Body Contouring

Art, Science, and Clinical Practice

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2.1 Introduction

Most plastic surgeons are probably more familiar with the anatomy of the face, abdomen, or breasts than with the anatomy of the gluteal region. Because only a small percentage of plastic surgery procedures involve the buttocks, retaining knowledge of its clinical anatomy is not a high priority for most surgeons. This picture, however, is changing as increasing number of patients request body contouring and are increasingly aware of the numerous techniques now available for enhancing the gluteal region. These include the use of implants, autologous fat transfer, autologous gluteal augmentation with tissue flaps, excisional procedures (lifts), and liposuction. Combinations of more than one of these techniques often produce superior aesthetic results.

Unfortunately, these procedures can produce gluteal deformities as well as serious complications if the anatomical structures of the buttocks are not well understood. Obviously, the buttocks are subjected to a great amount of pressure, especially when sitting or bending. Any wound complication that develops will require a prolonged healing time and keep patients from resuming their daily activities. Even more serious is a surgery that interferes with gluteal muscle function or alters nerve activity in the legs.

A well-developed and aesthetically-pleasing gluteal region is a trait unique to primates, which was likely an evolutionary adaptation to erect posture and bipedal locomotion. Buttock projection is largely formed by the gluteus maximus muscle and fat deposits in the superficial fascia. In addition, our erect posture contributed to the lumbosacral curve, which is also unique to primates. Evolutionary biology suggests that an hourglass figure, with a small waist and full buttocks, has historically been associated with female reproductive potential and physical health across cultures, generations, and ethnicities [1]. A waist-to-hip ratio of 0.7 in women remains the ideal of beauty even as different ethnic groups prefer different gluteal shapes and curvatures. As women age and fertility declines, skin laxity increases and the shape of the gluteal region usually changes as the content and distribution of fat and muscle change [2, 3]. The hourglass shape fades and the waist-to-hip ratio approaches 1.0, similar to men.

An aesthetic outcome of gluteal contouring relies on the knowledge of clinical anatomy, both superficial and deep, in and around this region. Such knowledge also reduces the incidence of complications and improves patient satisfaction. Anatomical knowledge is essential for procedures that augment, reduce, or recontour the buttocks in this still evolving area of plastic surgery.

2.2 Codifying the Gluteal Aesthetic

To determine the appropriate surgical plan for a patient inquiring about gluteal enhancement or body contouring surgery, the characteristics of ideal gluteal aesthetics must be carefully considered. In 2004, Cuencá-Guerra and colleagues first reported their analysis of more than 2,400 images of the gluteal area taken from various media sources [4, 5]. This study helped to codify four...
of the most recognizable characteristics of an aesthetically-pleasing gluteal region (Fig. 2.1). The following landmarks are discussed in detail later in this chapter.

1. Two well-defined dimples on each side of the medial sacral crest that correspond to the posterior-superior iliac spines (PSIS).
2. A V-shaped crease (or sacral triangle) that arises from the proximal end of the gluteal crease with each line of the “V” extending toward the sacral dimples.
3. Short infragluteal folds that do not extend beyond the medial two-thirds of the posterior thigh.
4. Two mild lateral depressions that correspond to the greater trochanter of the femur.

Most of these characteristics are universally accepted by a variety of cultures. However, Roberts has described specific variations in aesthetic ideals between ethnic groups in the U.S. [2]. Of the four landmarks just described, numbers 1 through 3 are generally constant features of attractive buttocks regardless of ethnicity. Number 4 (mild lateral depressions) is not preferred by Hispanic-Americans or African-Americans. Other aesthetic differences among ethnic groups have also been identified by Roberts. A short buttock with a high point of maximum projection is popular among Asian-Americans because this shape creates the illusion of longer legs and a balanced proportion between the torso and extremities. In Roberts’ analysis, Hispanic-Americans and African-Americans seem to prefer more projection than either Asians or Caucasians, with a higher point of maximum projection and more severe lumbosacral depression. Caucasians in the U.S. trend toward a more athletic ideal with greater definition of the muscular and bony anatomy or a rounded appearance, with either shape having less anterior-posterior projection.

Another way of evaluating the buttocks to help plan body contouring procedures and then assess their outcomes is to view the gluteal region as having eight aesthetic units (Fig. 2.2) [6]. From the posterior-anterior view, the gluteal region consists of two symmetrical “flank” units, a “sacral triangle” unit, two symmetrical gluteal units, two symmetrical thigh units, and one “infragluteal diamond” unit. All eight gluteal aesthetic units play a role in improving the aesthetic outcome of body contouring in the gluteal region, and all should be considered during the surgical planning process. Particular units may benefit from being augmented, reduced, preserved, or better defined. To enhance overall gluteal appearance, the junctions between these aesthetic units should guide incision placement during excisional procedures.

Procedures performed on the torso, gluteal region, and lower extremities may have an important impact on the aesthetic perception of the buttocks. As an example, patients who have significant intraabdominal fat may have a widened, squared appearance if only abdominoplasty is performed. The same procedure in a patient without significant intraabdominal fat can better define the waist and improve gluteal aesthetics. Gluteal aesthetics can be greatly enhanced by judicious liposuction of the abdomen, anterior thigh, medial thigh, lateral thigh, flanks, and lumbosacral region. However, overly aggressive liposuction of the buttock, infragluteal fold, or hips often produces suboptimal aesthetic results. Poorly placed incisions also detract from the gluteal aesthetic. For example, a circumferential body lift (CBL) incision that runs straight across the back will make the buttock appear too long and rectangular or too square, depending on whether the incision is too high or too low, respectively. An incision that curves into a V shape along the lateral and inferior borders of the sacral triangle can greatly help define this aesthetic unit (Fig. 2.3). This “inverted dart” incision has been previously described [6–8].
Fig. 2.2 The eight gluteal aesthetic units are:
2 symmetrical “flank” units (1 and 2); 1 “sacral triangle” unit (3); 2 symmetrical buttock units (4 and 5); 1 infragluteal “diamond” unit (6); and 2 symmetrical thigh units (7 and 8)

Fig. 2.3 Preoperative markings and postoperative position of the “inverted dart” modification to the posterior circumferential body lift incision
A patient’s existing anatomy plays an important role in Mendieta’s gluteal evaluation system, which is helpful for determining the best way to augment or recontour the buttocks [9, 10]. Because of space limitations, only portions of his system can be mentioned here, but it involves analysis of the underlying bony framework of the buttocks, the skin, and the subcutaneous fat distribution, in addition to the musculature that overlies the bony frame. Mendieta suggests that surgeons begin by evaluating the frame, including the height of the pelvis, and the shape of the frame (round, square, A- or V-shaped). The gluteus maximus muscle should be evaluated to determine whether the muscle is tall, intermediate, or short compared with its width. This information can guide the surgeon in selecting the most appropriate procedure for a patient. Also, they should determine where volume is needed by analyzing whether volume should be added or removed from the upper inner, lower inner, upper outer, and lower outer quadrants of the gluteus maximus. Useful information for determining the procedure that would produce a superior aesthetic result additionally requires an evaluation of the four points at which the gluteal maximus muscle and frame join: the upper inner gluteal/sacral junction, the intergluteal crease/leg junction, the lower lateral gluteal/leg junction, and the lateral midgluteal/hip junction. Finally, from the lateral view, they should determine the degree of ptosis, which is assessed much like breast ptosis, but identifies the degree to which skin droops over the infragluteal fold [9, 11].

Improvement of severe (grade III) ptosis usually requires an excisional procedure such as a buttock lift, and Gonzalez has recently described several techniques: an upper buttocks lift, a lower DTA (dermotuberal anchorage) lift, a lateral buttocks lift, and a medial buttocks lift [12]. Some of these lifts may be incorporated with gluteal implant or autologous tissue augmentation. Patients who have lost a massive amount of weight typically have an excess of lax skin throughout the gluteal region in addition to buttocks ptosis. They may be best served with a CBL and autologous tissue augmentation for additional volume [8]. Although some massive weight loss patients may not need additional volume, they may benefit from moving the volume to another part of the buttocks to produce better gluteal projection at the level of the mons pubis. In these cases, fat transfer provides a good option. Gluteal implants are not a good choice for MWL patients because the poor quality of their subcutaneous tissue and skin may increase the risk of complications.

2.3 Topical Anatomical Landmarks

The superficial features shown in Fig. 2.1 are clinically relevant to gluteal augmentation with Alloplastic implants or autologous tissue, either a flap or transferred fat [2, 13–20]. The definition of these features also can be greatly improved with liposuction and transferred fat [2, 21]. As mentioned earlier, the sacral dimples, sacral triangle, lateral depressions, and infragluteal folds that are well defined and proportioned are judged to be appealing across many cultures [2, 4, 7].

Several bony landmarks important to gluteal procedures are easy to identify in most patients. The palpable and often visible iliac crest forms the superior border of the buttocks and is important for guiding incision placement in a buttock lift or CBL with or without augmentation. The incision can be placed more superiorly or inferiorly with respect to the iliac crest depending on the postoperative result desired. Unfortunately, the incision location requires a trade-off between waist definition and buttock elongation. A higher incision can better maintain a pleasing waist-to-hip ratio, but it violates the sacral triangle aesthetic unit, elongates the buttocks, and limits autologous flap placement so that maximum projection is higher than ideal. A lower incision diminishes waist definition, but preserves the sacral triangle aesthetic unit, shortens the buttocks, and permits the point of maximum projection at the level of the mons pubis. Good waist definition is nearly impossible to achieve in MWL patients with a long history of obesity no matter where the incision is placed because many years of an expanded rib cage have left them with a “barrel chest” deformity that cannot be corrected.

The PSIS, which are typically easy to palpate, form two distinct depressions called the sacral dimples produced by the confluence of the PSIS, the multifidus muscles, the lumbosacral aponeurosis, and the insertion of the gluteus maximus. Because the sacral dimples are characteristic of attractive buttocks, attempts should be made to create, enhance, or unmask this anatomical feature [6]. The sacral dimples are also good reference points for aesthetic analysis of the buttocks.
Another reason for the sacral dimples being important is that they serve as the superior corners of the sacral triangle, which is defined by the two PSIS with the coccyx as the inferior border of the triangle. Liposuction and/or the “inverted dart” modification of the posterior CBL incision mentioned earlier are useful for enhancing the sacral triangle during body contouring procedures [6]. In all gluteal contouring procedures the location of the sacral triangle feature should be respected and marked prior to surgery. If implants are to be used for augmentation, regardless of their position, the sacral triangle serves as the medial borders of the dissection (Fig. 2.4).

Another important topical landmark is the lateral trochanteric depression formed by the greater trochanter and insertions of thigh and buttocks muscles, including the gluteus medius, vastus lateralis, quadratus femoris, and gluteus maximus. This depression is important in the aesthetics of an athletically-toned buttock preferred by many Caucasians, but some ethnic groups – such as African-Americans and U.S. Hispanics – request that the trochanteric depressions not be emphasized or even filled in if they are prominent [2].

The infragluteal fold is a fixed and well-defined structure that serves as the inferior border of the buttock proper and is formed by subcutaneous fat and thick fascial insertions from the femur and pelvis through the intermuscular fascia to the skin [22]. The length and definition of the infragluteal fold play important roles in aesthetically-pleasing buttocks. In his study of ideal buttock aesthetics, Cuenca-Guerra determined that an infragluteal fold that does not extend beyond the medial two-thirds of the posterior thigh contributes to a full, taught, and youthful-looking buttock. A longer infragluteal fold typically suggests an aged, ptotic, and deflated-looking buttock with skin and fascial excess [4, 23]. Although not a part of the buttock proper, the ischial tuberosities are the bony prominences upon which people sit.

Fig. 2.4 Implant augmentation locations for (a) submuscular, (b) intramuscular, and (c) subfascial procedures. IC iliac crest; PSIS posterior-superior iliac spine; GT greater trochanter; IGF infragluteal fold.
2.4 Gluteal Aesthetics and Subcutaneous Fat Distribution

The amount and distribution of subcutaneous fat content accounts for the round shape and projection of the buttocks. Subcutaneous fat content in the gluteal region is usually greater in women vs. men, infants vs. adults, and in some ethnic groups. Some evolutionary biologists believe that subcutaneous gluteal fat is important for padding the buttock region when sleeping in the supine position and evolved as an adaptive mechanism for heat dissipation while maintaining sufficient adipose stores critical to normal physiology [24].

The distribution of gluteal fat, as well as its volume, also plays an important role in gluteal aesthetics. Cuenca-Guerra and Lugo-Beltran have analyzed gluteal aesthetics from the lateral view that incorporates the buttocK, surrounding torso, and lower extremities. Ideally, the ratio of the anterior-superior iliac spine (ASIS) to the greater trochanter and the greater trochanter to the lateral point of maximum projection of the buttock should not exceed 1:2 [5]. The author has found this analytical system based on the lateral view to be very useful and clinically relevant in determining which surgical procedure(s) should best achieve desired results. In addition to attaining the ratio of 1:2 when viewed from the side, attractive buttocks have other characteristics that relate to the distribution of subcutaneous fat.

- A visible lumbosacral depression should help to distinguish the back from the buttocks.
- There should be no excess fat either in the lumbosacral area or in subgluteal region. Excess fat in areas commonly referred to as the “love handles,” “saddle-bags,” and “banana roll” also detract from gluteal aesthetics.
- The point of maximum projection of the buttocks should correspond to the level of the mons pubis.

Attaining these characteristics may require the use of combined procedures. Impressive recontouring can be achieved with liposuction alone, especially to better define the lumbosacral depression, the sacral triangle, and the subgluteal area. However, liposuction must not be too aggressive in the area of the “banana roll,” just inferior to the infragluteal fold. Too much liposuction in the most superior portion of the posterior thigh can exacerbate buttock ptosis and cause deformities in the infragluteal fold, a structure that is very difficult to replicate surgically [22]. A good understanding of gluteal anatomy reduces the risk of these outcomes.

Anthropometric and radiological studies have determined that both aging and weight gain cause the distribution of fat in the buttocks to change. One investigation of 115 randomly selected women ranging in age from 17 to 48 found statistically significant changes in several measurement parameters [23]. Weight gain produces an overall increase in buttock height and width, lengthens the intergluteal crease, and shortens the infragluteal fold. Aging, independent of weight gain, also increases buttock height and lengthens the intergluteal crease, but makes the infragluteal fold longer. Both aging and weight gain are associated with drooping of the infragluteal fold. Although weight gain alone increases buttock width, this measurement decreases with age regardless of weight. Changes in subcutaneous fat content and distribution, in addition to skin and fascial laxity, are believed to explain these findings.

Fat distribution has been studied in both men and women, and generalized body types have been described. These include the android, gynoid, and intermediate body types. An individual’s body type may change according to weight loss, aging, or gender. For example, as women age and reach menopause, they tend to develop a more centralized fat distribution (both intraabdominal and subcutaneous fat), and the gynoid body type of youth develops more android characteristics. The most visible differences in the distribution of subcutaneous fat when comparing young and older women occur at the waist and mid-trochanter level. In addition, obesity increases the android tendency or centralized fat distribution of both sexes. This helps explain why body type and overall fat distribution patterns are relatively consistent among people with rapid and significant weight loss [24].

Massive weight loss patients are greatly affected by platypygia, partly because weight loss, whether through diet or surgery, often occurs in an uneven manner. Studies have suggested that adipose tissues in certain body regions are more resistant to weight loss than others [25]. The genetic programming of the resistant adipocytes seems to differ from adipocytes in areas that are more responsive to weight loss, which may mean that genetics influence different somatotypes. Within the android, gynoid, and intermediate body types are subgroups of somatotypes. Following weight loss, the “Apple” somatotype seems to have less adipose tissue in the gluteal region than the “Pear.” Regardless of somatotype, however, many MWL patients tend to lose gluteal...
volume and projection and want to have this deformity specifically addressed along with the skin laxity.

**Skeletal changes in massive weight loss patients**: In addition to redistribution of subcutaneous fat following massive weight loss, anatomical changes in several areas of the skeleton are common, especially in patients who were morbidly obese before losing weight. Many of these changes relate to posture and permanently affect the morphology of the skeleton, which may limit the effectiveness of gluteal contouring efforts.

Spinal column lordosis, vertebral compression, and pelvic rotation all negatively affect gluteal projection [26]. In obese individuals, restrictive pulmonary disease is often associated with a postural obstructive component that produces pulmonary hyperinflation [27], which often leads to permanent expansion of the thoracic cage. This “barrel-chested” appearance cannot be corrected and has a deleterious impact on gluteal aesthetics. Massive weight loss does not improve these skeletal abnormalities, which may be magnified or even worsened as the body mass index is lowered. A worsening of skeletal changes after surgical weight loss procedures may relate to poorly managed chronic hypocalcemia, vitamin D deficiency, and serum telopeptides that lead to osteopenia [28].

Although they cannot be corrected, some of the problematic skeletal changes can be disguised, at least partially, with gluteal procedures, especially autologous gluteal augmentation with a tissue flap or fat transfer. Knowledge of the anatomical abnormalities common in MWL patients can help surgeons understand why the buttocks appear flattened after the posterior portion of a CBL or buttock lift. In many patients, a CBL magnifies preexisting gluteal hypoplasia. Understanding where and why more volume is needed to recreate gluteal projection comes from familiarity with the anatomy of the gluteal and hip region.

### 2.5 The Importance of Fascial Anatomy

The aesthetics of the aging buttocks are greatly affected by the fascial anatomy of the gluteal region. In addition to volume loss and skin laxity, which also affect MWL patients, relaxation of the fascial “apron” contributes to gluteal ptosis. This superficial fascial apron and the deep gluteal fascia fuse, become tightly adherent, and form the infragluteal fold, which is an important feature of aesthetically-pleasing buttocks [22, 29, 30]. The fascial apron (Fig. 2.5) is analogous to the superficial fascial system (SFS) described by Lockwood [31]. Liposuction in the infragluteal fold area (for correction of a “banana roll”) must be done carefully and

![Fig. 2.5 Gluteal and SFS fascial anatomy. (a) The structure of the SFS “fascial apron.” (b) The lumbosacral and gluteal fascia.](image)
prudently because this feature is extremely difficult to surgically recreate. Resection and tightening of the skin and this superficial fascial apron are major components of the CBL procedure or buttock lift – with or without autologous gluteal augmentation – and play an important role in improving gluteal ptosis.

The deep gluteal fascia, or investing fascia of the gluteus maximus muscles, is critically important as a fixation point in many types of gluteal procedures (e.g., autologous augmentation and/or lifts). It also serves as a strong retaining fascia in the subfascial approach to augmentation with implants.

### 2.6 Superficial Neurovascular Anatomy

Perfusion to musculocutaneous structures in the gluteal region is supplied by perforating branches of the superior and inferior gluteal arteries, both of which are terminal branches of the internal iliac artery and ultimately pass through the greater sciatic foramen into the thigh (Fig. 2.6). As described by Ahmadzadeh and colleagues, the superior gluteal artery can usually be found by envisioning a line between the posterior-superior iliac spine and the greater trochanter [32]. Several perforators from this artery should lie 5–10 cm adjacent to the medial two-thirds of this line. Before it enters the gluteus maximus muscle to supply perforators to the superior portion of this muscle and overlying skin, the superior gluteal artery passes superior to the piriformis muscle [32, 33]. The inferior gluteal artery passes inferior to the piriformis muscle and supplies the lower half of the gluteus maximus muscle and overlying structures. All perforators from the inferior gluteal artery pass through the gluteus maximus, as do half the perforators from the superior gluteal artery; the other half pass through the gluteus medius muscle. The superior gluteal artery typically has 5 ± 2 cutaneous perforators, with the inferior gluteal artery typically having 8 ± 4 [32].

Some of these perforating vessels must be sacrificed during the posterior portion of a CBL, an autologous gluteal augmentation, or a buttock lift. Even with this loss, however, the rich and reliable vascular supply in the gluteal region provides robust perfusion [32–35]. Many other arteries also supply the region, including the deep circumflex iliac, lumbar, lateral sacral, obturator, and internal pudendal arteries.

Sensation to the gluteal region and lateral trunk comes from several sources: the dorsal rami of sacral nerve roots 3 and 4, the cutaneous branches of the iliohypogastric nerve arising from the L1 root (Fig. 2.7), and the superior cluneal nerves that originate from the L1, L2, and L3 roots and then pass over the iliac crest (Fig. 2.8). A lower body or buttock lift with or without autologous augmentation temporarily disrupts protective cutaneous sensation transmitted by these nerves. Consequently, patients should be counseled about the need for frequent positional changes and avoidance of heating pads and blankets to prevent pressure necrosis or burns.

As branches of the L1 nerve root, the iliohypogastric and ilioinguinal nerves originate in the sacral plexus (Fig. 2.7). They then travel inferiomedially between the transversus abdominis and internal oblique muscles. The iliohypogastric nerve divides into lateral and anterior cutaneous branches to supply skin overlying the lateral gluteal region and the area above the pubis on the anterior surface. These nerves are put at risk when a CBL incision is made at or below the inguinal crease. The lateral cutaneous branch of the iliohypogastric and the intercostal nerves also can be entrapped laterally during surgery. This is most likely when aggressive lateral plication of the external oblique muscle is performed to enhance waist definition or if “3-point” or quilting sutures are used laterally to close “dead space.”
While contouring the lateral and anterior trunk and thighs during body contouring procedures, surgeons must be aware of clinically significant anatomic variations of the ilioinguinal, iliohypogastric, and lateral femoral cutaneous nerves. In a fresh cadaveric study, Whiteside and colleagues determined that, on average, the ilioinguinal nerve enters the abdominal wall 3.1 cm medial and 3.7 cm inferior to the ASIS and terminates 2.7 cm lateral to the midline and 1.7 cm above the pubic symphysis [36]. The iliohypogastric nerve enters the abdominal wall musculature 2.1 cm medial and 0.9 cm below the ASIS and ends 3.7 cm lateral to the linea alba and 5.2 cm above the pubic tubercle.

**Fig. 2.7** The ilioinguinal and iliohypogastric nerves, the latter of which extends around the body to supply the lateral and anterior aspects

**Fig. 2.8** Posterior cutaneous nerves: (a) Dorsal rami of S3 and S4. (b) The superior cluneal nerves
However, another study of human cadavers found that the position of the iliohypogastric nerve in relation to the ASIS can vary by as much as 1.5–8 cm on the right side and 2.3–3.6 cm on the left side. The ilioinguinal nerve and its relation to the ASIS vary by as much as 3–6.4 cm on the right and 2–5 cm on the left [37]. A study of 110 patients undergoing hernia repair determined that the course of both nerves was consistent with descriptions in anatomy texts in 41.8% of cases, but varied significantly in 58.2% of patients [38]. Most variations were related to “take-off” angles, bifurcations, aberrant origins, or accessory branches occurring at deeper layers of the abdominal wall. However, in 18 of 64 cases, the ilioinguinal nerve was superficial to the external oblique aponeurosis and the superficial inguinal ring.

Injury to the lateral femoral cutaneous nerve (LFCN) was described as early as 1885. Meralgia parasthetica is the clinical syndrome caused by LFCN compression or injury and is characterized by anesthesia, causalgia, and hypesthesias in its dermatomal distribution. Typically, the nerve is described as coursing anterior to the ASIS and inferior to the inguinal ligament. Aszmann et al. showed that in 4% of cadavers dissected, the nerve exited posterior to the ASIS and across the iliac crest [39]. In another cadaveric study, Grothaus and colleagues demonstrated that the LFCN is susceptible to injury as far as 7.3 cm medial to the ASIS and 11.3 cm below the ASIS on the Sartorius muscle [40].

### 2.7 Deep Neuromuscular Anatomy

The expansive gluteus maximus muscle (Fig. 2.9) originates in the fascia of the gluteus medius, the external ilium, the fascia of the erector spinae, the dorsum of the lower sacrum, the lateral coccyx, and the sacrotuberous ligament. It inserts on the iliotibial tract and proximal femur. Innervation of the gluteus maximus comes from the inferior gluteal nerve. This muscle is a powerful extensor of the flexed femur and provides lateral stabilization of the hip. Correct positioning of submuscular, intramuscular, and subfascial implants in relation to fascial structures and the gluteal maximus muscle are shown in Fig. 2.10.

Originating on the external ilium and inserting on the lateral greater trochanters, the gluteus medius abducts the hip and thigh and helps stabilize the pelvis during standing and walking (Fig. 2.11). Nearby, the gluteus minimus muscle originates on the external surface of the ilium and inserts on the anterior-lateral greater trochanter (Fig. 2.12). This muscle abducts the femur at the hip joint and also serves as a pelvic stabilizer. Both the gluteus medius and gluteus minimus are innervated by
Fig. 2.10  Implant position in relation to gluteal anatomy: (a) submuscular, (b) intramuscular, and (c) subfascial augmentation

Fig. 2.11  Gluteus medius muscle and relationships to nearby neurovascular structures
the superior gluteal nerve. The superior gluteal artery and nerve, which supply both muscles, exit the sciatic foramen above the piriformis muscle and travel through the plane between the gluteus medius and minimus.

A lateral rotator and abductor of the femur, the piriformis muscle is innervated by branches of L5, S1, and S2. The small, triangular-shaped piriformis, which is obliquely oriented, originates at the anterior sacrum and inserts on the superior medial border of the greater trochanters. The piriformis muscle divides the greater sciatic foramen into inferior and superior portions. The piriformis overlies the sciatic nerve and plays an important role as a landmark for the gluteal neurovascular structures, as well as the sciatic nerve (Fig. 2.13). For example, the piriformis marks the most inferior extent of an implant pocket for augmentation in the submuscular plane.

Many other muscles are lateral rotators and abductors of the femur, including the superior gemellus, inferior gemellus, and obturator internus muscles, which all lie caudal to the piriformis. The most anterior of the gluteal muscles is the tensor fascia lata (Fig. 2.14).
originates on the lateral iliac crest and ASIS, passes superficial to the gluteus medius and minimus, and inserts on the iliobibial tract. It helps with flexion, abduction, and rotation of the thigh, and stabilizes the knee during extension. The terminal branch of the lateral femoral circumflex artery provides perfusion, with innervation supplied by the superior gluteal nerve.

The sciatic nerve is the largest nerve of the body and originates in the sacral plexus – at the nerve roots of L4 through S3. Its only gluteal branch provides innervation to the hip joint. The sciatic nerve exits the gluteal region through the greater sciatic foramen below the piriformis muscle and above the superior gemellus muscle to enter the posterior compartment of the thigh (Fig. 2.15). Above the popliteal space, the sciatic nerve splits into the common peroneal nerve and the tibial nerve. Compression or injury of the sciatic nerve may cause loss of function of the posterior thigh compartment muscles, all muscles of the leg and foot, and loss of sensation in the lateral leg and foot, as well as the sole and dorsum of the foot [41].

Anatomical studies indicate that the sciatic nerve and its main branches – the tibial and common peroneal nerves – are subject to variability in relation to the piriformis muscle. The sciatic nerve leaves the pelvis through the infrapyriform foramen in 96% of cases. However, in 2.5% of cases, the common peroneal nerve may branch away from the sciatic nerve early and exit through the piriformis muscle while the tibial nerve exits below the piriformis. In another 1.5% of cases, the common peroneal nerve divides from the tibial nerve and exits the pelvis above the piriformis muscle.
muscle, while the tibial nerve exits below the muscle [42,43]. Although uncommon, these anatomic variations must be looked for during gluteal procedures because injury to these nerves could lead to clinical complications during submuscular and intramuscular implant augmentation.

Although rare, gluteal compartment syndrome has been reported in the literature. Possible causes include trauma, alcoholism, drug-induced coma, Ehlers-Danlos syndrome, sickle cell disease, gluteal artery aneurysm rupture, abdominal aortic aneurysm repair, orthopedic surgery, bone marrow biopsy, intramuscular injections, rhabdomyolysis, extreme physical overexertion, and prolonged surgical positioning in the lateral decubitus or lithotomy positions.

Even though gluteal surgery rarely causes gluteal compartment syndrome, surgeons need a thorough knowledge of the gluteal compartments and the potential impact different aesthetic procedures may have. A low index of suspicion and early intervention will reduce any permanent negative sequelae of this potentially devastating clinical problem.

Three gluteal compartments have relatively inelastic boundaries: the gluteus maximus compartment, the gluteus medius-minimus compartment, and the tensor fascia lata compartment. The gluteus maximus compartment consists of the muscle plus its superficial and deep fibrous fascia, which is contiguous with the fascia lata of the thigh. This compartment attaches superiorly to the iliac crest and laterally to the iliotibial tract. Medially, the superficial and deep gluteal fascia join the sacral, coccygeal, and sacrotuberous ligaments. The gluteus medius-minimus compartment is defined superiorly by the deep gluteal fascia, the tensor compartment, and the iliotibial tract laterally. The ilium comprises the deep surface. The tensor fascia lata compartment is formed by the tensor fascia lata and the iliotibial tract.

The gluteus medius-minimus compartment contains most of the critical neurovascular structures. Precise knowledge of their locations will help prevent operative injury and improve understanding of this rare compartment syndrome. The superior gluteal artery, vein, and nerve exit superior to the piriformis muscle. The inferior gluteal artery, vein, and nerve exit beneath the inferior edge of the piriformis and above the superior gemellus muscle to penetrate the gluteus maximus muscle. In addition, the sciatic nerve, posterior femoral cutaneous nerve, pudendal nerve, and nerves to the obturator internus and superior gemellus muscles exit in the same compartment, beneath the inferior border of the piriformis muscle.

Increased compartment pressures with diminished perfusion to the gluteal muscles and tensor fascia lata can be caused by mass effect within these compartments. Damage to the vessels with bleeding and hematoma formation, or mass effect from a large implant, can theoretically increase compartment pressures beyond a safe limit. While still disputed in the literature, a compartment pressure higher than 30 mmHg may cause necrosis of muscle in as little as 4–6 h and Wallerian nerve degeneration in 8 h [44–46].

2.8 Surgical Injuries

Many inadvertent opportunities for injuring patients are possible during gluteal procedures as the common prone and lateral decubitus positions carry risks, such as development of pressure sores, corneal abrasions, peripheral nerve compression, and traction injuries. Although the entire operative team is responsible for being vigilant and preventing these types of injuries, the surgeon possesses the most specialized knowledge of the impact that improper intraoperative positioning can have on a patient.

Major peripheral nerve structures are especially at risk in the lateral decubitus position commonly used for a CBL or contouring liposuction of the flanks, back, and lateral thighs. An axillary roll can protect the brachial plexus from compression against the clavicle while in this position. The common peroneal nerve can be protected by using a gel mattress on the operative bed and avoiding compression against hard surfaces. Perioperatively, a gel mattress, “Roho,” or “egg-crate,” will provide extra padding to prevent nerve injury or irritation and also decrease the risk for development of stage 1 pressure sores that may occur during and after long surgical procedures.

The prone position required for most gluteal procedures also puts the patient at risk in several ways. Moving a patient from the supine to the prone position should be a controlled process supervised by the surgeon to ensure that the airway is protected by anesthetists, the team is coordinated, and adequate personnel are available to make the turn effortless. The use of chest rolls to prevent hyperextension of the shoulder and compression of the brachial plexus is critical. Areas that include the ulnar
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nerves, knees, feet, and face should be padded to prevent pressure sores and/or nerve injuries. Protecting the eyes with goggles is more effective than taping the eyes closed because tape can easily be displaced with movement and moisture from lubricating ointment. If flexion of the hip is desired, a gel roll beneath the ASISs is a safe way of providing elevation [47–49].

Patients who are overweight or obese may develop hemodynamic and/or ventilatory problems when in the prone position. For example, the weight of the patient on the chest wall can decrease expansion of the chest and manifest as increased ventilatory pressures. Prone positioning also may decrease venous return, and therefore, affect preload and cardiac output. Careful vigilance and awareness will diminish the deleterious impact of these physiologic responses [50, 51].

2.9 Summary

Selection of a gluteal contouring technique begins by evaluating the anatomy and existing distribution of subcutaneous fat in the buttocks and determining where gluteal aesthetics could be improved. The surrounding areas of the abdomen, flanks, back, hips, and lower extremities should be part of this analysis because they play a role in identifying the most appropriate procedure. The gluteal contouring algorithm (Fig. 2.16) illustrates the preferred choices for gluteal contouring under various conditions depending on the deformities present, and should help with determining which procedures are most appropriate for patients. If there is a loss of gluteal tissue volume, skin laxity, and buttock ptosis, a lower body or buttock lift with augmentation is the best option. Excisional procedures may also be needed to address the thighs and infragluteal area. Volume excess in areas surrounding the buttocks does not preclude the coexistence of gluteal hypoplasia, which is quite common in massive weight loss patients and effectively treated with autologous tissue. Contouring of the buttocks and surrounding areas is often best achieved with liposuction alone or as an adjunctive procedure. Results may be further refined with fat transfer to better define features common to attractive buttocks.

This chapter has described some of the major anatomical issues that confront plastic surgeons when

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**Fig. 2.16** Decision-making algorithm for gluteal contouring procedures
contouring and augmenting the gluteal region. Unless surgeons are very experienced in gluteal procedures, they are encouraged to refresh their anatomical knowledge and the many types of nerve and vascular variations that occur. A better understanding of gluteal anatomy and aesthetics will not only improve cosmetic results, but also reduce the risks of complications, some of which may be long-lasting.

References