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ORIGINAL ARTICLE
Cosmetic

Prospective Controlled Study of Buttock Fat Transfer Using Ultrasound and Photographic Measurements

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Background: Buttock fat transfer is now the preferred method for gluteal augmentation. However, its efficacy has not been well-documented using measurements.

Methods: Twenty-five consecutive patients underwent buttock fat transfer performed by the author. Twenty-one patients returned for measurements ≥3 months after surgery (inclusion rate, 84%). A separate group of 25 patients undergoing cosmetic surgery without buttock fat transfer served as controls. All patients underwent superwet liposuction using total intravenous anesthesia and no prone positioning. A closed filtration system was used to collect the fat. Subcutaneous fat thickness was assessed using ultrasound imaging. Measurements were made on standardized photographs. The data were controlled for change in body mass index. Clinical data were also evaluated.

Results: The mean fat volume injected per buttock was 287 mL (range, 70–550 mL). Ultrasound measurements detected a significant increase in the subcutaneous fat thickness ($P \leq 0.001$), with mean increments of 0.66 cm for the right buttock and 0.86 cm for the left buttock and no significant change for control patients. The mean calculated fat retention, based on the measured surface area injected, was 66%. Photographic measurements of buttock projection revealed a significant increase in treated patients ($P < 0.01$) and no significant change in control patients. There were no clinical complications at either recipient or donor sites and no evidence of oily cysts on ultrasound examinations.

Conclusions: Photographic and ultrasound measurements, and clinical findings, confirm that buttock fat transfer effectively and safely increases buttock projection. *(Plast Reconstr Surg Glob Open 2016;4:e697; doi: 10.1097/GOX.0000000000000700; Published online 4 May 2016.)*

Fat injection of the buttocks has increased dramatically in popularity over the past decade[1] and is now frequently performed at the time of liposuction. In patients with sufficient donor sites, buttock fat transfer is preferred over silicone implants because of its lower risk of complications.[2,3] However, its efficacy has not been well-documented by measurement studies. Ultrasound imaging has been previously used to assess the thickness of the subcutaneous fat layer in other

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Received for publication December 10, 2015; accepted March 9, 2016.

DOI: 10.1097/GOX.0000000000000700

Disclosure: *The author has no financial interest to declare in relation to the content of this article. The Article Processing Charge was paid for by the author.*

Supplemental digital content is available for this article. Clickable URL citations appear in the text.

applications.[4,5] This modality has been compared with anthropometric measurements and computerized axial tomography and found to be similar in accuracy and sensitivity for measuring changes in gluteal projection.[6] Measurements on standardized photographs may also be used to assess changes in fat thickness.[7] This study was undertaken to determine whether fat grafting increases buttock fullness and the magnitude of any change. Clinical findings regarding safety and complications (including donor sites) were also evaluated.

PATIENTS AND METHODS

Patients

Twenty-five consecutive patients underwent buttock fat injection performed by the author between March 2014 and June 2015. All patients agreed to participate in the study. The inclusion criteria were simply patients having buttock fat injection and returning to follow up at least 3 months after surgery. Twenty-one patients met the inclusion criteria (inclusion rate, 84%). A separate group of 30 patients underwent cosmetic surgery without buttock fat transfer during the same study period.Twenty-five control patients returned to follow up at least 3 months after surgery (inclusion rate, 83%). Eight of the control patients underwent liposuction. The 8 patients treated with liposuction served as controls for the photographic analysis. Institutional review board approval was obtained from Chesapeake Institutional Review Board Services, accredited by the Association for the Accreditation of Human Research Protection Programs, Inc.

Liposuction donor sites always included the abdomen and flanks. The outer thighs were treated in 6 patients. Many patients prefer lateral gluteal (trochanteric) fullness to accentuate the hourglass shape,[2,8] and this area was routinely treated with the rest of the buttock during lipoinjection. Patients were marked in a standing position before surgery. All patients underwent Doppler ultrasound imaging as part of routine surveillance for deep venous thromboses preoperatively, on the day after surgery, and 1 week postoperatively.[9]

Surgery

All patients were treated as outpatients under total intravenous sedation using a propofol infusion.[10] Patients were prepped with warm chlorhexidine solution in a standing position. Patients were first positioned supine on the operating table and were then turned from side to side to perform the infusion.[10] The sequence was repeated for liposuction, giving the lidocaine and epinephrine at least 15 minutes to work and providing movement of the lower extremities (Fig. 1). Prone positioning was not used.

The donor and recipient sites were infused using a superwet technique. **(See Video 1, Supplemental Digital Content 1**, which demonstrates injection of the local anesthetic, fat harvesting, and fat injection. This video is available in the "Related Videos" section of the Full-Text article on PRSGlobalOpen.com or available at ***http://links.lww.com/PRSGO/A198.***). The wetting solution consisted of 1 L normal saline with 500 mg (0.05%) lidocaine and 2 mL epinephrine (1:526,000). Liposuction was performed using a 4-mm blunt 3-hole ("Las Vegas tip") and 4-mm 1-hole spatula-tipped cannula. No other device such as ultrasound, laser

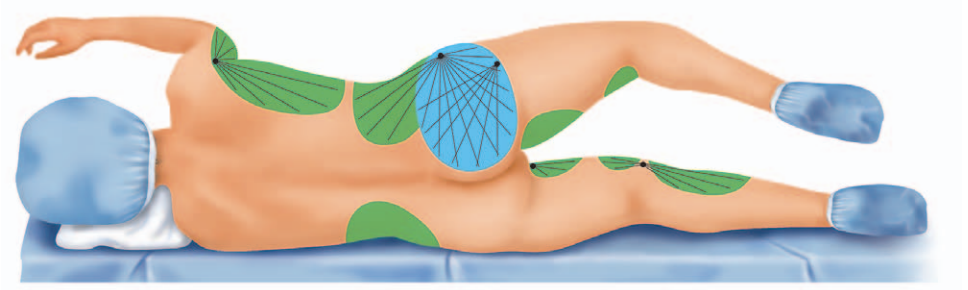

Fig. 1. Illustration of liposuction (green) and fat injection treatment areas (blue) with the patient positioned on her left side for liposuction of the right flank, arm, axilla (including the scapular area), and left medial knee. The abdomen and inner thighs have already been treated with the patient in the supine position. In some cases, the left medial calf and right lateral calf are also treated while the patient is on her side. The outer thigh may be treated if desired (not illustrated). The patient is then turned onto her right side, and the contralateral areas are treated in the same sequence completing the liposuction. Prone positioning is not used. After liposuction is used to harvest the fat, the lipoaspirate is injected subcutaneously into each buttock using 2 access incisions located laterally, with cross-hatching over the central buttock.

Video 1. See video, Supplemental Digital Content 1, which displays a 43-year-old woman undergoing fat harvesting by closed inline filtration and fat transfer to the buttocks. Details of the local anesthesia injection and intraoperative positioning are also provided. This video is available in the "Related Videos" section of the Full-Text article on PRSGlobalOpen.com or available at ***http://links.lww.com/PRSGO/A198***.

assistance, or radiofrequency was used to maximize adipocyte viability.[11] A Tissu-Trans Filtron 500 closed inline filtration system (Shippert Medical Technologies, Centennial, Colo.) was used to collect the fat without centrifugation. After collection, the fat was used to fill 60-mL syringes. The fat was then injected into the buttocks and lateral gluteal regions using a blunt 4-mm cannula with a side hole (Genesis Biosystems, Lewisville, Tx.). No drains were used.

A compression girdle was worn postoperatively for 1 month, providing uniform compression of the buttocks and donor sites. Patients were allowed to return to full activities including exercising in 1 month. Patients typically received a single dose of cefazolin 1 g IV immediately before surgery and then 3 doses of cephalexin 500 mg p.o. q12h.

Photographic Measurements

Patient photographs were matched using the Canfield 7.4.1 imaging software (Canfield Scientific, Fairfield, N.J.). The surface area of each buttock within the treatment area was measured (Fig. 2). This area corresponded to the region marked preoperatively, extending from the lateral gluteal border to the intergluteal cleft, superiorly to the transitional area between the buttock and the flank and inferiorly to the gluteal fold. The horizontal distance from the anterior margin of the mons

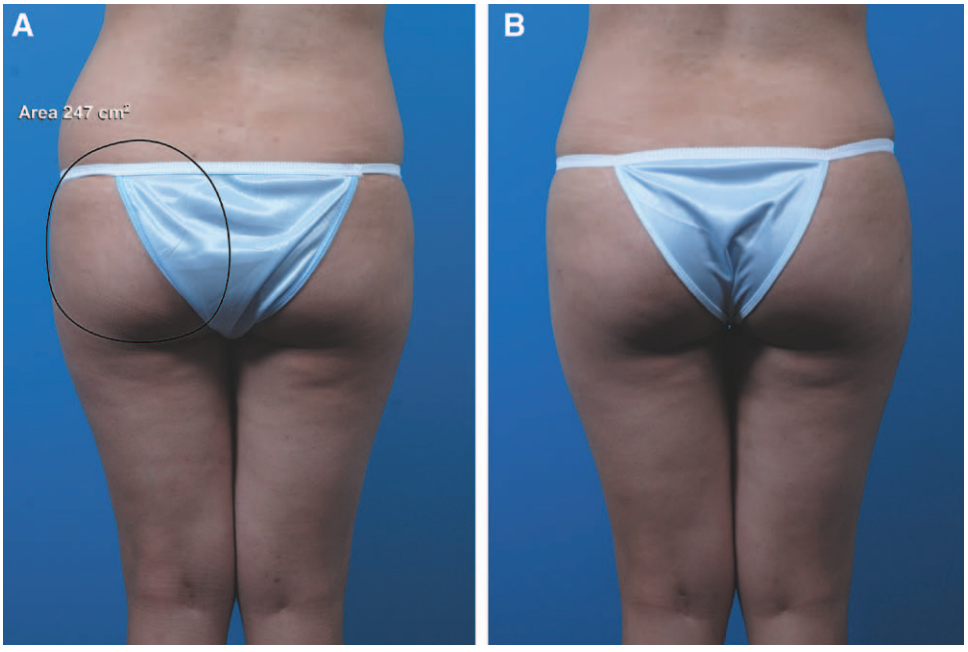

Fig. 2. Posterior photographs of a 25-year-old woman before (A) and 6 months after (B) liposuction of the abdomen, flanks, inner thighs, arms, and axillae. A volume of 285 mL of lipoaspirate was injected into the subcutaneous tissues plane in each buttock. This patient's fat injection volume was very similar to the mean injection volume (287 mL) for study patients. The photographs were matched for size and orientation using the Canfield 7.4.1 imaging software (Canfield Scientific, Fairfield, N.J.). The treated gluteal area was measured on both sides using the area measurement function of the imaging software. The surface area (247 cm^2) is indicated for the left buttock. The combination of liposuction of the flanks and buttock augmentation with fat produces a more aesthetic, rounder appearance. There is no contour deformity of the flank donor sites.

pubis to the point of greatest buttock projection ("buttock projection") was recorded (Fig. 3). In addition, the horizontal distance from the level of maximum lumbar lordosis to the point of greatest buttock projection was measured ("relative buttock projection"). The same examining room, lighting, focal distance, Nikon D80 digital camera, and fixed 60-mm lens (Nikon, Tokyo, Japan) were used for all patients.

Ultrasound Measurements

A single linear measurement was made in the central gluteal area with the patient positioned prone at the point of greatest fat thickness of each buttock (Fig. 4).[6] All ultrasound measurements were made in the office by the same full-time sonographer employed by the author. The caliper function was used on the Terason t3200 software (Terason Ultrasound, Burlington, Mass.). Ultrasound measurements were recorded at the time of the preoperative appointment (usually 2 weeks before surgery) and ≥3 months after surgery. Patient weights were recorded simultaneously using the same hospital scales. Fat retention was calculated using the following formula: Fat retention = buttock area (cm^2) × difference in buttock fat thickness (cm)/fat injection volume (mL).

Statistical Analysis

Statistical analyses were performed using SPSS for Macintosh version 23.0 (SPSS, IBM Corp. Armonk, N.Y.). Independent *t* tests were computed to compare the treatment group with the control group. Chi-square tests were used when the data were categorical. Paired *t* tests were computed to compare mean differences between the parameters before and after fat injection. Analyses of covariance were used to control for any changes in patient weight after surgery. A *P* value of <0.05 was considered significant.

RESULTS

There was 1 male patient in the treatment group and 2 males in the control group; all other patients were female. Age, sex, smoking status, and body mass index were similar for the treatment and control groups (Table 1). The mean follow-up time for treated patients was 5.8 months (range, 3–15.5 months). The mean fat volume injected per buttock was 287 mL (range, 70–550 mL). Photographs of the patient with lipoinjection volumes (285 mL per buttock) closest to the mean are provided (Figs. 2, 3). Body mass indices did not change significantly after surgery for either controls or treated patients.

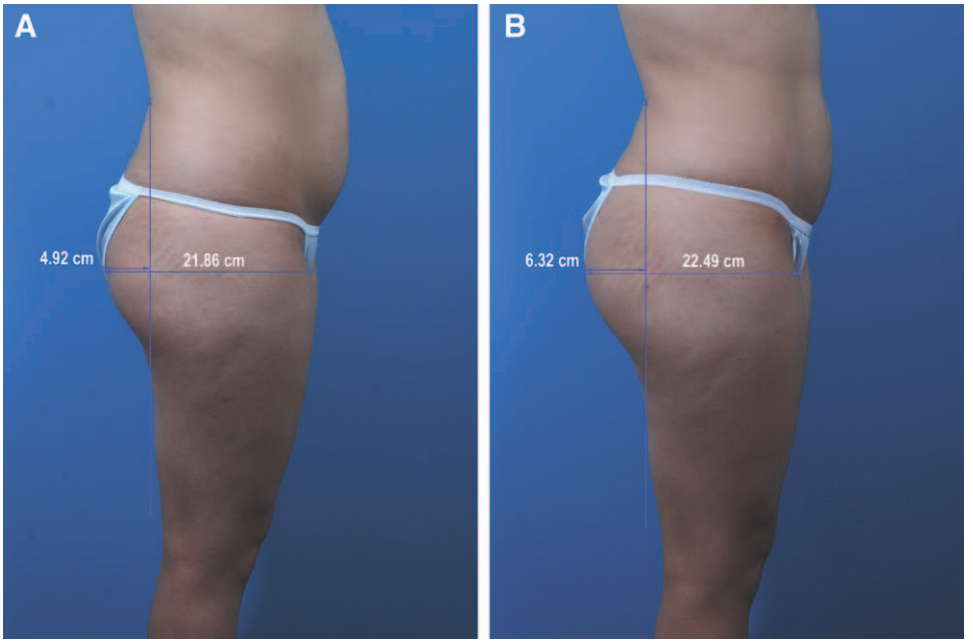

Fig. 3. Lateral photographs of the same patient depicted in Figure 2, before (A) and 6 months after (B) liposuction and buttock fat injection. Photographs are matched for size and orientation. Buttock projection is defined as the horizontal dimension connecting the mons pubis with the point of greatest buttock projection. This measurement has increased approximately 0.6 cm. Relative projection is measured from the level of the lumbar lordosis to the same point of maximum buttock projection. The difference is 1.4 cm in this patient. An increased relative projection is provided by simultaneous liposuction of the flank and lower back.

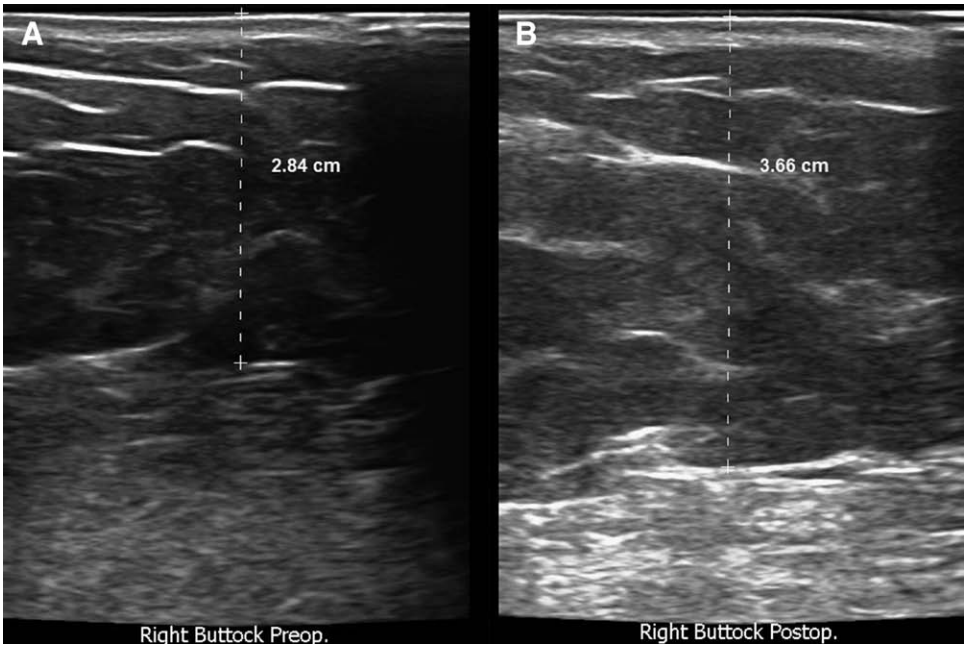

Fig. 4. Preoperative (A) and 6-month postoperative (B) ultrasound images of the right buttock for the patient depicted in Figures 2 and 3. The thickness of the fat layer, measured from the muscle fascia to the skin surface, increased from 2.84 to 3.66 cm, a gain of 0.82 cm. The patient's weight is unchanged.

Ultrasound measurements detected a significant change in the thickness of the subcutaneous fat layer after surgery ($P \leq 0.001$), with a mean increase of 0.66 cm for the right buttock and 0.86 cm for the left buttock, corrected for a slight postoperative decrease in body mass index (Table 2). The mean right buttock area was 253 cm^2 (range, 192–325 cm^2), and the mean left buttock area was 251 cm^2 (range, 203–307 cm^2). The mean calculated fat retention was 66%. Photographic measurements revealed a significant increase ($P < 0.01$) in buttock projection (right, 0.44 cm; left, 0.54 cm) and relative buttock projection (0.69 and 0.73 cm, respectively) for treated patients corrected for change in body mass index (Table 3). There were no significant changes for control patients.

Complications

No infections were encountered. No patient developed symptoms or signs of fat necrosis, and no evidence of fat necrosis was detected on the ultrasound examinations. There were no seromas or hematomas. There were no cases of fat embolism. No deep venous thromboses were detected on any of the ultrasound examinations. No patient required hospitalization or a blood transfusion. All patients were treated with fat injection once. No patient underwent reoperation. There were no cases of sciatic neuropathy or painful paresthesias. There were also no complications among the 4 treated patients who did not return to follow up at least 3 months after surgery and therefore did not meet the study inclusion criteria.

DISCUSSION

Buttock augmentation was originally accomplished using silicone implants.[2,12,13] However, the complication rate is very high (38.1% among surveyed surgeons[16]).[2,12,13] Because of its lower risk, fat injection is more commonly performed by plastic surgeons than buttock implants.[1]

The patient is not paralyzed or intubated. Instead, a laryngeal mask airway is used and the patient breathes spontaneously.[10] This airway has proved to be safe with the patient in the lateral position, provided it is secured using tape. In a departure from traditional prone patient positioning,[2,8,14–16] the author never uses prone positioning for liposuction or lipoinjection or any other procedure.

Previous studies report mean injection volumes in the range of 350–700 mL per buttock.[14–19] Some investigators use aggressive liposuction in an effort to obtain more fat for grafting.[2,17] However, aggressive liposuction increases the risk of wound complications, such as seromas.[2,15,17] Murillo,[17] who injects an average of 700 mL fat per buttock, reports a donor site (abdomen and sacrum) seroma rate of 40%. Drains may be needed.[2,8,17] Painful paresthesias of the flanks and gluteal regions are sometimes

Table 1. Patient Data

	Buttock Fat Transfer (%)	Control (%)	*P**
No.	21	25	
Age, y			
Mean	43.0	44.6	
SD	11.9	12.4	NS
Range	25.1 to 70.2	25.6 to 71.6	
Sex			
Female	20 (95.2)	23 (92.0)	NS
Male	1 (4.8)	2 (8.0)	
Follow-up time, mo			
Mean	5.8	3.6	
SD	4.2	1.2	<0.05
Range	3.0 to 15.5	3.0 to 8.4	
Smoking status			
Nonsmoker	18 (85.7)	17 (68.0)	NS
Smoker	3 (14.3)	8 (32.0)	
Preoperative BMI, kg/m^2			
Mean	26.8	25.3	
SD	4.9	4.5	NS
Range	20.6 to 35.8	17.8 to 35.2	
Postoperative BMI, kg/m^2			
Mean	26.4	25.5	
SD	4.8	4.5	NS
Range	17.2 to 33.9	18.9 to 35.0	
Change in BMI, kg/m^2			
Mean	−0.45	0.19	
SD	1.46	0.94	NS
Range	−3.72 to 2.31	−2.67 to 1.88	
Fat injection volume, right buttock, mL			
Mean	287	—	
SD	136	—	—
Range	80 to 550	—	
Fat injection volume, left buttock, mL			
Mean	287	—	
SD	138	—	—
Range	70 to 550	—	

*Independent *t* tests were used to compare the treatment group with the control group when the data were measured continuously. Chi-square tests were computed when the data were categorical.
BMI, body mass index.

encountered.[16,19] Contour irregularities may occur, especially in thin women.

Recently, concern has been raised regarding the risk of fat emboli after buttock fat injection.[20] Cárdenas-Camarena et al[20] recommend keeping the injection cannula parallel to the gluteal surface to avoid entering the subpiriformis or suprapiriformis channels where the gluteal vessels are located. Intramuscular fat injection was once preferred.[2,14,18,19] However, recent investigators have injected the subcutaneous plane instead.[16] No incision is made in the gluteal fold so as to avoid neurovascular injury. Injection in multiple tunnels is a well-known measure[2,8,15,16] to maximize fat vascularization.

The use of 60-mL syringes may be challenged by surgeons who believe that too much fat is injected in each pass of the infusion cannula. This concern is based on the work of Carpaneda and Ribeiro,[21,22] who report that greater fat necrosis is likely if fat is injected in tunnels that exceed a diameter of 3 mm. Shear stress is minimized by using large infusion cannulae,[23] which are less likely to impair adipocyte viability.[24,25]

Centrifugation is cumbersome and time-consuming, especially for large fat volumes.[2] Smith et al[26] report no advantage in cell viability from washing the fat or centrifuging it and recommend against unnecessary manipulation or delayed reinjection. Gerth et al[27] report that a closed-membrane filtration system provides greater fat retention than centrifuged fat when injected in the face. Fisher et al[28] report that both filtration (using the same Filtron device used in this study) and centrifugation effectively remove fluid fractions and result in comparable graft retention, with minimal loss of the stromal vascular fraction in the discarded filtrate. Any fat that passes through the filter seems to have negligible viability.[28]

Despite theoretical concerns about fat necrosis using large syringes and cannulae to inject fat, there were no clinical cases of fat necrosis in this series. Moreover, there was no evidence of fat necrosis on the ultrasound scans, which are highly sensitive for the detection of oily cysts caused by fat necrosis.[29] Although early investigators used 3-mL syringes,[18] the time commitment was substantial (eg, 2–4 hours for harvesting plus 1–1.5 hours for injection[18]). In the past decade, most plastic surgeons[2,8,14–16] have adopted 60-mL syringes for large-volume fat transfer.

The dilution of the lipoaspirate is variable, depending on whether a superwet (1:1 ratio) or tumescent (3:1 ratio) is used.[10] The supranatant typically represents 40–50% of the lipoaspirate volume.[2,18] Recognizing that fluid is injected with fat, some operators recommend overcorrection.[16,19] However, Del Vecchio and Del Vecchio[30] caution that higher graft-to-capacity ratios can reduce volume maintenance (fat retention). A superwet infusion and a filtration system that separates the fat from the wetting solution may account for the relatively small lipoinjection volumes used in this study. Moreover, for many patients, buttock fat transfer was not their main objective but rather an adjunctive procedure. If offered the option, many patients elect to have some fat obtained by liposuction injected in their buttocks, even if only an incremental benefit is expected.

Using closed filtration, buttock fat transfer typically adds no more than 20 minutes to a liposuction procedure. The efficient use of operating time lowers the cost and permits the procedure to be done

Table 2. Ultrasound Measurements of Gluteal Fat Thickness Comparing Treated and Control Patients

	Before Fat Transfer	After Fat Transfer	Difference	
	Mean (SD)	Mean (SD)	Mean (SD/SE)	*P**
Actual means and SDs				
BMI, kg/m²				
Treatment (n = 21)	26.81 (4.91)	26.36 (4.76)	−0.45 (1.46)	NS
Control (n = 25)	25.32 (4.52)	25.50 (4.48)	0.19 (0.94)	NS
Right buttock, cm				
Treatment	3.42 (0.96)	4.02 (0.89)	0.60 (0.68)	0.001
Control	3.65 (1.26)	3.46 (1.20)	−0.18 (0.58)	NS
Left buttock, cm				
Treatment	3.27 (0.94)	4.06 (0.73)	0.79 (0.69)	<0.001
Control	3.57 (1.26)	3.41 (1.18)	−0.17 (0.55)	NS
Estimated marginal means and SEs				
Right buttock, cm				
Treatment	—	—	0.66 (0.13)	
Control	—	—	−0.24 (0.12)	
P†			<0.001	
Left buttock, cm				
Treatment	—	—	0.86 (0.13)	
Control	—	—	−0.23 (0.12)	
P			<0.001	

*Paired *t* tests were used to compare preoperative measurements with postoperative measurements.
†Analyses of covariance were computed to test whether the preoperative versus postoperative difference in buttock fat thickness differed between the treatment and control groups when controlling for the change in BMI. The covariate, change in BMI, was evaluated at a value of −0.102.
BMI, body mass index.

in conjunction with other body-contouring procedures including breast surgery and abdominoplasty. (**See Video 1, Supplemental Digital Content 1**, which demonstrates injection of the local anesthetic, fat harvesting, and fat injection. This video is available in the "Related Videos" section of the Full-Text article on PRSGlobalOpen.com or available at ***http://links.lww.com/PRSGO/A198.***)[8,14]

Although several studies provide clinical data and subjective evaluation of buttock fat transfer,[2,8,14–18] objective measurements are lacking. Murillo[17] used magnetic resonance imaging to document a qualitative increase in buttock fullness in 6 patients undergoing intramuscular buttock fat injection. Magnetic resonance imaging was also used by Wolf et al[14] in a quantitative study of 10 patients undergoing gluteal muscle injection, but only muscle areas were measured, not subcutaneous fat thickness, despite fat injection in both locations. Neither study[14,17] controlled for postoperative changes in body mass index.

Magnetic resonance imaging is prohibitively inconvenient and expensive to use in a large number of patients. Ultrasound examinations are more practical and were already being administered to these patients as part of surveillance for deep venous thromboses. A minimum follow-up time of 3 months was selected based on previous studies of fat injection[31,32] using magnetic resonance imaging that reveal little change in the fat layer thickness beyond 3 months, suggesting that swelling has resolved at that time.

The clinical safety of buttock fat transfer stands in stark contrast to the high complication rate of buttock implants.[12] Importantly, all the patients in this study had areas of excess adiposity available as donor sites. An increase in fat thickness of <1 cm is admittedly modest but complemented by fat reduction of the flanks, as demonstrated by the increase in relative buttock projection. Even if fat retention was 100%, one could expect only about 1 cm of increased projection from 287 mL fat distributed over an area of 250 cm². Accepting a lesser degree of augmentation may be preferable to donor site deformities, seromas, and paresthesias caused by overly aggressive harvesting.

Only 1 surgical method and 1 type of fat collection device were studied. Other techniques and devices may produce different results. The size of the treatment group (n = 21) is relatively small. No information is available regarding possible changes in fat thickness occurring at longer follow-up times (eg, >1 year). One-dimensional fat thickness measurements do not assess volume changes. Future studies may incorporate 3-dimensional imaging methods. This study provides quantitative evidence of the efficacy of buttock fat transfer using a reliable diagnostic tool corroborated by simultaneous photometric data. By measuring patient weights before and after surgery, a change in body mass index is ruled out as a possible confounding variable. Consecutive patients and a high inclusion rate add to the reliability of the findings. The prospective study design and inclusion of a control group achieve a high level of evidence.

Table 3. Photographic Measurements of Buttock Projection, Comparing Treated and Control Patients

	Before Fat Transfer	After Fat Transfer	Difference	
	Mean (SD)	Mean (SD)	Mean (SD/SE)	*P**
Actual means and SDs				
BMI				
Treatment (n = 19)	26.91 (4.95)	26.27 (4.81)	−0.63 (1.40)	NS
Control (n = 8)	26.75 (3.17)	27.22 (3.41)	0.47 (0.82)	NS
Right buttock projection, cm				
Treatment	23.46 (1.60)	23.89 (1.69)	0.43 (0.54)	<0.01
Control	25.90 (1.53)	26.09 (1.54)	0.19 (0.46)	NS
Left buttock projection, cm				
Treatment	23.64 (2.01)	24.13 (1.82)	0.49 (0.54)	0.001
Control	25.53 (1.50)	25.60 (1.38)	0.07 (1.04)	NS
Right buttock relative projection, cm				
Treatment	4.94 (1.32)	5.60 (1.39)	0.65 (0.54)	<0.001
Control	6.38 (1.02)	6.28 (1.08)	−0.10 (0.40)	NS
Left buttock relative projection, cm				
Treatment	4.61 (1.42)	5.34 (1.52)	0.73 (0.64)	<0.001
Control	6.18 (1.19)	6.14 (1.06)	−0.04 (0.38)	NS
Estimated marginal means and SEs				
Right buttock projection, cm				
Treatment	—	—	0.44 (0.12)	
Control	—	—	0.16 (0.20)	
P†			NS	
Left buttock projection, cm				
Treatment	—	—	0.54 (0.17)	
Control	—	—	−0.03 (0.26)	
P			NS	
Right buttock relative projection, cm				
Treatment	—	—	0.69 (0.12)	
Control	—	—	−0.18 (0.19)	
P			0.001	
Left buttock relative projection, cm				
Treatment	—	—	0.73 (0.14)	
Control	—	—	−0.04 (0.22)	
P			<0.01	

*Paired *t* tests were used to compare preoperative measurements with postoperative measurements.
†Analyses of covariance were computed to test whether the preoperative versus postoperative difference in buttock thickness differed between the treatment and control groups when controlling for the change in BMI. The covariate, change in BMI, was evaluated at a value of −0.307.
BMI, body mass index.

CONCLUSIONS

Comparisons of matched photographs and ultrasound measurements may be used to evaluate changes in buttock fat thickness. Buttock fat transfer effectively and safely increases buttock projection.

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ACKNOWLEDGMENTS

I thank Jane Zagorski, PhD, for statistical analyses, Christina Engel, RT, RVT, RDMS, for ultrasound studies, Sarah Maxwell, RN, for data collection, and Gwendolyn Godfrey for the illustration.

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