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Complications of Buttocks Augmentation: Diagnosis, Management, and Prevention

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Introduction

The past 2 decades have witnessed extensive growth and interest in body contouring. The buttocks are no exception. Currently, the concept of beautiful buttocks includes maximum prominence at the level of the upper and mid buttocks, smooth inward sweep of the lumbosacral area and waist, and minimal or no infragluteal crease, without ptosis above this line [1]. According to Douglas and colleagues [2], any significant disproportion of body components, such as diminutive buttocks, can be a significant psychological detriment to the individual. The specialty of plastic surgery has witnessed great strides in surgical procedures to change body contour. The earliest operations generally consisted of wedge excisions of skin and adipose tissue, thereby improving body contour but leaving extensive surgical scars. With the advent of silicone breast implants in the 1960s [3], it was not long before creative surgeons would use them for gluteal augmentation. The first case report was performed by Bartels and coworkers in 1969 [4], and subsequently followed by Cocke and Ricketson in 1973 [5]. While silicone breast implants have been effective at augmenting the buttocks, experience has shown that they are prone to rupture and leakage because of their thin silicone shell

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[6]. In fact, it was soon thereafter that major complications of infection and dehiscence associated with gluteal implants were reported [2]. These complications continue to haunt buttocks augmentation with gluteal implants.

The first documented free fat grafts were established by the end of the nineteenth century [7]; however, it was not until Illouz introduced liposuction in 1983 [8] that large volumes of potentially transplantable fat became available for augmentation of the gluteal region [9,10].

Currently, placement of silicone implants continues to be the most popular method for buttocks augmentation [11]. However, surgeons' preference for autologous fat grafting is increasing in popularity because of certain advantages in creating ideal buttocks shape and size. (See article by Roberts and colleagues, this issue.) Unfortunately, both surgical techniques can have significant complications [1,6,11–15], and there has been a great disparity among what has been reported in the literature (Tables 1 and 2). Dr Sidney Coleman [24–26]

was one of the early advocates of a meticulous, drop-by-drop fat-grafting technique, and his persistence brought autologous fat grafting into the mainstream, primarily for facial soft tissue. Roberts et al [1] presented the first large well-documented series of micro fat grafting for moderate buttocks augmentation and the complications associated with this volume of grafting.

Many reports on silicone implants for buttocks augmentation were from outside the United States (Table 1), and few of these were open in discussing complications. Mendieta [6] published the first large American series on buttocks implants and was very thorough in presenting complications. This candor opened the door and gave other surgeons the courage to present and discuss complications. This openness has led us, working together, to begin solving some of the problems that confront all types of buttocks augmentation. For the most current information on techniques and complications, we strongly recommend the instructional course offered by Roberts, Young,

Table 1:	Complications of sub- or intramuscular buttocks implants			
Authors	**Country**	**Year**	**Patients**	**Complications**
Robles et al [16]	Argentina	1984	9	Muscle dehiscence: 1/9 Seroma: 1/9
Gonzales-Ulloa [17]	Mexico	1991	Not stated	Not stated (subcutaneous placement)
Vergara & Marcos [18]	Mexico	1996	16	"None. All patients satisfied with results."
Mendieta [6]	United States of America	2003	73	Wound dehiscence: 30% Infection: 1/73 Implant exposure: 2/73 Implants too firm: 10% Transient sciatic paresthesias: 20% Most frequent complaint: Implants not large enough
Vergara & Amezcua [15]	Mexico	2003	160	Complications: 16/160 Wound dehiscence: Not mentioned Seroma: 7 (4%) Asymmetry: 4 (2.6%) Capsular contracture: 3 (2%) Rupture: 1 (0.7%) Overcorrection: 1 (.7%) Satisfactory results: 90%
Gonzalez [19]	Brazil	2004	746	Infection: 3/746 Dehiscence: 14% Reoperation: 2/746 Rupture: 2/746 Seroma: 1/746 All patients greatly satisfied with results

Table 2: **Complications of buttocks autologous fat grafting: extraction from literature**

Authors	Country	Year	Patients	Vol (cc) fat grafted	Complications/ Results	Estimated fat survival
Chajchir et al [20]	Argentina	1990	Not stated	Not stated	Not stated	
Toledo [21]	Brazil	1991	Not stated	Up to 500	Not stated	
Lewis [9]	United States of America	1992	12	30–150	None. All points satisfied	
Guerrerosantos [10]	Mexico	1996	6	150–200	None. All points demonstrate expected improvement	
Cardenas-Camarena et al [13]	Mexico	1999	66	210	Seroma: 4/66 (6%) Cellulitis: 12/66 Fat embolism: 1/66 Tissue irregularities: 8/66; 90% of patients with good or excellent results	
Peren et al [12]	Mexico	2000	40	120–240	pain: 31/40, seroma: 4/40 (10%) hyperpigmentation: 1/40	100%
Pedroza [22] (Dermatologist)	Colombia, S.A.	2000	879	200–350	Cellulitis: 1/879 (min) Long-lasting results	0.5–1.0 cm less projection
Roberts et al [1]	USA & Brazil	2001	566	400	Cellulitis: 1.9% Seroma/hematoma: 0.8% Abscess: 0.2% Blood transfusion: 0.4% Reaugmentation rate: 10%	50%–75%
Restrepo Ahmed [11]	Colombia, S.A.	2002	96	410	Paresthesias Small irregularities: 10/96 Septic shock: 1/96 Satisified: 94/96 Asymmetries: 3/96 Not satisified: 2/96	60%–80%
Monreal [23]	Spain	2003	No # of buttocks	453	"None of any sort." 86.4% good or very good	80%–90%
Murillo [14]	Colombia, S.A.	2004	162	250–260 (700)	Abscess: 1/162 Seroma: 64/162 (40%) Sacral numbness: 10% Asymmetry: 2.4%	80%

Mendieta, De La Pena and colleagues at both the American Society for Aesthetic Plastic Surgery and American Society of Plastic Surgeons future annual meetings.

There are three current methods for buttocks augmentation: autologous micro fat grafting, intramuscular silicone prosthesis, and subfascial silicone prosthesis. In addition, subcutaneous placement of silicone implants has been attempted in the past, but has an unacceptably high risk of long-term problems [2,5,27]. Buttocks augmentation by any of the aforementioned techniques is major surgery with potential for major complications, including serious infections (cellulitis, abscess, and sepsis), wound dehiscence, loss of implant, hematologic and metabolic disturbances including DIC (disseminated intravascular coagulopathy), pulmonary edema, electrolyte imbalance, and aspiration pneumonitis. Some complications, such as infections, seromas, and wound problems are common to all techniques, but even these present differently depending on the augmentation technique. For this reason, we will discuss the complications separately for each procedure.

Silicone implants

Early attempts at implant augmentation of the buttocks often employed silicone gel breast prostheses [2]. The buttocks are routinely subject to both shear and compressive forces much greater than the breasts [28,29], so it is not surprising that breast implant failure was a common and major problem when they were used in the buttocks [2]. Currently approved buttock implants in the United States are made of semisolid silicone elastomer, which is much more durable than the breast implant. These are, however, more palpable when placed subfascially [6,30].
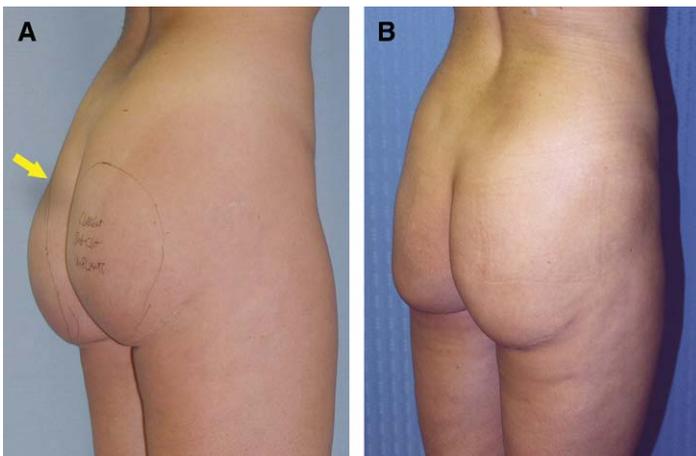
Subcutaneous placement

Subcutaneous placement of implants requires the simplest dissection, therefore is a tempting approach, especially for a surgeon with limited experience in buttocks augmentation. Only one paper in the English language literature, from 1991, documents a series of patients who received subcutaneous placement of buttock implants [17], and no other author has supported this technique in the subsequent 15 years. When the fascial bands holding the skin to the gluteus muscle are transected by subcutaneous dissection, there is no ligamentous or muscular structure to restrain the implant. This results inevitably in one or more of the following problems: (1) palpability, (2) visible margins of implant, (3) excess mobility, (4) displacement, (5) ptosis, (6) extrusion, or (7) bizarre-appearing encapsulation. Fig. 1A shows the ptotic position of a subcutaneous implant with a "double bubble" effect at the arrow. The pocket extends 3 inches superior to this point, and the implant moves back and forth when the patient lies down.

Fig. 1B shows the patient 2 years after implant removal; the skin is still ptotic and mobile due to a persistent thick capsule and fluid. Fig. 2 is an example of the marked deformity that can occur when capsular contracture occurs around a subcutaneously placed implant. We have never seen this visible encapsulation when the implant is placed subfascially or intramuscularly. Because of the high incidence of long-term complications, we feel that subcutaneous placement of silicone implants in the buttocks should not be performed.

Intramuscular or submuscular implant augmentation

Most of the early reports on intra- or submuscular buttocks augmentation were from outside the

Fig. 1. (*A*) Excess mobility of subcutaneously placed gluteal implant. Ptosis results in "double bubble" effect indicated by the arrow. Pocket has elongated 3 inches inferiorly. (*B*) Two years after removal of subcutaneous buttock implants, the skin is still ptotic and mobile due to a persistant thick capsule and fluid.

Fig. 2. Bizarre mushroom-like encapsulation of subcutaneously placed implants.

United States [16], and even in large series, reported "no complications" [18], or complications were minimized and not quantified [19]. We are indebted to Dr Constantino Mendieta [6], who published the first large American series on intramuscular buttocks implant augmentation, for his transparency in reporting the complications and challenges confronting this technique. The submuscular plane is difficult to identify, smaller than the intramuscular plane, and in direct continuity with the sciatic nerve. For these reasons, most implant surgeons now use the intramuscular plane; therefore, our discussion will be limited to this technique.

Wound dehiscence

Mendieta [6] reported approximately 30% incidence of wound dehiscence in his series of 73 patients. Although the midline incision margins occasionally look dusky from the beginning, dehiscence usually does not occur until postoperative day 6 to 14. Typically, the skin appears healthy, then separates, revealing brown, nonviable subcutaneous tissue up to 2 cm from the wound edge. Cultures obtained from the wound may grow fecal bacteria, or they may be sterile. This, combined with the fact that the white blood cell count of a patient with dehiscence is usually normal, suggests that dehiscence is not primarily of infectious origin. Fortunately, unless there is dehiscence of the gluteus muscle incision and resultant implant exposure, the wound usually heals secondarily after repeated debridement without loss of the implant. This does, however, cause some social inconvenience to the patient with drainage and an open wound for 2 to 3 months until healing occurs by secondary intention (Fig. 3A, B).

There may be multiple factors that contribute to dehiscence of the midline wound in implant augmentation.

- Intrinsically poor blood supply: The intergluteal crease is a "watershed" area without major identifiable arterial supply.

Fig. 3. (*A*) Intramuscular Implant Augmentation: Dehiscence of intergluteal incision at 1.5 weeks postop. (*B*) Same patient, 1 month postop intramuscular implant augmentation.

- Desiccation and crushing of the skin and subcutaneous tissue because of the prolonged and intense retraction necessary for dissection and visualization (Fig. 4A, B). Because implants are always bilateral, both sides of the incision are traumatized.
- Inadequate muscle or fascial coverage, or muscle closure that is too tight, can contribute to shearing motion of the implant with hip flexion, extension, or sitting. This in turn may result in a periprosthetic seroma, causing physical or hydraulic disruption of the wound.

Mendieta [31] reported up to 80% dehiscence in patients who are overweight or who needed implants over 350 cc, and has switched to autologous fat grafting for these patients.

Potential means of decreasing dehiscence include the following. (1) Keeping both wound edges moist and relaxing the retraction when possible should improve perfusion and minimize tissue trauma. (2) An effort is being made to develop a noncrushing retractor. (3) Some authors are trying to avoid a single midline incision (both sides of which become traumatized) by using two paramedian incisions [31], or leaving a midline ellipse of deepithelialized skin with a broad base of subcutaneous tissues over which the incision is closed [30,32]. Early reports of these techniques offer some encouragement. (4) The judicious use of drains for a limited period of time may decrease seroma formation as a cause of dehiscence. (5) Appropriate antibiotic coverage (typically cephalosporin plus gentamicin) may help decrease infectious causes of dehiscence, provided the wound is healthy. (6) The use of three layers of skin glue (Dermabond and others) seems to decrease the incidence of wound separation, acting as an antimicrobial barrier. The skin glue will generally remain intact for 8 to 10 days. By giving mechanical support to the skin, it may decrease the need for an excessively tight skin suture, thereby decreasing

this compromise of the circulation to the wound edges.

Seroma formation

Seromas around the implant may occur in 2% to 4% of intramuscular augmentations [6,15], even when drains are used. This problem is greater for textured implants, and Vergara [33] himself has now changed to smooth implants made of cohesive gel. Smaller seromas may resolve spontaneously, but most require repeated aspiration. When they become chronic, Mendieta [31] recommends surgery to score the capsule, implant replacement, and drainage for 3 days. Vergara and Amezcua [15] insert drains and irrigate with hydrocortisone (Cortef). A perplexing problem is the late appearance of seromas, occurring up to 1 to 2 years postop.

Infection

This occurs in about 2% to 3% in large series [6,15], and may result in loss of the implant. The use of a plastic sleeve around the implant during insertion can decrease contamination of the implant by debris and bacteria. The anus is only 3 to 4 cm from the incision, and we staple or suture a gauze soaked with povidone-iodine over the anus during surgery.

Loss of the implant as a result of muscle dehiscence and implant exposure

The incidence for all patients is 2% to 5% [6], but up to 30% in overweight patients or those receiving larger implants (>350 cc or >3.5-cm projection) [31]. To decrease these problems, check the submuscular pocket with a sizing implant to be sure the muscle incision can be easily closed under minimal or no tension. Mendieta uses intraoperative tissue expansion while dissecting the other side. If the muscle still cannot be closed with minimal tension, a smaller implant must be used.
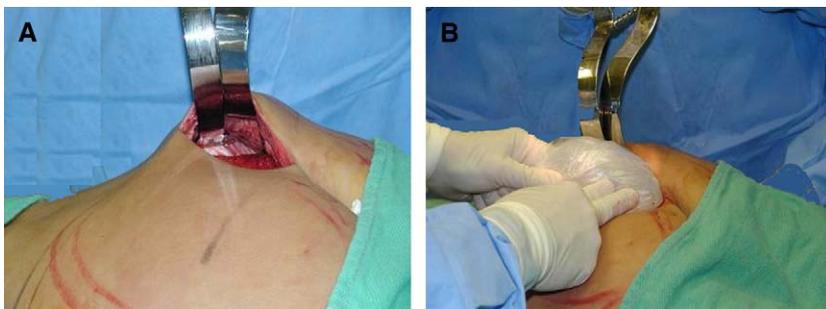
Fig. 4. (*A*) Prolonged, forceful retraction of the intergluteal incision is necessary for dissection of the pocket and may contribute to the high incidence of dehiscence after intramuscular or subfascial implant augmentation. (*B*) Additional force and wound edge trauma is necessary to insert the implant.

Asymmetry, implant migration, or malposition

These problems develop in 3% to 5% of intramuscular implants [6,15]. One of the most common causes is to inadvertently allow the dissection to become too superficial while progressing laterally or superiorly. Because the muscles are somewhat hemispherical in shape, dissecting tangentially perforates the fascia, resulting in the lateral or superior margins of the pocket extending into the subcutaneous plane. Once the edge of the implant enters the subcutaneous plane, it is easily palpable, may become painful, becomes progressively more mobile, and can cause visible deformity. To avoid this, dissection must continuously curve downward (deeper) as dissection proceeds laterally or superiorly. Correction of malpositioning requires reoperation, capsulorrhaphy, or creation of a new pocket.

Implant rupture

This is uncommon, occurring in fewer than 1% of cases [15]. Two factors may increase the risk of rupture: (1) using a "carving block" to cut your own implant, and (2) inadequate muscle repair so that a portion of the implant herniates into the subcutaneous pocket, subjecting the implant to pinching or shearing forces where it emerges through the tight muscle opening.

Capsule contracture

This is reported in the range of 2% [15].

Sciatic paresthesias

Mendieta [31] finds that transient sciatic paresthesias occur in about 20% of his intramuscular implant cases. They respond to Neurontin (gabapentin) and disappear by 3 weeks.

Aesthetic problems and limitations

Because of the limitations of the intramuscular space and the underlying sciatic nerve, intramuscular implants can only be placed in the upper or upper and mid buttock. Often, there is flatness also in the lower buttocks, and intramuscular augmentation may result in a "double bubble" deformity (Fig. 5A, B). This is especially true in thin patients with very little subcutaneous tissue on the buttocks. Vergara and Mendieta (personal communication, 2005) are independently developing an elongated or oval-shaped implant, but this still should not extend more than 2 cm below the tip of the coccyx. Thus, the ideal patient for intra- or submuscular augmentation has flatness superiorly but fullness inferiorly that will disguise the lower edge of the implant.

The other aesthetic problems include patients complaining the implant feels too firm (10%), and the most common complaint is that the implants are too small. This is especially true for African American patients, who seek a very large augmentation, and for Asian patients whose narrow pelvis usually permits only the use of a small implant (100 to 240 cc).

Technical considerations

The submuscular or intramuscular dissection is done primarily in a blunt fashion and can be very bloody. There is no visible marker to indicate the correct surgical plane. The operation is very painful for 1 to 2 weeks; this can be helped by using a pain
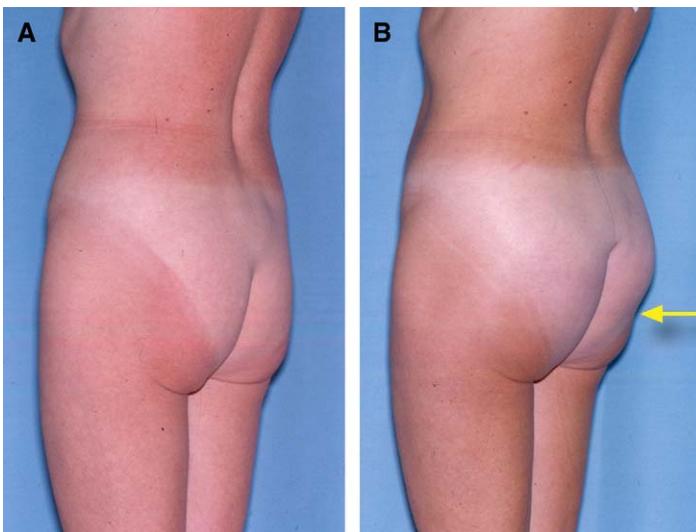
Fig. 5. (*A*) A poor candidate for intramuscular implant augmentation. The lower pole of the buttocks is flat, and the subcutaneous tissues are thin. (*B*) After submuscular augmentation, the upper curve of the buttock looks good, but the mid buttock reveals the lower edge of the implant as a "double bubble" deformity (at arrow).

pump ("on-Q" and others) with lidocaine (Xylocaine) dripped around the implant for 3 days.

Subfascial implant placement

The placement of silicone implants under the fascial covering of the gluteus maximus muscle was pioneered by de la Peña of Mexico [30]. This fascia is not a smooth continuous sheet, but is intimately connected to innumerable vertical septae perforating the fibers of the gluteus. This makes for a meticulous dissection, taking about 4 hours, and requires constant retraction and direct visualization. The reward is a larger potential pocket, especially inferiorly. A textured implant is used, with the goal of less unwanted mobility. This technique offers the possibility of creating more fullness inferiorly, and the use of a larger implant. Problems with this approach include the following.

Dehiscence

De la Peña also reports about 30% dehiscence of the midline intergluteal incision [32]. He notes that one third of these are more than 2 cm deep and therefore pose a greater problem. The other two thirds are more superficial (< 2 cm deep), and eventually heal secondarily, although still require 1 to 3 months for complete closure.

Infections

De la Peña reports a 7% infection rate, but only 1% resulted in loss of the implant [32].

Seromas

De la Peña reports a 2% incidence with subfascial placement [32]. It is important to note that de la Peña's experience is entirely with cohesive gel implants. These are not currently available in the United States, and semisolid elastomer must be used. The experience of this author combined with that of Dr. Schlomo Widder [34] consists of 31 patients using this semisolid textured de la Peña implant subfascially, and our total complication rate was 51% (Table 3). We did experience 19% seromas, some of which may be blamed on early drain removal; but leaving a drain in for 10 days resulted in our one infection requiring implant removal. Frustratingly, one third of these seromas appeared later (ie, 1 to 2 years after surgery). Because of this high seroma rate, Widder has exchanged implants from the textured de la Peña semisolid implants to the smooth semisolid implant in four cases with no subsequent seroma formation. In one of these four cases, the skin became detached from the presacral fascia, and the implants overlapped each other in the midline and had to be removed.

Ptosis

Use of larger implants (545 cc or more), a proposed advantage of the subfascial technique, can result in severe inferior ptosis (Fig. 6A, 6B) requiring reoperation, capsulorrhaphy, change to a smaller implant, vest-over-pants fascial repair, and excision of resulting redundant skin through a new infragluteal incision.

Table 3: Complications of subfascial buttocks augmentation (with textured semisolid implant) (Roberts & Widder; n = 31 patients)

Major complications	Patients (n = 31)	Incidence
Wound dehiscence	5	16%

Large seromas (up to 1800 cc) requiring multiple aspirations
    Early seromas—4
    Late seromas (1–2 years)—2
	6	19%

Infection requiring implant removal	1	3%
Capsule contracture, extrusion, and loss of implant	1	3%
Implant flipping 180° (concave side out)	2	6%
Severe ptosis requiring reoperation	1	3%
Reoperation for patient aesthetic dissatisfaction	1	3%
Total major complications	17 in 11	35% with major complications
Minor complications		
Small wound separation	5	16%
Total complication rate	22 in 16	51% had 1 or more complications
Note: Lower pole of implant palpable		100%
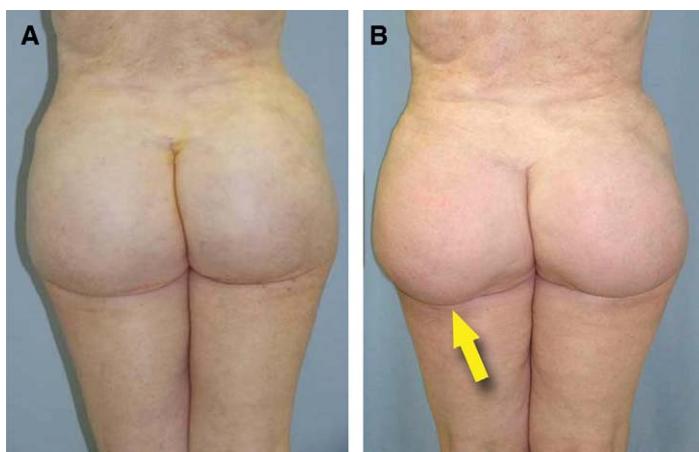
Fig. 6. (*A*) Two weeks after large (545 cc) subfascial implant augmentation. (*B*) Same patient 5 months following large subfascial augmentation; visible ptosis of the left implant (arrow) required reoperation through a new infragluteal incision, lateral capsulorrhaphy, change to a smaller implant bilaterally, and vest-over-pants fascial repair inferiorly.

Implant palpability

One hundred percent of the semisolid implants are easily palpable by the patient (and her partner) [34], which requires complete acceptance of this palpability by the patient after preoperative discussion. We find many patients opt not to have the subfascial procedure because of this problem.

Autologous fat grafting

Early reports of buttocks augmentation by fat grafting [9,10,20] and some recent reports [22,23], did not give rigorous reports of their complications or reported "none." Most of these authors only grafted tiny amounts of fat per buttock (30 to 210 cc), which could keep complications low, but this amount is so small that there was little or no visible augmentation. Most of the apparent improvement came from the adjacent liposuction.

Based on our experience and the experience of larger detailed series [11,14], it is impossible to perform substantial augmentation of the buttocks without complications; authors reporting this must be ignoring complications that eventually resolve, such as infections, seromas, paresthesias, and so forth.

The first authors to detail their complications were Cardenas-Camerena and coworkers [13]. Even though they only grafted an average of 210 cc/buttock, they reported 18% cellulitis, 6% seromas, 12% tissue irregularities, and one case of fat embolism in their series of 66 patients.

In our own experience of 261 cases of micro fat grafting to the buttocks, the first large strictly American series, we have meticulously tracked every complication (Table 4). In our early experience, from 1998 to 2002, we were frustrated by the rate of infection in the recipient site and fluid accumulation in the donor site, and continuously looked for additional ways to decrease these problems. The third column of Table 4 shows our results in the last 100 cases with a dramatic decrease in major complications from 17.6% to 7% with our current technique; if we eliminate those patients with very high volume grafting (>1000 cc/buttock), the major complication rate is reduced again, down to 2.7% (fourth column of Table 4).

It is our experience (and that of others with reasonably large numbers of cases) [11,14] that it is necessary to graft 500 to 900 cc or more of fat per buttock to obtain the range of gluteal fullness and shape requested by the various ethnic groups. When this volume of augmentation is performed, the following complications may occur.

Infection

In our first 100 cases, we experienced an almost 14% infection rate, about one half of these being major and the other half minor. There are several reasons why infection could be a problem in buttocks augmentation by fat grafting: (1) The incisions are within 6 inches of the anus. (2) Each stage of harvesting, preparing, and grafting the fat has a potential for contamination. (3) Until vascular ingrowth occurs (at least 4 to 7 days), the grafted fat is an ideal culture medium, placed in a warm, moist, traumatized environment. It seems likely that a very small inoculum of bacteria could cause an infection under these conditions. (4) Further, the skin of the injection site is traumatized by friction, making it less effective as a bacterial barrier.

The causative organisms of the infections in our entire series are shown in Table 5.

The following routines were progressively instituted, which resulted in a decrease from our initial infection rate of almost 14% to our present rate of 4% in our last 100 cases.

Major Complications	Total series, n = 261, %	Current technique (last 100 cases), %	Last 100 cases, excluding >1000 cc graft, n = 74, %
Table 4: Complications of buttocks augmentation by autologous fat grafting			
Infection			
Major	4 ⟩ 7	2 ⟩ 4	1.4 ⟩ 2.7
Minor	3	2	1.4
Donor site fluid accumulation requiring aspiration totaling >100 cc	9	0*	0*
Donor site Ischemia			
1 diabetic patient	0.4	1	0
Pulmonary embolus			
1 (late-30 days)	0.4	1	0
Aspiration pneumonitis: 1	0.4	0	0
DIC (disseminated intravascular coagulation)	0.4	0	0
Sterile abscess (fat necrosis)	0.4	1	0
Hematoma	0	0	0
Chronic seroma	0	0	0
Gluteal muscle dysfunction	0	0	0
Total major Complication	17.6	7	2.7
Minor complications			
Donor site fluid accumulation (total aspiration <100 cc)	10	2*	1.4
Minor liquified fat drainage	4	4	4.1
Transient sciatic paresthesias			
1–2 weeks	4 ⟩ 4.8	4	2.7
1–3 weeks	0.8		
Minor donor site cellulitis	2	3	4.1
Fibrotic nodules in buttocks	0	0	0
Total minor complications	20.8	13	12.2

* Data for our last 50 patients, in which we used two drains. In this group, fluid accumulation decreased dramatically.

- Systemic antibiotics: Based on the sensitivities of the causative organisms and clinical response in our patients, we administer intravenously at the beginning of surgery ampicillin 2 gm and sulbactam 1 gm (Unasyn 3.1 mg) q6h, gentamicin (Garamycin) 5 mg/kg/24 hours, and cefazolin (Ancef) 2 gm IV q4h. Postoperatively, we use ampicillin and clavulanic acid (Augmentin) 875 mg q12h and gatifloxin (Tequin) 400 mg q24h for 5 days, since we feel there is no vascular ingrowth until at least this time.
- No shaving—just clipping of pubic hair.
- Circumferential standing prep with povidone/iodine.
- Lap pad soaked with povidone/iodine placed in gluteal cleft at beginning of surgery, even when supine, to minimize wicking of tumescent fluid to and from the anal area.
- Minimal handling of fat. No washing is performed. After centrifugation, free oil is decanted, the aqueous layer drained off, and the fat is transferred through a closed system into 3-cc syringes for grafting.
- The grafting cannula is coated with povidone/iodine as each syringe is handed to the surgeon.
- The single most important change we made was to add the same three antibiotics to each canister of fat immediately upon harvesting. For each canister (roughly 200 cc aspirate), we add 10 cc of a solution containing ampicillin 2 g and sulbactam 1 gm plus 80 mg of gentamycin plus 2 gm cefazolin in 1 L of saline. This permits the fat particles to be bathed for 1 to 2 hours in a concentration of antibiotics three times higher than can be given systemically.

Fluid accumulation in the fat donor sites

This is especially problematic in the lumbar and sacral areas, since fairly aggressive sculpting of this area is necessary to obtain the ideal feminine inward sweep of the low back, and to create an

Table 5: Causative organisms: infections in buttocks augmentation by micro fat grafting (261 patients)	
18 Total infections (8 minor, 10 major)	
5/261	Gram negative, most commonly: *E coli* *Bacteroides fragilis* *Microaerophilic strep* *Pseudomonas* *Enterococcus* - Non-gas-forming *clostridum*
1/261	Peptostreptococcus
1/261	Staph aureus
1/261	Mycobacterium fortuitum chelonei (slow growing)
6/261	Unknown (1 major, 5 minor)
4/261	Minor cellulites (donor site)

Fig. 7. Patients requiring aspiration of fluid accumulation.

attractive superior gluteal cleavage. Further, a relatively large surface area must be suctioned if enough viable fat is to be obtained (total 1000 to 2000 cc fat from a total aspirate of typically 5 to 8 L).

Even when as little as 100 to 240 cc of fat were harvested and grafted, Cardenas-Camarena et al [13] experienced a 6% seroma rate, and Peren et al [12] a 10% rate. Like Murillo [14], who grafted an average of 700 cc/buttock with a 40% seroma rate, our initial rate of fluid accumulation requiring aspiration was 45% before implementing the use of drains, and the average aspiration total in the postoperative course was 415 cc, including both abdominal and sacral fluid accumulation. We initially hesitated to place additional compression externally on the sacral area, or to put drains in this location, fearing compromise of the circulation of the skin over the bony prominences. However, because of the frequency of significant fluid accumulation, we finally began placing one round 3-mm multiperforated silicone drain across the sacral area, exiting under the right bra strap, with some resulting decrease in fluid accumulation (Fig. 7). For the last 50 cases, we have added a second drain, from the left lower abdominal area, exiting under the left bra strap. A long (40 cm) curved 3.5-mm liposuction cannula is passed downward along these paths and out through an existing incision. The drain end is forced securely over the tip of the cannula, and the cannula withdrawn, leaving the drain in place.

In addition, a soft, 2- to 3-inch-thick triangular pad made from Kerlix gauze is placed over the sacral "V" to promote skin adhesion in this concave area, prevent seroma, and maintain the attractive superior gluteal cleavage. Without this pad, the garment
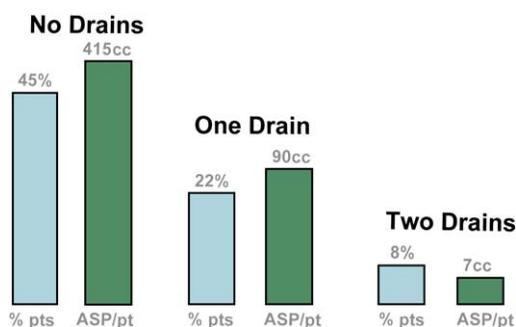
cannot compress this area, edema and later fibrosis fill the area, and the feminine cleavage is lost. With this combination of two drains and compressive padding, our seroma rate has dropped to 2% in the last 50 cases, with a single patient requiring a one-time aspiration of 55 cc. We have seen no skin ischemia or compromise from the padding or the drains.

Transient sciatic paresthesias

These tend to be minor, with discomfort, tingling, or slight numbness along the course of the sciatic nerve, and usually last less than 2 weeks. Mendieta [31] reported a frequency of less than 1% in his autologous fat-grafting patients, and Restrepo and Ahmed [11] mention paresthesias but do not quantify them. Our incidence is 4% in our series of 261 patients. We have had two patients who experienced a transient decrease in sciatic motor function; in these patients, MRI confirmed no hematoma or visible injury to the sciatic nerve. Their motor symptoms resolved in 1 to 2 weeks, and their paresthesias resolved between 1 and 3 months. The grafting cannulae are small (2 mm) and completely blunt, so no nerve laceration is possible. Etiology probably includes physical contact of the cannula plus swelling and inflammation. We now routinely give a bolus of 12 mg of dexamethasone (Decadron) at the beginning of the surgical procedure. Gabapentin (Neurontin) and anti-inflammatory medications may be useful if the symptoms are annoying.

Minor drainage of liquified fat from recipient incisions

This is typically a few drops per day to 1 to 3 cc per day. Despite our efforts, there is some frictional damage to the small (2 to 4 mm) recipient incisions. We are attempting to develop a small port protector to minimize this. We use up to five of these small incisions per side, to minimize frictional damage to each incision. The trauma to these

incisions may not become evident until sutures have dissolved or are removed by postoperative day 10 to 14. We see a small amount of drainage about 4% of the time, although it is often so trivial that it may be underreported by our patients. This drainage may continue until secondary healing of the incision, which may require up to 6 to 8 weeks. Liquified fat can look like pus, so when this drainage appears, always look for redness and new tenderness and obtain a culture, stat gram stain, white blood count, and differential. If these are all negative, close observation of the patient is warranted. When these evaluations continue to be normal, we have never seen this typical small open wound become infected, except for one patient who obsessively and aggressively massaged the area frequently, trying to force out any fluid. At 5 weeks, she developed an unusual peptostreptococcal infection, which presented as a draining flat cavity about 4 inches in diameter, but was completely nontender with a normal white blood count and differential. Instead of widely opening the wound, which would have caused great deformity, we managed her by enlarging the draining incision to 2 cm and then performing vigorous high-vacuum suction debridement of the pocket with a Yankauer (tonsil) suction tip. A "pigtail" catheter was inserted from above percutaneously to permit through-and-through irrigation, and the incision below was kept open with an iodoform gauze wick until the pocket healed (Fig. 8). These pigtail catheters will stay patent for weeks, and have been a major breakthrough in the management of intra-abdominal and other abscesses. This patient clearly lost volume on this side and will need to be regrafted later.

Sterile abscess (fat necrosis)

One patient with 1008 cc fat grafted/buttock had oily drainage of less than 1 cc/day beginning at 2 weeks. When we were finally able to get her to

return, we found her with no infection but a wide, thick-walled cavity from which we suctioned 200 cc of nonviable fat. She was managed like the patient in the preceding section with suction debridement and irrigation/drainage with a pigtail catheter.

Minor donor site cellulitis

This occurs in 2% to 3% of the cases and responds quickly to antibiotics.

Other complications

We had one case of unexplained disseminated intravascular coagulopathy, which was treated appropriately, and the patient had an uneventful full recovery after a 3-day hospitalization. One patient developed a small pulmonary embolus 1 month after surgery and recovered quickly. One patient with diabetes had an unusual complication of liposuction with ischemia of the lower thoracic area (Fig. 9A, B). In an informal poll of plastic surgeons during two instructional courses, approximately 3% of plastic surgeons report having seen this complication of liposuction, especially in diabetic patients. After we encountered this problem, Dr V. Leroy Young (personal communication, 2005) recommended considering the topical application of dimethyl sulfoxide (DMSO) 75% as an arterial and venous vasodilator (an off-label use of this product). Fig. 10A shows our only patient whose right buttock, 10 minutes after completing grafting of 987 cc, suddenly turned white centrally. After observing this unchanged for 10 minutes, dimethyl sulfoxide 75% was applied topically. Within 10 minutes, the circulation dramatically improved (Fig. 10B), and by 20 minutes, was back to normal (Fig. 10C). Although these events might have been coincidental and due to the opening of the choke vessels, unpublished clinical experience suggests DMSO may be helpful, and we offer this observation for what it is worth. Regardless, all patients should be informed of any off-label use of a product.

Symptomatic hypovolemia

This may be present on the first postoperative day and usually responds to intravenous fluid administration. We always check hemoglobin and hematocrit the day after surgery and again on day 5. Two percent of patients have required blood transfusions, attributable to extensive liposuction or a low hemoglobin preoperatively. Most of these were early in our series when we used only the "wet technique"—0.5 cc tumescent fluid per 1 cc of anticipated fat removal. We found a decreased incidence of drop in hemoglobin postoperatively when a full 2 to 4 cc of tumescent fluid is used for each 1 cc of anticipated fat removal.


Fig. 8. Closed management of draining cavity of right buttock with pigtail catheter and counter drainage (see text).

Fig. 9. (*A*) Ischemia of lipo-suction donor site on the lower posterior chest in a diabetic patient, postop day 4. (*B*) Same diabetic patient, 1.5 weeks postop.

Minor metabolic derangements

In addition to checking hemoglobin and hematocrit on the first and fifth postoperative days, we always check serum electrolytes and calcium levels. We find typically the potassium is slightly low on day one (3.0-3.2 mmol/l), and the calcium also slightly low (9.0-9.5 mg/dl). These have never required intravenous replacement. We do ask patients to drink a gallon of Gatorade™ or other sports electrolyte drink each day for a week to avoid dehydration and replenish electrolytes.

Partial reabsorption of grafted fat

Partial reabsorption is not truly a complication of autologous fat grafting, but an expected outcome. The only accurate way of measuring reabsorption would be serial MRIs. Although this has once been attempted with fat grafting to the buttocks [14], only six patients were evaluated. There was clear radiologic evidence of persistence of the grafted fat, but the small number of cases prevented any quantification of fat survival. Unfortunately, the cost of serial MRIs precludes their routine use. It is our clinical
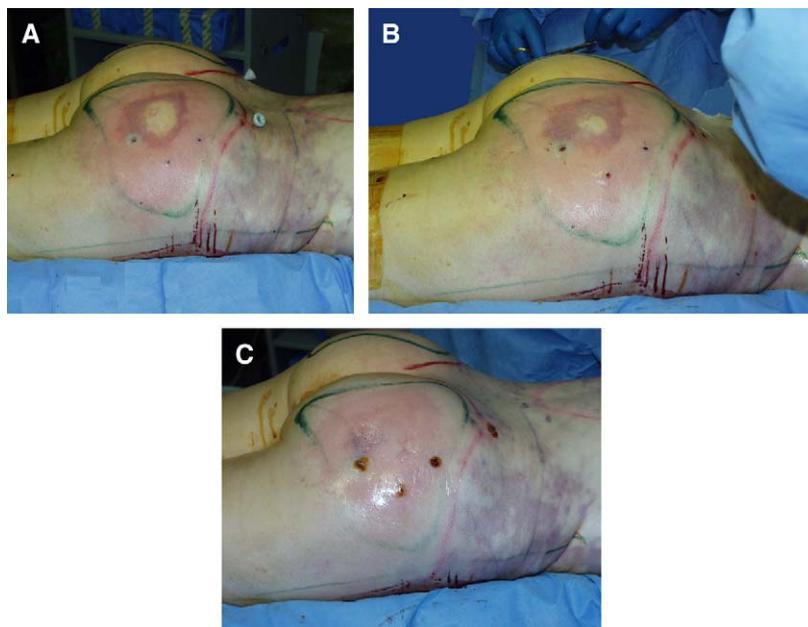

Fig. 10. (*A*) Potentially ischemic area of central buttock immediately after autologous fat grafting. (*B*) Same patient, after 10 minutes of topical DMSO. (*C*) Same patient, after 20 minutes of topical DMSO (see text).

estimate, based on our 261 cases, that less than 20% to 40% of the grafted fat is resorbed (Fig. 11A, B, C). This is similar to the estimates in the two other large series of large-volume (> 400 cc) buttocks grafting [11,14].

Although the optimal method of maximizing survival of autologous fat grafting is still a matter requiring further scientific investigation, our clinical experience and that of others suggests that the following techniques provide the best survival.

- Use low vacuum of aspiration: The vacuum generated by commercial liposuction pumps and by syringe aspiration is typically 25 to 28 inHg. At these vacuum levels, we observed that gas appears to bubble out of the fat tissue in the canister or syringe. Although at extremely high vacuums (> 30 inHg) water may boil at room temperature, this cannot be the explanation at 25 to 28 inHg. The most likely explanation is the "gassing out" phenomenon in solutions, in which dissolved oxygen and nitrogen come out of the solution. If this is occurring in extracellular water in our containers, the assumption can be made that it is occurring in the intracellular fluid, which could result in disruption of intracellular organelles or the cellular membrane, thereby decreasing the viability of the fat cells. Niechajev and Sevcuk [35] reported that microscopic evaluation of fat cells harvested at high vacuum (28 inHg) revealed that these adipocytes were 41% larger than those harvested at lower vacuum (15 inHg). We observed that this bubbling ceases when the vacuum is less than 22 inHg, which is compatible with the concept of "gassing out." For this reason, we maintain our vacuum below 22 inHg. Aspiration of fat at low vacuum was also recommended by Coleman [24–26] and others (Murillo [14], Pedroza [22], Chajchir and colleagues [20]), although no reason was offered for this suggestion.
- Use small harvesting cannula: Several authors (Carpaneda and Ribeiro [36], Coleman [24–26]) have found that graft survival is highest when the fat particle size is less than 3 mm. Coleman points out that anything larger than this will not pass easily through a Luer-lock tip without being disrupted. Since almost all authors' techniques involve injection through a Luer-lock tipped syringe, we recommend using a harvesting cannula that produces a 3-mm or smaller particle. Our choice is the "Keel"-shaped 3.0- or 3.5-mm harvesting cannula, which is faster and less traumatic than the original "bucket handle" tip designed by Coleman, yet produces particles less than 3 mm in diameter.
- Graft only tiny amounts (< 0.3 cc) in each tunnel: This is one of Coleman's and Guerrosantos' major recommendations [10,12,24–26,37] to ensure that each particle of fat is surrounded by a blood supply. This requires extensive time for grafting, as over 2000 tunnels per side are thus required to graft 600 cc per buttock.
- Graft the fat in all layers of the buttocks, both intramuscularly and subcutaneously: Too much fat deposited in any single area means less contact with recipient blood supply.
- Minimize shear and compression on the buttocks postoperatively: While authors differ in how long before patients may return to full activity, we feel that any shear or compression could damage ingrowing capillaries and result in greater reabsorption. Although extensive
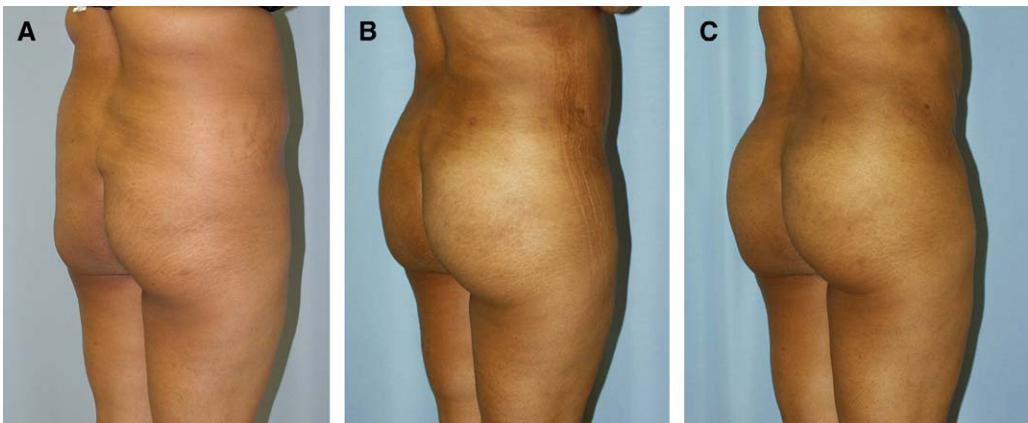
Fig. 11. (*A*) Forty-seven-year-old Caribbean woman requesting youthful and feminine shape. (*B*) Same patient, 3 months after liposuction of the hips and lumbosacral area, and buttocks augmentation by autologous fat grafting (939 cc per buttock). (*C*) Same patient, 1 year and 3 months after autologous fat grafting. There appears to be very little reabsorption.

Table 6:	Factors influencing complication rate in autologous fat grafting (last 100 cases)							
		BMI			Volume of fat grafted per buttock		Volume of fat remove	
	Last 100 cases	*<25*	*25–30*	*>30*	*<1000 cc*	*>1000 cc*	*<2.5 L*	*>2.5 L*
Major complications (infection, pulmonary embolus, donor site ischemia, donor site fluid accumulation >100 cc)	7%	2.9% (1/3)	11.1% (6/54)	0% (0/12)	2.7% (2/74)	19.2% (5/26)	4.9% (4/81)	15.8% (3/19)
Minor complications	13%	5.9% (2/34)	18.5% (10/54)	8.3% (1/12)	12.2% (9/74)	15.3% (4/26)	11.1% (9/81)	21% (4/19)
Total complications	20%	8.8% (3/34)	29.6% (16/54)	8.3% (1/12)	14.9% (11/74)	34.6% (9/26)	16% (13/81)	36.8% (7/19)

ambulation is encouraged from the day of surgery onward, we ask our patients not to lie supine or to sit (except for a bowel movement) for 2 weeks. This may be overly conservative, but until more information is available, we try to protect the fat as long as possible.

Factors affecting the incidence of complications in augmentation by autologous fat grafting

Our operative and management techniques have been stable for the last 100 patients (with the exception of using two drains in the last 50 patients). Therefore, we used this group to analyze risk factors.

Preoperative body mass index (BMI)

Contrary to most trends in surgical complications, there does not appear to be any correlation between incidence of complications (both major and minor) and increasing BMI. An analysis of BMI data and rate of complications was performed for the last 100 cases (Table 6). There appears to be a bell-shaped curve distribution of percent complication rate according to BMI, with a peak incidence of 11% major complications for BMI between 25 and 30. There were 3% major complications associated with patients whose BMI was less than 25 and none in patients whose BMI was greater than 30; minor complications followed a similar pattern.

Volume of fat grafted

Twenty-six of the last 100 patients had more than 1000 cc/buttock grafted, and these were responsible for five of the seven major complications (infection, pulmonary embolus, donor site ischemia, sterile abscess) in these last 100 patients. This is not surprising, since these patients had both the most extensive liposuction and the longest operative procedures, both of which are known to increase morbidity. Further, as the volume grafted increases so does the trauma to the recipient site, the frictional injury to the skin, and the turgor of the buttock (which could decrease the perfusion to the tissues). These factors resulted in a major complication rate of 19.2% for patients receiving more than 1000 cc graft/buttock. There were eight patients receiving more than 1200 cc graft/buttock, and in this group, major complications rose to 25%. By contrast, only 2 out of 74 patients with less than 1000 cc/buttock (2.7%) had a major complication.

In addition to the 19.2% major complications, the patients receiving more than 1000 cc/buttock had 15.3% minor complications; those with less than 1000 cc/buttock had a similar rate of 12.2% minor complications.

Amount of fat aspirated

With liposuction alone, complications increase as the amount of fat aspiration increases, especially over 5 L ("high volume liposuction"). In our last 100 cases, we had 19 patients with more than 2.5 L of fat aspirated; these 19 had three major complications, or 15.8%. The 81 patients from which less than 2.5 L of fat was aspirated had four major complications, or 4.9%. Liposuction of 2.5 L of fat is not enough to account for a 15.8% major complication rate. We feel that this is "guilt by association," with the real etiology being the attempt to augment more than 1000 cc/buttock (total > 2000 cc graft). A 2000-cc graft mandates harvesting more than 2.5 L, but it is probably the trauma associated with the grafting this much that is at fault, rather than the harvesting.

Summary

Subcutaneous implant augmentation

This should never be done for cosmetic purposes because of the very high incidence of implant mobility, displacement, ptosis, capsular contracture, and patient dissatisfaction.

Intramuscular implant augmentation

This has an overall wound dehiscence rate of up to 30%, increasing to 80% in overweight patients and is also very high in patients in whom an implant of more than 350 cc or more than 3.5 cm projection is used. Seroma, infection, implant malposition, and loss of implant due to muscle dehiscence and implant exposure each occur in 2% to 5% of cases. This brings the major complication rate to roughly 15% to 25%.

Subfascial implant augmentation

This has a similar dehiscence rate of 15% to 30%. Unfortunately, with the textured semisolid implant available in the United States, the incidence of seroma is about 20%; this may possibly be decreased by using a smooth implant. Other problems bring the major complication rate to 35%, and total complication rate to 51%. In addition, 100% of these implants are easily palpable by the patient and his or her partner.

The cohesive gel implant for subfascial buttocks augmentation hopefully will become available in the United States at some point in the future. De la Peña's experience with this implant is much more favorable [30]. These implants are less palpable, although the dehiscence rate remains approximately 30%.

Buttocks augmentation by autologous fat grafting

This may be the safer alternative with major complications at 7% with current techniques, but requires a major investment of time and is labor-intensive. Major complications may be reduced to less than 3% by grafting less than 1000 cc per buttock (Table 4, column 4).

The good news is twofold: (1) the techniques and patient selection indicated in this paper can significantly decrease complications in all of these procedures, and (2) discussion of complications is now more open, and thanks to the ongoing efforts of Mendieta, de la Peña, Young, Centeno, Roberts, and others, we are continuing to develop new techniques and implants and selection criteria that promise to decrease these problems even further. Much is yet to be done.

References

[1] Roberts TL, Toledo LS, Badin AZ. Augmentation of the buttocks by micro fat grafting. Aesthetic Surg J 2001;21(4):311–9.

[2] Douglas WM, Bartels RJ, Baker JL. An experience in aesthetic buttocks augmentation. Clin Plast Surg 1975;3(3):471–6.

[3] Cronin TD, Gerow FT. Augmentation mammaplasty: a new "natural feel" prosthesis. In: Broadbent TR, editor. Transactions of the Third International Congress of Plastic Surgery. Amsterdam: Amsterdam: Excerpta Medica Foundation; 1964. p. 41–9.

[4] Bartels RJ, O'Malley JE, Douglas WM, et al. An unusual use of the cronin breast prosthesis. Plast Reconstr Surg 1969;44(5):500.

[5] Cocke WM, Ricketson G. Gluteal augmentation. Plast Reconstr Surg 1973;52(1):93.

[6] Mendieta CG. Gluteoplasty. Aesthetic Surg J 2003;23(6):441–55.

[7] Billings E, May JW. Historical review and present status of free fat graft autotransplantation in plastic and reconstructive surgery. Plast Reconstr Surg 1989;83(2):368–81.

[8] Illouz YG. Body contouring by lipolysis: a 5-year experience with over 3000 cases. Plast Reconstr Surg 1983;72(5):591–7.

[9] Lewis CM. Correction of deep gluteal depression by autologous fat grafting. Aesthetic Plast Surg 1992;16:247–50.

[10] Guerrerosantos J. autologous fat grafting for body contouring. Clin Plast Surg 1996;23:619–31.

[11] Restrepo JC, Ahmed JA. Large-volume lipoinjection for gluteal augmentation. Aesthetic Surg J 2002;22(1):33–8.

[12] Peren PA, Gomez JB, Guerrerosantos J, et al. Gluteus augmentation with fat grafting. Aesthetic Plast Surg 2000;24:412–7.

[13] Cardenas-Camarena L, Lacouture AM, Tobar-Losada A. Combined gluteoplasty: liposuction and lipoinjection. Plast Reconstr Surg 1999;140(5):1524–31.

[14] Murillo WL. Buttock augmentation: case studies of fat injection monitored by magnetic resonance imaging. Plast Reconstr Surg 2004;114(6):1606–14.

[15] Vergara R, Amezcua H. Intramuscular gluteal implants: 15 years' experience. Aesthetic Surg J 2003;23(2):86–91.

[16] Robles JM, Tagliapietra JC, Grandi MA. Gluteoplastia De Aumento: Implante Submuscular. Cirugia Plast Ibero Latinoamericana 2984;10: 365–9

[17] Gonzalez-Ulloa M. Gluteoplasty: a ten-year report. Aesthetic Plast Surg 1991;15:85–91.

[18] Vergara R, Marcos M. Intramuscular gluteal implants. Aesthetic Plast Surg 1996;20:259–63.

[19] Gonzalez R. Augmentation gluteoplasty: the XYZ method. Aesthetic Plast Surg 2004;28:417–25.

[20] Chajchir A, Benzaquen I, Wexler E, et al. Fat injection. Aesthetic Plast Surg 1990;14:127–36.

[21] Toledo L. Syring liposculpture: a two-year experience. Aesthetic Plast Surg 1991;15:321–6.

[22] Pedroza LV. Fat transplantation to the buttocks and legs for aesthetic enhancement or correction of deformities: long-term results of large volumes of fat transplant. Dermatol Surg 2000;26(12):1145–9.

[23] Monreal J. Fat tissue as a permanent implant: new instruments and refinements. Aesthetic Surg J 2003;23(3):213–6.

[24] Coleman SR. Long-term survival of fat transplants: controlled demonstrations. Aesthetic Plast Surg 1995;19:421–5.

[25] Coleman SR. Facial recontouring with lipostructure. Clin Plast Surg 1997;24(2):347–67.

[26] Coleman SR. Structural fat grafting. Aesthetic Surg J 1998;18(5):386–8.

[27] Roberts TL, De La Pena JA, Toledo LS, et al. Panel discussion: cosmetic surgery of the buttocks region. Aesthetic Surg J 2003;23(5):381–7.

[28] Buchuk L. Complication with gluteal prosthesis. Plast Reconstr Surg 1986;77:1012.

[29] Ford RD, Simpson WD. Massive extravasation of traumatically ruptured buttock silicone prosthesis. Ann Plast Surg 1992;29(1):86–8.

[30] De La Pena JA. Subfascial technique for gluteal augmentation. Aesthetic Surg J 2004;24(3): 265–73.

[31] Mendieta C. Intramuscular buttocks implant augmentation. Presented at The Annual Meeting of the American Society of Plastic Surgery. Chicago, September 27, 2005.

[32] De La Pena A. Subfascial buttocks implant augmentation. Presented at The Annual Meeting of the American Society of Plastic Surgery. Chicago, September 27, 2005.

[33] Vergara R. Intramuscular buttocks implants. Presented at The Annual Meeting of the American Society of Plastic Surgery. Chicago, September 27, 2005.

[34] Roberts T. Complications of buttocks augmentation. Presented at The Annual Meeting of the American Society of Plastic Surgery. Chicago, September 27, 2005.

[35] Niechajev I, Sevcuk O. Long-term results of fat transplantation: clinical and histologic studies. Plast Reconstr Surg 1994;94:496–506.

[36] Carpaneda CA, Ribeiro MT. Percentage of graft viability versus injected volume in adipose autotransplants. Aesthetic Plast Surg 1994;18:17–9.

[37] Guerrerosantos J. Microlipofilling. Aesthetic Surg J 2002;22(2):196–8.