Gluteal Ligamentous Anatomy and Its Implication in Safe Buttock Augmentation

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PATIENT SAFETY

Background: The number of buttock augmentations with fat transfer is steadily increasing, but a number of fatalities caused as a direct result of gluteal fat grafting have been reported. The technical details relating to cannula size, injection angle or trajectory, and plane of injection are critical for avoiding morbidity and mortality. However, the ligamentous anatomy has not been thoroughly explored, particularly how the ligaments are encountered in the clinical setting of fat transfer by means of cannulas.
Methods: The gluteal regions of five fresh cadavers were dissected, for a total of 10 hemidissections. All pertinent cutaneous ligaments in the region were identified. In addition, cannulas were used to simulate typical variations in injection planes.
Results: The osseocutaneous and fasciocutaneous ligaments of the buttocks were identified.
Conclusions: The authors describe important ligamentous structures consistently found in the region in cadaveric dissections and discuss the implications while safely performing gluteal augmentation. The anatomical features, boundaries, and soft-tissue attachment points may play a role in cannula-directed fat injection misguidance. The ligaments, when not released, can lead to undesired deep injection and therefore fat lobule migration into the venous system. The density, danger zones, and soft-tissue attachments must be clarified further as we continue to offer our patients improved buttock contour with a higher safety profile. (*Plast. Reconstr. Surg.* 142: 363, 2018.)

Demand for gluteal augmentation procedures is increasing significantly in the United States, particularly over the past 4 years. Of the procedures available for buttock augmentation, fat grafting has become the most commonly performed.[1] Despite the increasing popularity, a number of fatalities caused as a direct result of gluteal fat grafting have been reported.[2,3] As a result, these fatalities have raised serious concerns about performing this procedure, and have led to a task force seeking to identify causes and provide recommendations to improve the safety of the procedure.[4] The Aesthetic Surgery Education and Research Foundation task force estimated a fatality rate as high as 3 percent and a nonfatal fat embolism rate as high as 7 percent in their report. There are various reports in the literature on techniques that include fat grafting in either the subcutaneous plane, the intramuscular plane, or a combination of both.[5–30] However, there is a strong correlation with intramuscular fat grafting and fat emboli. The technical details in cannula size, injection angle or trajectory, and plane of injection are critical for avoiding morbidity and mortality.

Understanding of the subcutaneous anatomy and its relation to deeper planes is important not only for achieving aesthetically optimized results but also for improving the safety of

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buttock fat grafting procedures.[31] The subcutaneous anatomy in this region has been described previously.[32–36] However, to our knowledge, the implications of this anatomy and how it can influence fat transfer during gluteal augmentation have not been described. We describe important ligamentous structures consistently found in the region and discuss the implications while safely performing gluteal augmentation. The senior author's (A.G.) surgical experience with fat transfer to the buttocks, since 2007, will be drawn on to aid in clinical implications of this vital ligamentous system.

MATERIALS AND METHODS

The gluteal regions of five fresh cadavers were dissected, for a total of 10 hemidissections. Incisions were made below the infragluteal crease, medially in the natal cleft, superiorly from the lumbar region to the iliac crest. The dissections were carried down to the superficial fascial system, the muscular fascia, or bone. Anatomical visual observations and photographic documentation were made throughout the dissection, with identification of all pertinent cutaneous ligaments in the region. The superficial and deep borders and extensions of the ligaments were noted. In addition, cannulas were used to simulate typical variations in injection planes to better understand the role that these ligaments and fascial condensations may play in gluteal fat transfer.

RESULTS

Osseocutaneous Ligaments

At the depth of the superior border of the intergluteal sulcus, the sacrocutaneous ligament was consistently found (Fig. 1). The ligament has dense attachments from the lateral margins of the sacrum and extends directly to the dermis. In addition, the subcutaneous and subsuperficial fascial adipose layers are thinner in this area (Fig. 2). Inferior to its border, there is a "drop-off" in which larger fat lobules are encountered. Laterally, the ligament extends superolaterally and transitions to interdigitate with less dense adhesions from iliac crest to the dermis (Fig. 1). The thickness of this ligament varies between individuals and seems to be unrelated to fat, dermal thickness, or fullness.

The next relevant large osseocutaneous ligament in this region is the ischiocutaneous ligament (Figs. 1 and 3). This is a broad fan-shaped ligament that extends directly to the dermis. Superiorly, it merges with the natal cleft fasciocutaneous ligament and inferolaterally to the infragluteal crease fasciocutaneous ligament (Fig. 4). Its lateral border varies but tapers from inferior to superior and angles toward the intergluteal cleft to form a triangular configuration. The size and density of this ligament varies. This was the most difficult ligament to pierce and pass the cannula through. The lateral border attachment density and superior extent partly determine the

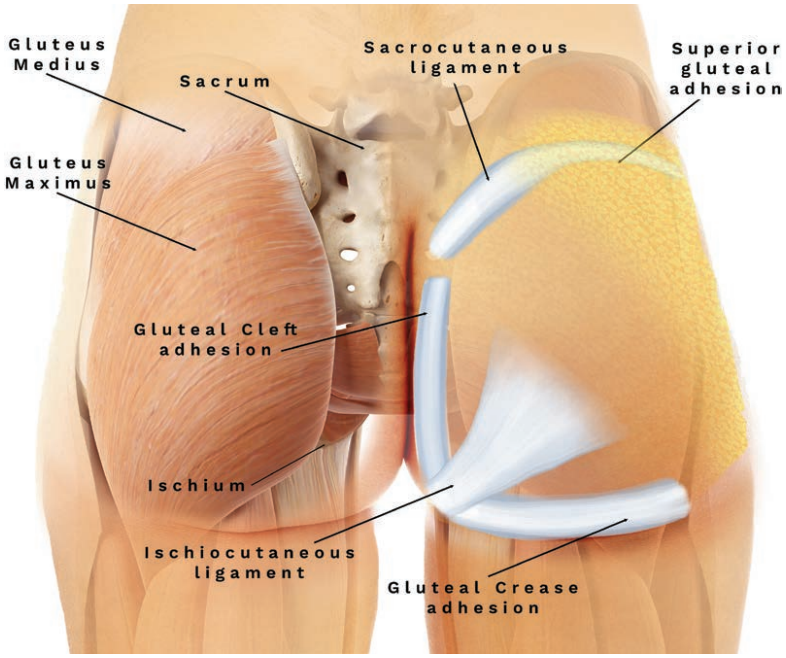

Fig. 1. Gluteal ligaments and adhesion zones.

Fig. 2. Sacrocutaneous ligament. Blue marker traversing through the ligament, which has dense attachments from the lateral margins of the sacrum and extends directly to the dermis.

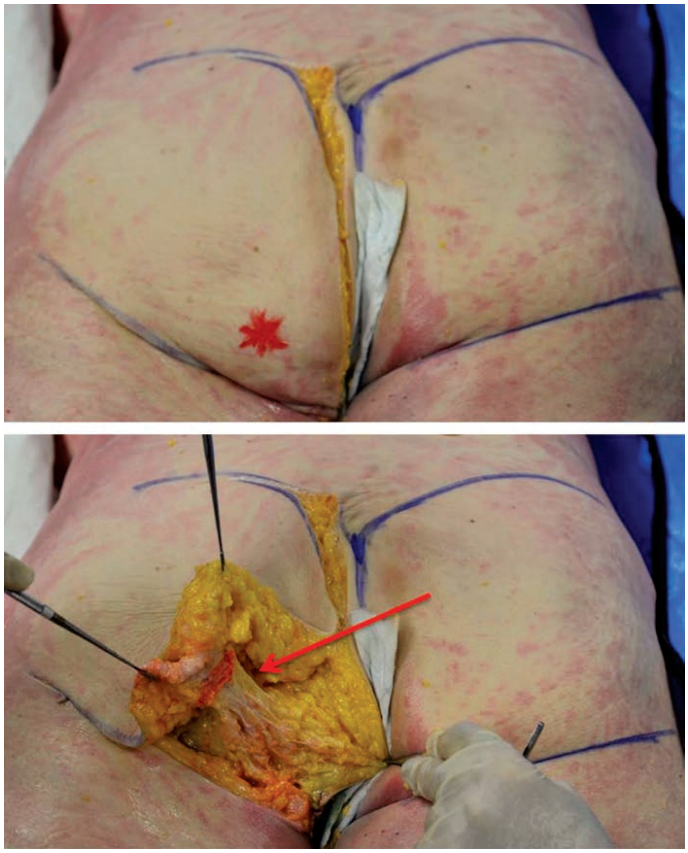

Fig. 3. Ischiocutaneous ligament. (*Above*) The ischial tuberosity is marked, which is the origin of the ligament. (*Below*) The fan-shaped osseocutaneous ligament attaching to the dermis.

curvilinear shape and contour of the medial third to half of the infragluteal buttock region.

Fasciocutaneous Ligaments

The natal or gluteal cleft fasciocutaneous ligament parallels and defines the natal cleft (Fig. 1). It extends from the gluteal fascia to the dermis. It merges superiorly with the sacrocutaneous ligament and inferiorly with the ischiocutaneous ligament.

Inferiorly, the infragluteal crease ligament defines the inferior border of the buttock (Fig. 4,

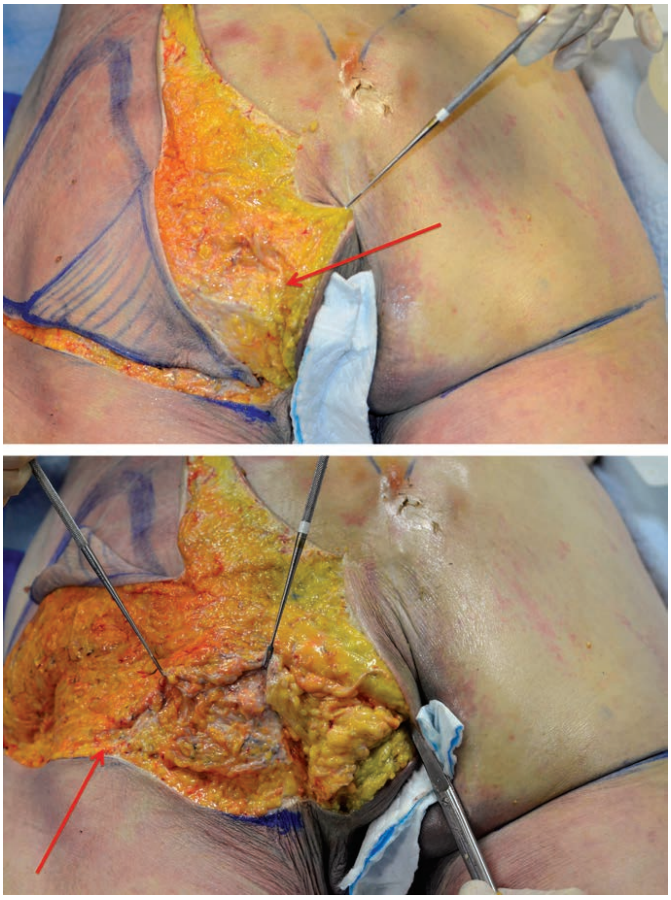

Fig. 4. Ischiocutaneous ligament extensions. (*Above*) Superiorly, it merges with the intergluteal cleft fasciocutaneous ligament (*red arrow*). Note: the fan-shaped expansion of the ligament is drawn in *blue*. (*Below*) Inferolaterally, it merges with the infragluteal crease fasciocutaneous ligament (*red arrow*) Note: the portion of the ligament that is visualized is the superficial condensation of the ligament just below the dermis.

below). It extends from the muscular fascia in the region with loose attachments to the dermis. The subsuperficial fascial fat is minimal or nearly absent in this region. This ligament closely mimics the inframammary fold and ligamentous attachments. As with breasts that lack a defined inframammary crease or fold, similarly, this ligament helps define the depth and formation of the infragluteal crease.

DISCUSSION

The fascial and ligamentous anatomy of the buttocks has been previously described by means of numerous studies.[14,32–40] However, the ligamentous anatomy has not been thoroughly explored, particularly how the ligaments are encountered in the clinical setting of fat transfer by means of cannulas. The fascial densities and ligamentous borders of the various regions of the buttocks must be understood, because their selective release is imperative for attaining proper buttock aesthetics by means of fat augmentation. Much as with a tuberous breast, release of attached tissue in specific planes and regions will allow proper expansion of the soft tissues. As with scoring the breast parenchyma and subcutaneous layers in a breast, the buttock soft-tissue attachments require release for fat injection. Partial or full ligamentous release is typically performed with an expanded tip basket cannula or a pickle fork. Appropriate release is judged clinically by manual palpation and soft-tissue resistance to cannula excursion. These ligaments may play a significant role in preventing dangerous and unnecessary fat injection in the region of the sciatic nerve and large gluteal veins. This can lead to fat emboli through either direct intravenous injection or untoward

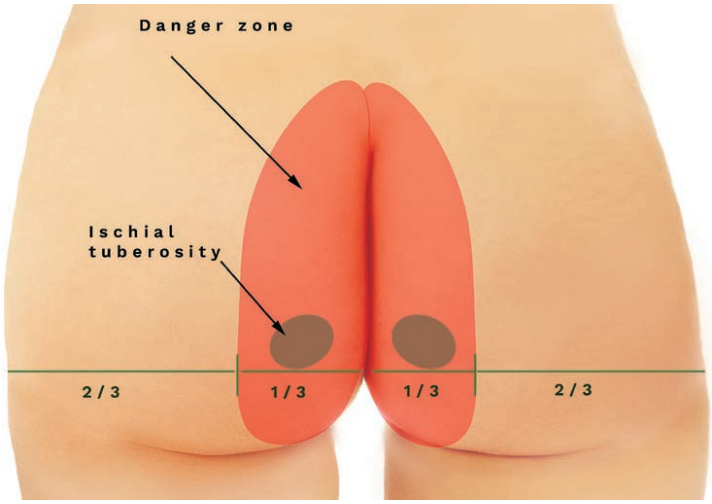

Fig. 5. Danger zone of the buttock. The deep medial third of the buttock is the area of greatest risk of gluteal vessel injury and possible fat embolism. This can be due to direct submuscular injection or fat migration from submuscular injection adjacent to the danger zone.

negative-pressure siphoning of fat lobules into lacerated large veins.

The senior author's (A.G.) injection technique, which has been performed safely for 10 years, consists of fat harvest using standard liposuction techniques. A closed collection system is used and the fat is then processed with an open strainer. The fat is then transferred to Toomey syringes for injection. The use of automated systems requires extensive surgical experience with the technique because large-volume injection into incorrect planes can occur more easily if the procedure is not done correctly. Furthermore, with careful manual injection, there is greater manual tissue feedback, which helps keep the injection cannulas in the correct planes.[3] The majority of fat transfer is into the subcutaneous planes for safety. However, in a select patient population, superficial muscular or subfascial injection may be difficult to avoid completely. These patients are typically thinner, with very taut skin elasticity. These patients may require injection into this plane, subfascial, because of insufficient tissue expansion potential in contouring. The ligament release and cannula angulation allow avoidance of the limited submuscular space with the larger vessels. Superficial muscular injections are performed within the danger zone whenever possible, where the large gluteal veins are predominantly located (Fig. 5).[41] A Leur Lock canal is never used, as this can bend at the hub and increases "cannula misguidance" risk. Even though this technique is used, the anatomical findings of this study are relevant to all injection techniques.

As a general anatomical point, the subcutaneous fascia of the buttocks fuses with the gluteal crease and infragluteal fold medially and the iliac crest superiorly.[32] We found this to be consistent in our study. Further dissection revealed a consistent attenuation in the lateral two-thirds of the buttock. The inferomedial buttock region contains the densest fascial and ligamentous attachments. This is considered the inferior aspect of the danger zone of the buttocks in fat injection (Fig. 5).

The origin of the infragluteal crease does not correspond to the margin. The ligament of Charpy or the ischiocutaneous ligament is a triangular fibrous structure that forms the fixed medial limit of the crease.[33] It originates from the ischial tuberosity and fans out posteriorly and laterally and goes into the deep dermis. It generally measures 4 cm in length. Only the medial portion of the crease is fixed by the ligament and forms the invariable fixed point. The remainder of the crease is flaccid, but its orientation is dependent on the lateral extension of the ligament. Those with a better defined and longer crease may have denser and longer fibrous condensations that extend laterally from the ischiocutaneous ligament. Regardless of the crease length, the main triangular fanning fibers do not extend beyond the lateral half to two-thirds of the buttock width (Fig. 4, *below*). The danger zone for fat injection is, therefore, consistent. Thus, this is the most important "zone of adherence" to understand in injecting more safely.

Cannula injection from an infragluteal crease access incision must be angled toward the superficial fat layers and away from muscle and deeper

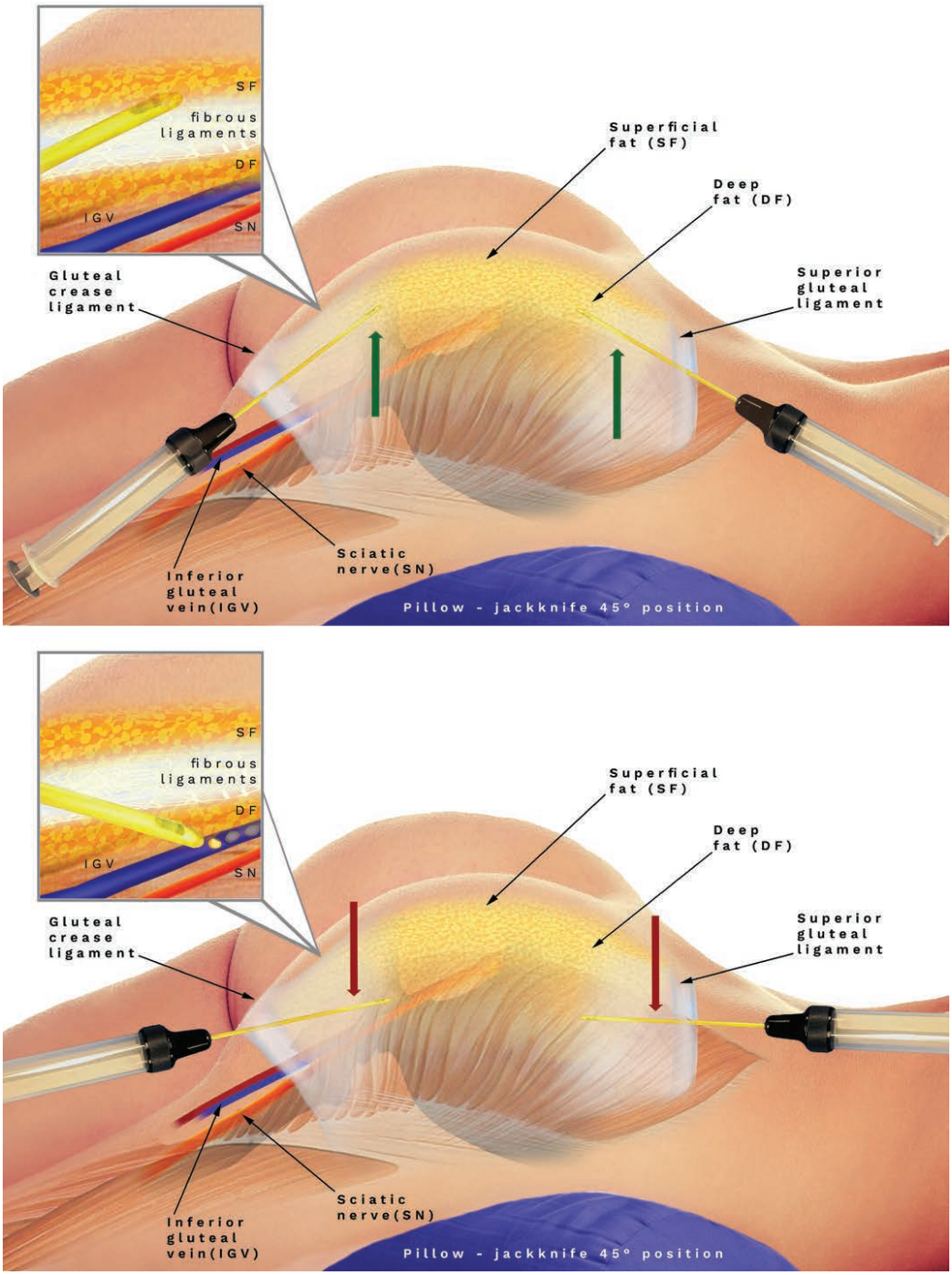

Fig. 6. Fat injection. (*Above*) Correct injection planes through the ligaments with correct trajectory of the cannula. (*Inset*) Close-up view, demonstrating cannula tip in superficial fat. (*Below*) Incorrect cannula trajectory through the ligaments with penetration into deeper planes increasing risk of injury to vessels and sciatic nerve. (*Inset*) Close-up view, showing that direct injection leading to fat emboli can occur with deep injection. A Leur-Lock should never be used, as the cannula can bend easily at the canal/syringe connection, leading to possible incorrect injection planes.

structures (Fig. 6, *above*). Generally, for upper lateral thigh and buttock injection, pointing the cannula from medial to lateral, either superolateral, directly lateral, or inferolaterally, has an improved margin of safety because the inferior gluteal vein and largest vessels are located in the medial third of each buttock. When injecting medially, ligaments and fascial condensations must be released and weakened because they can cause inadvertent misguidance of the cannula tip into deep planes

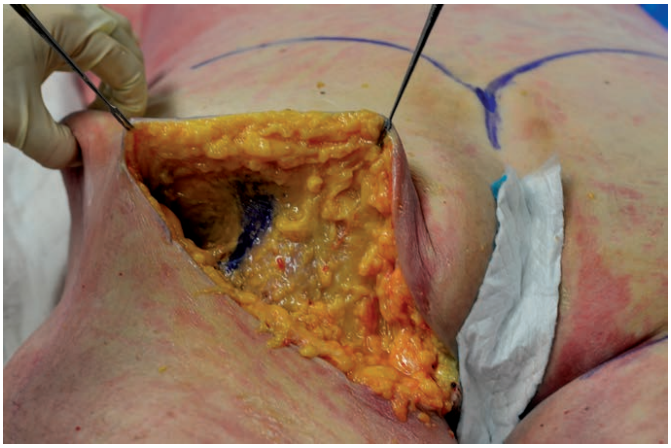

Fig. 7. Lateral gluteal depression. Area lateral to the infragluteal crease adhesion (*blue*). There were no significant ligamentous or fibrous attachments noted that can lead to potential dead space and fat necrosis and cyst formation during fat transfer.

(Fig. 6, *below*). Combining ligamentous release before and between injections along with angling the cannula superficially will avoid unnecessary deep fat injection. Abandoning the infragluteal crease access incision and any medially oriented injections is another option, but many patients require release and expansion of this region for optimizing the final gluteal contour. The inferomedial buttock region is often difficult and may be even more dangerous to approach from superiorly located access points.

Superior buttock release is commonly required to achieve balanced buttock contour. Access incisions from superior points either within the danger zone or lateral to it are more easily facilitated, as ligamentous attachments are not as strong and dense as those originating from the ischial tuberosity and infragluteal crease. In male patients, the superficial fascial system is tightly adherent to the periosteum of the iliac crest, and in female patients, it is relatively adherent to the muscle fascia in the gluteal depression and several centimeters below the iliac crest.[34] However, this superiorly located system typically does not mandate extensive release. Often, one release is required to allow for expansion by means of fat injection.

Other zones of adherence are also important to understand, such as the infragluteal crease, and the inguinal to lateral gluteal depression.[35] The superficial fascial system sends elements through the deep fat compartments as it attaches to the investing fascia of the underlying musculature and becomes most dense at zones of adherence. Zones exist where there is minimal or no deep fat and the superficial layer and overlying dermis are thin and can vary greatly. This was seen within our 10 hemianatomical dissections.

The sacrocutaneous ligament is composed of attachments between the sacrum and the gluteal sulcus. Disruption of this ligament leads to effacement of the sulcus.[36,42] The infragluteal crease marks the lower border of the gluteal region. The infragluteal crease has no relation with the gluteus maximus muscle; however, it is part of the supporting system that maintains soft-tissue structures in place in the gluteal and thigh area as first described by Morestin in 1984.[36] This supporting system extends from the ischial tuberosity to the lateral portion of the pubis. It may or not be visible. Liposuction along this crease may help deepen and define it. Excess lipoaspiration in this region leads to the classic "banana roll" appearance and requires augmentation for correction. The system is composed of dense fascial and fibrous condensations that connect osseoligamentous structures to the dermis.

The last region, which is the safest for injection but, interestingly, the most difficult to expand, is the lateral gluteal depression. For the purposes of this study, this is the zone that comprises the upper two-thirds of the buttock lateral to the danger zone. It is a large drop-off that has the most dead space potential and is the most prone to cyst and excessive fat lobule coalition (Fig. 7). There were no significant ligamentous or fibrous attachments noted here other than variations in superficial dermal and subcutaneous density. The lateral depression is formed by the lateral border of the gluteus maximus, the quadratus femoris, and the insertions of the gluteus

medius and vastus lateralis to the greater trochanter.[31,37,43] Injection in this region is almost always necessary and can be accomplished from superior and inferior access points. Approaching this area may be difficult and less safe when coming from an intergluteal cleft incision unless buttock size is inherently small. The injection cannula can be misguided deep near the region of the sciatic nerve from this access point as it crosses the upper lateral ligamentous border of the danger zone.

CONCLUSIONS

Gluteal augmentation with fat transfer has rapidly increased in popularity and has been a large part of the senior author's (A.G.) practice since 2007. Since that time, the zeal in performing buttock fat transfer has not been matched with proper understanding of the anatomy and improving the safety profile of this operation until more recently.[4,31,37,39] Going back to basics and understanding the role that anatomical features, boundaries, and soft-tissue attachment points may play in cannula-directed fat injection misguidance is vital. The ligaments, when not released, can lead to undesired deep injection and therefore fat lobule migration into the venous system. The density, danger zones, and soft-tissue attachments must be clarified further as we continue to offer our patients improved buttock contour with a higher safety profile. We hope that this study and the anatomical implications we discuss will help all surgeons in this process.

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