuring the proper placement of the fat graft and preventing complications.<sup>11,13,14</sup> Moreover, other authors also explored the use of fat grafting for body contouring in additional torso muscle groups.<sup>4</sup> It is important to highlight that the selection of the body contouring surgery, including the intensity and muscle groups for fat grafting, must be based on a comprehensive and 360° analysis of the patient’s body structure, muscle and fat



**Figure 2.** Markings and zones for fat grafting in a 27-year-old female (6 months after surgery). The traditional negative spaces of the abdomen will aid for the definition of the Linea Alba and semilunaris (green lines) as well as the footprint of the breast. The enhancement of the facets will be done by autologous adipose grafting of the anterior superior iliac spines (encircled blue lines) and the athleticism of the abdomen can be improved by grafting the internal oblique muscles (blue lines).

body mass, age, skin laxity, and previous surgery history, among other important factors.

Based on the concepts of torso aesthetics described by Hoyos,<sup>15-17</sup> *feminine facets* are of paramount importance when sculpting the body. These concepts bring into play a new transformative way of approaching the deep, intermediate, and superficial adipose layers to soften the muscle contours, while also enhancing the curves and the projection of different muscle groups (Figure 1). Moreover, Oñate Valdivieso et al<sup>7</sup> explained the importance of modifying the bone structure of the ribcage through rib remodeling procedures in order to improve the feminine silhouette in patients with a waist-to-hip  $>0.7:1.0$  and a masculine appearance of the torso. Although subperiosteal lipoinjection in body contouring procedures has not been previously described, it is a well-known technique in facial aesthetic and reconstructive surgery, with over 2 decades of development and refinements.<sup>18</sup> Therefore, we are describing our experience with the combination of subperiosteal fat grafting of the anterior superior iliac spine (ASIS) plus intramuscular fat grafting of internal oblique muscles, with HDL (bikini bridge). The goal of this procedure is to improve the feminine appearance of the abdomen by increasing the anterior projection of the abdominal facets.

## METHODS

### Study Design

A retrospective analytical cohort study was conducted across 6 specialized plastic surgery centers, including 7 experienced plastic surgeons, from October 2022 to December 2023. All plastic surgeons were trained in HDL, US-guided fat grafting, and specifically in bikini bridge technique (ASIS subperiosteal fat grafting) + internal obliques intramuscular fat grafting both combined with dynamic definition



**Figure 3.** Luer connectors with a 2.0 mm adipose graft filter (orange). Syringes are attached to each side of the connector to prepare the lipograft. In the picture, there are also 1.5, 2.5, and 3.0 mm filters (red, yellow, and blue, respectively).



**Video 2.** Watch now at <http://academic.oup.com/asjopenforum/article-lookup/doi/10.1093/asjof/ojae103>

liposculpture (HD2). Our study included adult patients aged between 18 and 60 years, with ectomorph or mesomorph body structure, considered candidates for moderate and extreme muscular definition, who had undergone bikini bridge procedure and HD2 at one of the inclusion centers. Patients had a follow-up of at least 6 months and complete data available for analysis. As part of the outcome's evaluation, patients were asked to answer a nonstandardized satisfaction scale for liposuction procedures, during any appointment from the third to sixth month postop. We take photographic image records before surgery and at every visit at 24 to 48 h postop, then 1 week and 1, 3, and 6 months after surgery.

## Ethical Considerations

Patients were informed about the authors' purpose, methods, funding sources, and potential conflicts of interest. Furthermore, patients were explained the experimental and innovative nature of the bikini bridge technique, the expected benefits, the potential risks and discomfort specific to fat grafting, and dynamic definition liposculpture. Surgery was planned based on the patient's expectations and different levels of muscle definition. Each patient was free to choose



**Video 1.** Watch now at <http://academic.oup.com/asjopenforum/article-lookup/doi/10.1093/asjof/ojae103>

whether to fat graft certain muscles/areas. All enrolled patients freely signed informed consent for the procedure and the use of photographs and information for academic and research purposes. Due to the retrospective and observational nature of the study, it was considered minimal risk. The study was conducted following the principles of the Declaration of Helsinki, the guidelines of the International Committee on Harmonization of Good Clinical Practice, the regulations and laws on healthcare research, and private information management.

## Data Collection

Variables for analysis included demographics, type of procedure, surgical time, location of the injection and injected volume, complications, and patient satisfaction with the final aesthetic outcomes. Each center had a trained nurse who collected data in a standard spreadsheet and blinded to the study aims, for accuracy. The data were extracted from the patient's clinical charts and surgery notes.

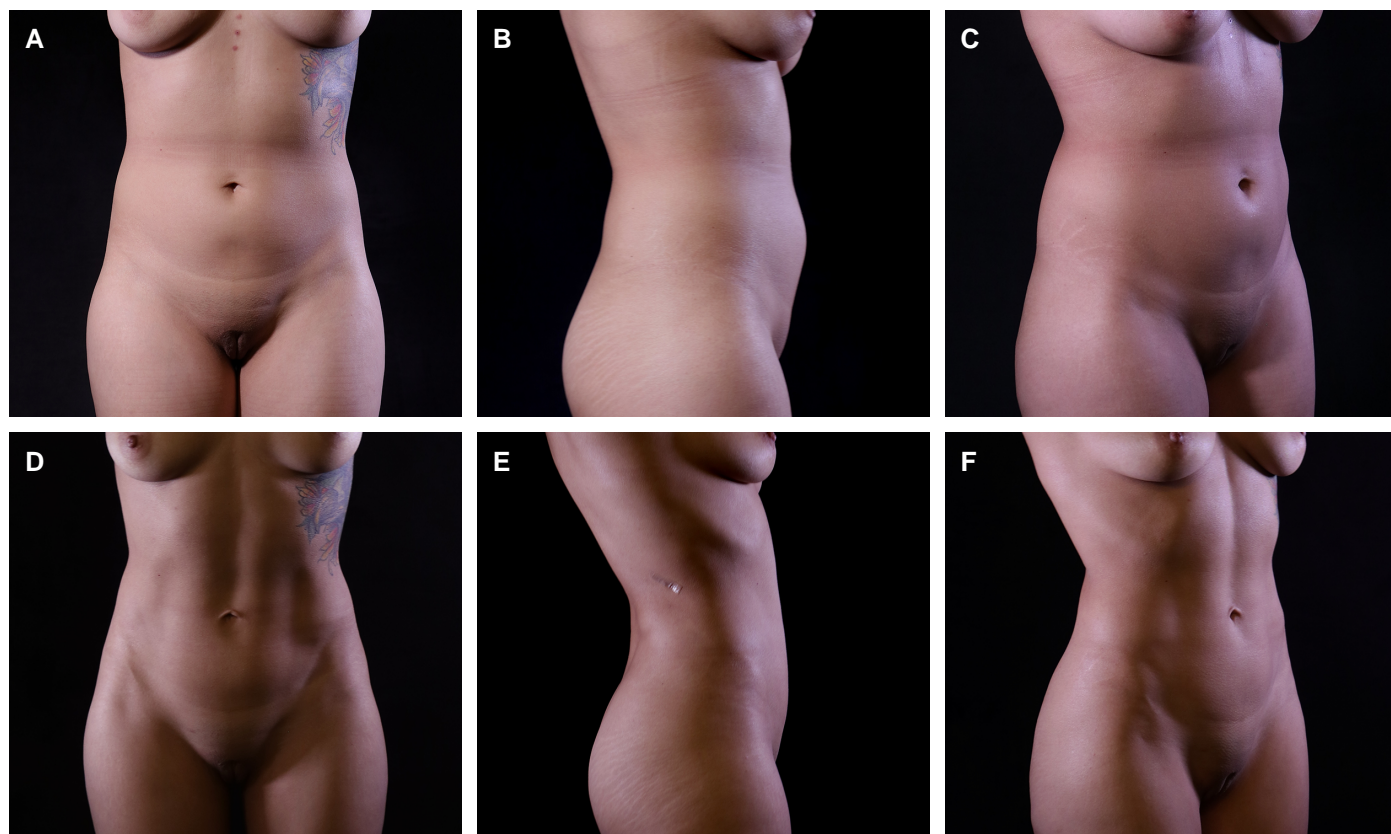
## Statistical Analysis

Variables were summarized with univariate analysis. Percentages and absolute and relative frequencies were estimated for qualitative variables. Shapiro–Wilk test was used to evaluate the normal distribution of quantitative variables. Variables with normal distribution were analyzed using mean and standard deviation (SD), and for nonnormal variables, median, and interquartile range (IQR) were calculated. Due to the sample size, the low rate of complications, and the relatively high satisfaction scores, bivariate statistical analysis proved impractical in finding statistically significant differences. Statistical analysis was carried out using *Jamovi* computer software (Version 2.3).

## Surgical Technique

Preoperative assessment comprised a thorough physical examination. Patients were advised about the surgical plan based on this evaluation and their expectations, overall risks were assessed as well as a detailed explanation of the procedure and its potential aesthetic results. All patients underwent general anesthesia, protocols for thrombotic event prevention, normothermia, and blood conservation strategies were all implemented for all patients. Intraoperative





**Figure 4.** This is a 29-year-old female who underwent fat grafting (20 cc) of the iliac crests (bikini bridge) + high-definition liposculpture + rib remodeling surgery through drill-assisted waistline reduction by puncture. Preoperative photographs (A-C) show a bulky abdomen with a distortion of its facets and lack of projection of the iliac crests. Seven-month postoperative photographs (D-F) show a new athletic definition of the abdomen with a stylish definition of the anterior superior iliac spines, that improve the muscular appearance of the lower belly.

medications included: antibiotic prophylaxis (cefazolin or clindamycin), dexamethasone, metoclopramide, diclofenac, and ranitidine. Surgical markings are drawn with the patient in standing position, and according to the planned muscular definition. Both ASISs are located by palpation and marked, as well as the medial borders of the oblique muscles (Figure 2).

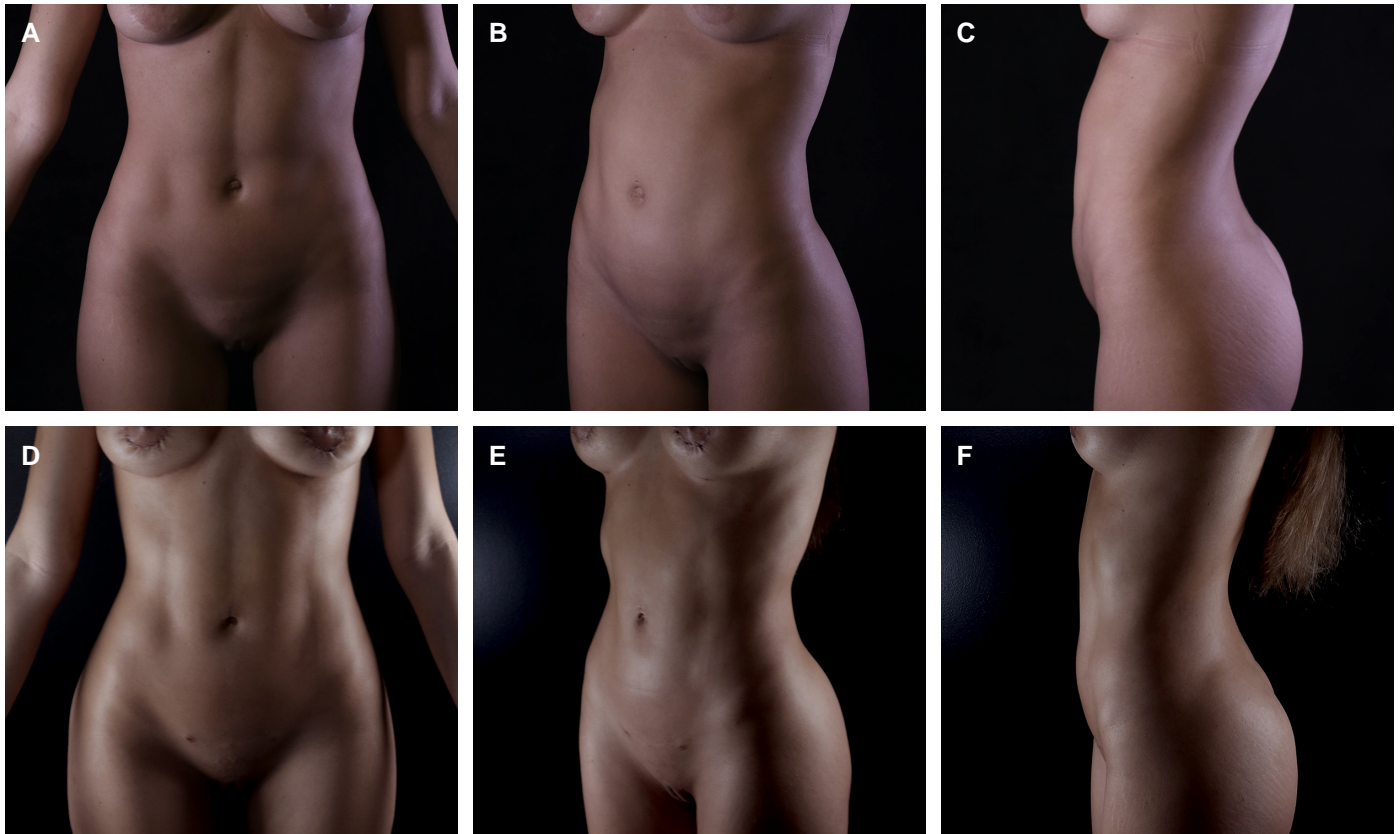
Liposculpture (HD2) is performed as a 3-step procedure: infiltration, emulsification, and extraction. The infiltration is performed with a tumescent solution, prepared with 1,000 mL of normal saline and 1 mL of epinephrine, for a 1:1,000 proportion. The ratio of infiltration/lipoaspirate is ~2:1. For adipose tissue emulsification, we use third-generation US (VASER Lipo System—© 2021 Solta Medical—Bausch Health Companies Inc., Bothell, WA) in pulsed and continuous modes (power according to tissue resistance), starting at the superficial and then the deep layers. Finally, the liposuction is done using 4.0 and 3.0 mm Mercedes cannulas connected to Microaire system (Microaire—© 2020 MicroAire Surgical Instruments, LLC—Charlottesville, VA), starting deep and going superficial, following the markings of the negative spaces to achieve the desired level of muscular definition. Adipose tissue is harvested through a sterile closed system. Then, we washed it with a stabilized molecule of hypochlorous acid (AQUILABS—Copyright © 2023—Bogota, DC, Colombia) at a final concentration of 150 ppm per liter of fat. It is purified by active decantation (vibratory tissue separator—Wells Johnson—Copyright © 2019. Tucson, AZ) and placed in 60 cc

syringes connected to 3.0 or 4.0 mm blunt tip cannulas for intramuscular lipoinjection, and 10 to 20 cc syringes connected to a 16 G needle for subperiosteal lipoinjection. The latter requires additional graft preparation by using a 2.0 mm Luer filter for adipose tissue (Figure 3).

## Fat Grafting Procedure

Real-time US mapping enabled us to locate the ASIS and the internal/external oblique muscles. Cannulas are disinfected with HOCI before use. A puncture incision is made above the ASIS using a 16 G needle before inserting a new needle for subperiosteal grafting. Syringe is inserted in a perpendicular angle until the periosteum. Then, a small angulation is done to place the infiltration at the subperiosteal layer. Approximately, 15 to 20 cc of adipose tissue is grafted on each ASIS (bikini bridge). A gentle massage is performed to homogenize the graft (Video 1). The same incision is then used to access the external oblique muscle. A 3.0 mm blunt-tip cannula is inserted into the muscle, and 30 to 50 cc of adipose graft is deposited near the aponeurosis of the external oblique. Additional fat grafting between the internal and external oblique muscles as well as the rectus abdominis muscle can be done to support prior lipoinjection and further enhance the muscular definition (Video 2). Overall, this approach will accentuate the shadow next to the linea semilunaris, therefore improving the athletic definition of the oblique muscles. The authors





**Figure 5.** This is a 24-year-old female who wanted a more athletic abdomen and underwent U-Femme with 15 cc of the iliac crests + 50 cc of the internal oblique muscle + 10 cc of each rectus abdominis belly (total = 4). She also underwent high-definition liposculpture. Preoperative photographs (A-C) show a slim abdomen but no definition and lack of projection of the hip bone. Six month postoperative photographs (D-F) show a more muscular appearance of the abdomen with a better anterior projection of the hips by enhancing the iliac crests. This patient underwent nipple reduction surgery 5 months after the initial procedure.

named this combined procedure U-Femme Graft: US-guided Female Equilibrated Minimal Muscularization and Enhancement (Figures 4, 5). We use an Epifoam splint over the surroundings of the periosteal and oblique muscles graft (Figure 6). The patient is dressed up in postoperative foam vest and garments before transferring the patient to the recovery room.

## RESULTS

A total of 105 consecutive patients who underwent HD2 + U-Femme procedures were included for analysis. The majority of these patients were females, accounting for 86.7%, with a noteworthy inclusion of 14 male patients (13.3%), who were undergoing the gender reassignment process. Mean age was 34.3 years (SD 8.7 years), mean weight was 60.1 kg (IQR 7.7 kg), mean height was 1.61 m (IQR 0.05 m), and median BMI was 22.9 kg/m<sup>2</sup> (SD 2.74 kg/m<sup>2</sup>). Most patients were Latino ethnicity (61.9%), followed by White Americans (31.4%), with a smaller proportion of Afro-Americans (6.7%). Most patients (91.4%) had no medical history and were undergoing their first liposculpture procedure (82.8%). Median surgical duration was 300 min (IQR 230 min). The HD2 + buttocks fat grafting was the most frequent procedure (81.9%). All patients underwent fat grafting of the iliac crests (bikini bridge) as an additional procedure, with a median volume of

fat injected of 15 cc over the iliac crests (IQR 12 cc). About 25% of patients ( $n = 26$ ) underwent fat grafting of the internal oblique muscles. For those patients who underwent buttocks fat grafting ( $n = 100$ ), the median grafted volume was 531 cc (IQR 357 cc). See Table 1 for further details. All additional technologies used in our cohort are described in Table 2. Follow-up period ranged from 3 to 13 months. Most patients were followed up for at least 6 months postop ( $n = 89$ , 85%).

The complication rate of the total cohort was 12.38% ( $n = 13$ ). No major complications or life-threatening events were reported. The most frequent complications were seroma ( $n = 5$ ), hyperpigmentation ( $n = 2$ ), and anemia ( $n = 2$ ), all related to the liposculpture procedure rather than the bikini bridge technique itself. Seromas were treated with physical means, hyperpigmentation required CO<sub>2</sub> laser therapy, and hydroquinone lotion, without further concerns. Only 2 patients had postoperative anemia, but neither of them required transfusion. A total of 71 patients (67.62%) answered the satisfaction questionnaire. Most patients ( $n = 66$ , 93%) were very satisfied with the surgical intervention results, scoring between 8 and 10. Only one patient rated her satisfaction with a score of 6/10, due to a preexisting fibrosis that was not completely solved with HD2. Further details are described in Table 3. Fat retention rates were measured by US at 3- and 6-month follow-up visits for some patients. A statistically significant difference was observed between the immediate postoperative period and both



**Figure 6.** This intraoperative photo shows a 26-year-old patient who underwent the U-Femme procedure, receiving 20 cc of fat grafting to the iliac crests and 40 cc to the internal oblique muscle. A splint made from Epifoam was applied postoperatively to help maintain the graft in place.

the 3- and 6-month follow-ups. However, there was no significant difference between the third and sixth months (see [Table 4](#)).

## DISCUSSION

Subperiosteal and multicompartiment fat grafting of the face has been widely known for its great outcomes and long-lasting results. In a meta-analysis, Krastev et al<sup>10</sup> showed that autologous fat grafts in facial surgery is an efficient and safe procedure, with a low rate of minor complications, and good volume retention at 1-year follow-up. In recent years, the definition of female body aesthetics has shifted toward a more athletic figure. This change has led to an increase in ectomorph and mesomorph patients seeking body contouring procedures. Consequently, new surgical strategies have been developed to accentuate the female muscular and body structure, using light and shadow techniques, resulting in more natural-looking outcomes. Apart from bone structure modification surgeries, such as rib remodeling and/or resection, these strategies often include the use of US-guided fat grafts in specific body areas and muscle groups. Real-time US imaging to guide fat grafting techniques ensures the accurate placement of the fat in the intended location, therefore avoiding vascular and tissue

**Table 1.** Baseline Demographic, Clinical, and Surgical Characteristics

Variable	Measure of central tendency or %	Dispersion measurement
Gender	<i>n</i> (%)	NA
Female	91 (86.67)	
Male	14 (13.33)	
Weight	Mean 60.1	SD 7.77
Height	Mean 1.61	SD 0.05
BMI, kg/m <sup>2</sup>	Median 22.9	IQR 3.4
Race	<i>n</i> (%)	NA
White American	33 (31.43%)	
Afro American	7 (6.67%)	
Latino	65 (61.9%)	
Medical history	<i>n</i> (%)	NA
None	96 (91.43%)	
Bad healing	4 (3.8%)	
Depression	2 (1.9%)	
Dyslipidemia	1 (0.95%)	
Cancer	1 (0.95%)	
Thyroiditis	1 (0.95%)	
Surgical time	Median 300 min	IQR: 232 min
Infiltration	Median 4075 cc	IQR: 1718 cc
Lipoaspirate	Median 3635 cc	IQR: 1590 cc
ASIS fat grafting	Median 15 cc	IQR: 12 cc
Obliques Fat grafting	Median 40 cc	IQR: 35 cc
Butt fat grafting	Median 531 cc	IQR: 357 cc

ASIS, anterior superior iliac spine; IQR, interquartile range; NA, not applicable; SD, standard deviation.

injuries. This also implies the need for a hand-held US device inside the OR, a trained surgeon, and of course a proper learning curve.

Fat is considered the safest filler due to its biocompatibility, ease of harvest, and immediate availability during liposculpture procedures. Numerous studies have highlighted the benefits of autologous adipose tissue transfer for various purposes, including reconstruction in oncologic breast surgery, correction of facial deformities, and enhancements in ophthalmologic surgery. Furthermore, many authors have documented their experiences with fat grafting across different muscle groups, underscoring its essential role in enhancing aesthetic outcomes.<sup>4-7,11</sup> Proper fat preparation must ensure the preservation of the vascular stromal fraction, which contains growth factors and mesenchymal cells that will improve graft survival.<sup>12</sup> The retention rate of fat grafts over time can vary widely and is influenced by several factors, including the surgical technique, the area of the body

**Table 2.** Use of Additional Technologies

Variable	Frequency	Percentage
MicroAire		
Yes	94	89.52
No	11	10.48
VASER		
Yes	83	79.04
No	22	20.95
Renuvion		
Yes	33	31.43
No	72	68.57
Morpheus		
Yes	23	21.9
No	82	78.1
Argoplasma		
Yes	14	13.33
No	91	86.67
Body tite		
Yes	4	3.81
No	101	96.19

IQR, interquartile range; SD, standard deviation.

**Table 4.** Fat Graft Retention Rate

Variable	RerR at 3 mo (%)	RetR at 6 mo (%)	T0 vs 3 mo (P-value)	T0 vs 6 mo (P-value)	3 mo vs 6 mo (P-value)
ASIS fat grafting (n = 12)	≈60%	≈60%	1.94E-05	.0004	.4979
Obliques fat grafting (n = 4)	≈50%	≈60%	.0037	.0018	.4235

ASIS, anterior superior iliac spine; RetR, retention rate.

where the fat is grafted, the patient's metabolism, and postoperative care. In general, fat grafting procedures have reported retention rates ranging from 30% to 70% after 1 year. We reported average fat retention rates of 50% to 60%, as measured by US 3 months after surgery. These retention rates appear to stabilize by 6 months postoperatively. Our manuscript describes the bikini bridge technique, a method that involves US-guided intramuscular fat grafting of the obliques in the lower third, as well as subperiosteal fat grafting of the ASIS, in patients undergoing HDL. The application of this holistic approach has led to excellent aesthetic outcomes, featuring zero complications associated with the fat grafting procedure and only minor

**Table 3.** Complications and Satisfaction

Variable	Frequency	Percentage
Complication		
None	92	87.62
Seroma	5	4.76
Hyperpigmentation	2	1.90
Anemia	2	1.90
Surgical wound dehiscence	1	0.95
Pain	1	0.95
Fibrosis	1	0.95
Oily cyst	1	0.95
Satisfaction		
6	1	1.4
7	4	5.6
8	11	15.5
9	25	35.2
10	30	42.3

IQR, interquartile range; SD, standard deviation.

complications associated with liposculpture, thereby upholding it as an effective and safe technique. It is not strictly necessary to distinguish between subperiosteal and suprapariosteal graft placement, as the strong attachment of the muscles and the Epifoam taping will both help to secure the graft in place. However, we recommend using US guidance to familiarize oneself with the ideal graft placement location and to avoid inadvertent intraosseous placement.

Our method introduces a novel technique aimed at enhancing the aesthetic and athletic features of the female abdomen. This includes improving the projection of the ASIS and enhancing the muscularity of the lower abdomen, a characteristic uniquely attributed to the athletic female form. In contrast, for males, the emphasis often lies on the upper abdomen and its relationship with the chest, which is considered more significant than the lower zone. Of note, this procedure has been developed for patients with specific goals regarding the muscular definition of their abdomen. It is sometimes also combined with rib remodeling techniques, which collectively offer a broad spectrum of possibilities for females who felt constrained by a physical form where athleticism and femininity needed to converge.

## Limitations

Some limitations of our study include the absence of a control group, its observational and retrospective design, and the limited follow-up duration. However, our sample size is significantly larger than previously reported studies on abdominal fat grafting. The efficacy and long-term outcomes, including fat graft retention, have already been demonstrated in both abdominal muscles and other muscle groups, as well as in subperiosteal applications in the face.<sup>10,19,20</sup>



## CONCLUSIONS

This manuscript presents the first description of a body contouring procedure associated with a technique that combines US-guided intramuscular and subperiosteal fat grafting to improve the athletic definition of the female abdomen. Our technique can be considered a safe and reproducible procedure, with a minimal rate of complications. Further studies with long-term follow-up periods are required to support our findings.

## Disclosures

Dr Hoyos performs as a speaker receives royalties, compensation, and sponsorships from InMode (Irvine, CA). All other authors declare that they have no conflicts of interest.

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