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Anatomy In Fresh Frozen Corpses For Gluteal Harmonization

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Abstract:
The gluteal region, an anatomical segment of notable morphofunctional relevance, constitutes a sophisticated topographic complex with structural organization, whose detailed understanding is essential in the scope of biomedical sciences. Its importance transcends the purely biomechanical domain, extending to the clinical, surgical and therapeutic spheres, due to its active participation in locomotion, maintenance of orthostatic posture and support of body mass. The application of fillers for gluteal harmonization is part of a set of tools available for the aesthetic and functional approach to the gluteal region.
Objective*: This article aims to offer a systematic and technically based exposition of the anatomy of the gluteal region, based on the most recent advances in anatomical knowledge, to the reader, whether an academic in training, health professional or researcher, anatomically demonstrating.*
Results: *The results of the anatomical dissection clearly demonstrate where we can safely apply the biostimulators, serving as a guide to the parametron harmonizers.*
Conclusion: *This article objectively demonstrates the anatomy of the gluteal region in Fresh Frozen Cadavers, with a solid, technical, and up-to-date conceptual foundation capable of supporting the application of anatomical knowledge in clinical, surgical, and therapeutic contexts, and in the aesthetic harmonization of glutes. Demonstrating where we should safely apply biostimulators, which promote collagen production and improve skin quality, as well as lipolytic actives used in cases of localized fat accumulation; and subcision, indicated to treat irregularities such as cellulite and scar retractions.*
Key Word: *Body harmonization, anatomy, cadaver dissection, glutes, body harmonization, gluteal fillers, biostimulators, aesthetics, fresh frozen*

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I. Introduction

The gluteal region, an anatomical segment of notable morphofunctional relevance, constitutes a sophisticated topographic complex with structural organization, whose detailed understanding is essential within the scope of biomedical sciences. 1,2 Its importance transcends the purely biomechanical domain, extending to the clinical, surgical, and therapeutic spheres, due to its active participation in locomotion, maintenance of orthostatic posture, and support of body mass. 3

This article aims to offer a systematic and technically grounded exposition of the anatomy of the gluteal region, based on the most recent advances in anatomical knowledge. 1,4

From an osteological perspective, the gluteal region lies on the robust structure of the bony pelvis, formed by the hip bones (ilium, ischium, and pubis), sacrum, and coccyx—structures whose primary purpose is to support the trunk, protect the pelvic viscera, and anchor the muscle groups of the lower limbs. 1,3,5 Its myofascial structure includes the gluteus maximus, medius, and minimus muscles, which, arranged in successive planes and interconnected by complex fascial layers, have specific insertions in the proximal appendicular skeleton, notably in the greater trochanter of the femur. 1,2,4 These muscles perform essential kinetic functions, such as extension, abduction, and rotation of the hip joint, in addition to being a crucial part of dynamic postural control. 2,4 Regarding vascularization, arterial blood supply to the region is provided by branches of the superior and inferior gluteal arteries, originating from the internal iliac artery, with accessory involvement from branches of the internal pudendal artery, the lateral sacral arteries, and the iliolumbar artery. 3 Venous return generally follows the arterial pathways, establishing anastomotic networks responsible for the effective drainage of superficial and deep tissues. 4

The innervation of the gluteal region has high topographic specificity, consisting of efferent and afferent fibers originating from the sacral plexus. The superior and inferior gluteal nerves innervate the deep and

superficial muscle planes, while the perforating cutaneous nerve and other sensory branches provide afferent blood supply to the gluteal integumentary region, playing an essential role in proprioception and postural reflexes. 4,5

Therefore, this booklet aims to provide the reader — whether an academic in training, a health professional or a researcher — with a solid, technical and up-to-date conceptual foundation, capable of supporting the application of anatomical knowledge in clinical, surgical and therapeutic contexts.

II. Anatomy Of The Gluteal Region

Bones

We will begin our study with a detailed description of the bony pelvis, which consists of the two hip bones, the sacrum, and the coccyx (part of the spine), and is the base of the axial skeleton (Figure 1). These bones are incapable of independent movement, except during childbirth in women. The bony pelvis is solidly structured, acting as a protective and supportive structure, anchoring the trunk and muscles of the upper and lower limbs, and also serving as a skeletal base for the birth canal.

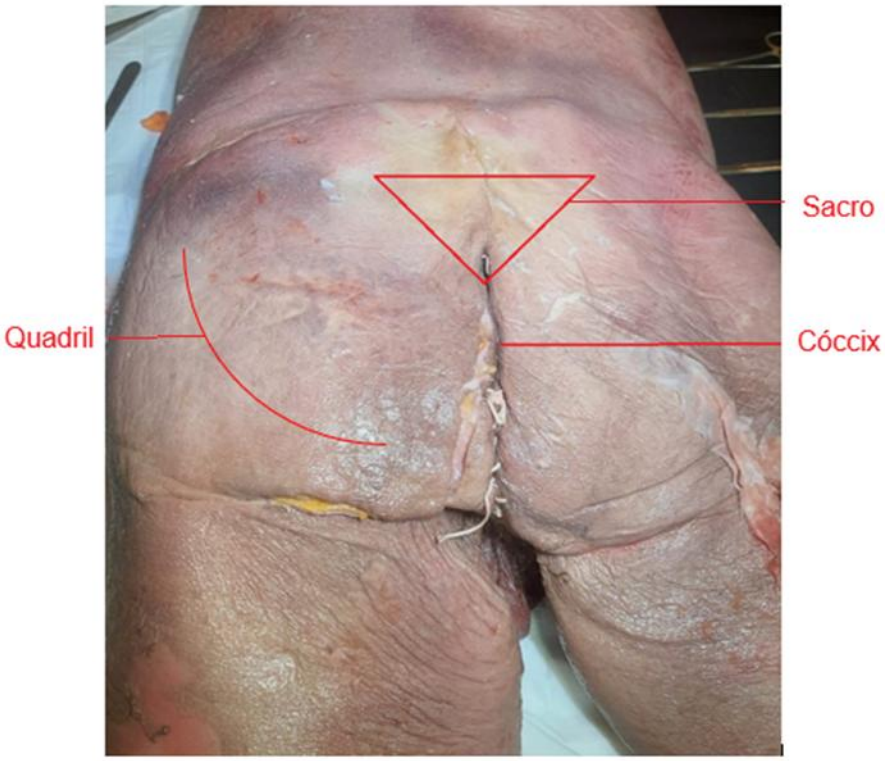

Figure 1: Anatomy of the gluteal region - Sacrum, Hip and Coccyx in a fresh frozen anatomical specimen. Source: Author's personal archive.

Gluteal Region

The gluteal region is located at the back of the pelvis and can be defined by an imaginary line that passes superiorly from the highest point of the iliac crests to the infragluteal groove. The gluteus medius muscle is superficial, contributing to the contour of the gluteal region.

Most of the skin of the gluteal region is supplied by musculocutaneous perforating vessels of the superior and inferior gluteal arteries. There are also small peripheral contributions from similar branches of the internal pudendal, iliolumbar, and sacral arteries. Cutaneous veins are tributaries of the vessels corresponding to the homonymous arteries.

The posterior hip muscles, also known as the gluteal muscles, are divided into superficial and deep gluteal muscles. The muscles of the gluteal region are: gluteus maximus, medius, and minimus, tensor fasciae latae, piriformis, obturator internus, superior and inferior gemelli, and quadratus femoris. 8 The superficial gluteal muscles receive their blood supply from the superior gluteal artery.

Superficial Fascia

The superficial fascia of the gluteal region is continuous with that of the lumbar region and contains a variable amount of adipose tissue. 9 The superficial fascia of the thigh is composed of loose areolar tissue containing fat. 10 In some regions, it is divided into layers, within which branches of superficial vessels and nerves are observed. 11 The fascia is thick in the inguinal region. Its two layers surround the superficial inguinal lymph nodes and the great saphenous vein, with the superficial layer being continuous with the abdominal fascia. 12

The deep connective tissue layer is clearly visible medial to the great saphenous vein and inferior to the inguinal ligament, lying between the subcutaneous vessels, nerves, and deep fascia. This structure merges inferiorly with the ligament, integrating with the adjacent layers. 13

This membranous layer of superficial fascia overlies the saphenous opening, blending with the femoral sheath. 14 Beyond the opening, the fascia is pierced by the great saphenous vein, the superficial branches of the femoral artery, and lymphatic vessels—cribriform fascia (from the Latin cribrum = pierced)15,16 (Figure 2).

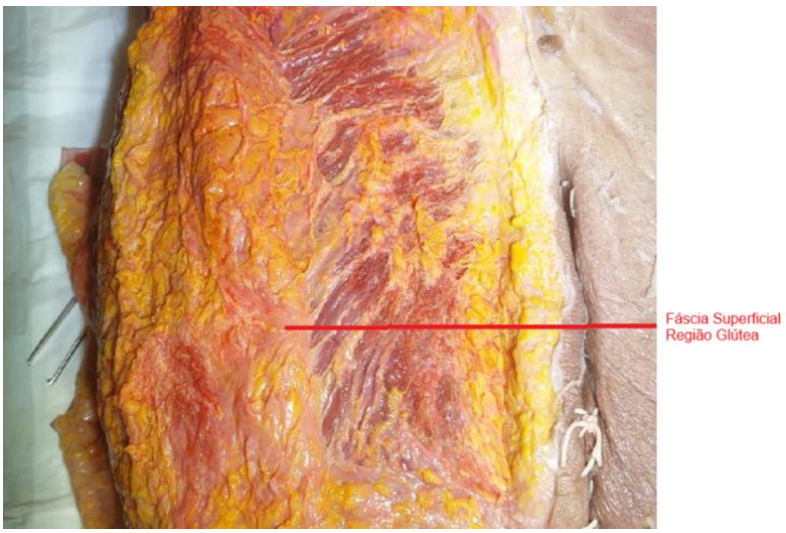

Figure 2: Superficial fascia region in a fresh frozen anatomical specimen.
Source: Author's personal archive.

Deep Fascia

The deep fascia covering the gluteal muscles varies in thickness. The fascia is thin in the region corresponding to the gluteus maximus muscle, but thickens over the anterior two-thirds of the gluteus medius muscle, forming the gluteal aponeurosis.

Superiorly, it inserts on the lateral margin of the iliac crest and divides anteriorly to wrap around the tensor fasciae latae and posteriorly to surround the gluteus maximus. The fascia creates different interdependent layers with varying depths, from the skin to the periosteum, forming a three-dimensional mechanometabolic structure.

There are two subtypes of deep fascia: aponeurotic fascia, which forms sheets of pearly-white fibrous tissue to attach muscles that require a wide attachment area. The aponeurosis can thin into a tendon and become a point of origin or insertion for other muscles. Some examples of aponeurotic fascia include the fascia of the limbs, the thoracolumbar fascia, and the rectus sheath. It is the thicker of the two subtypes, which are typically easily separated from the underlying muscle layer. It is composed of two to three parallel bundles of collagen fibers.

And the epimysial fascia, also known as epimysium, is the connective tissue sheath that surrounds skeletal muscle and can, in some cases, connect directly to the periosteum of bones. Some of the major muscle groups enclosed in epimysium include the trunk muscles, pectoralis major, trapezius, deltoid, and gluteus maximus.

Muscle Insertions

The greater trochanter of the femur serves as an insertion for the gluteus minimus and medius. The gluteus minimus is inserted into its anterior portion, and the gluteus medius into its lateral, more oblique margin. The bone is separated from the gluteus medius tendon by a synovial bursa. The posterior region is covered by deep fibers of the gluteus maximus, with part of the intertrochanteric bursa interposed. The gluteal tuberosity receives the deep fibers of the distal half of the gluteus maximus. 17

Gluteus Maximus

The gluteus maximus is the largest and most superficial muscle in the gluteal region and the most prominent muscle in the buttocks. It is a thick, quadrilateral mass that, with its adipose fascia, forms the familiar bulge of the gluteal region. It has a thick fascicular architecture, with wide bundles of fibers separated by fibrous septa. 18 (Figure 3).

It is composed of two layers of fibers. The superficial layer inserts into the iliotibial band, and its contraction produces extension and lateral rotation of the thigh. The deep layer inserts into the gluteal tuberosity of the femur, producing extension, adduction, and lateral rotation of the thigh during contraction.

The iliotibial band is the thickening of the thigh fascia. It extends from the ilium to the tibia. It is formed by the thigh fascia with the tendinous projections of the gluteus maximus muscle and the tensor fasciae latae muscle. The iliotibial band reinforces and laterally stabilizes the knee joint.17

It is innervated by the inferior gluteal nerve, and the other three are innervated by the superior gluteal nerve. It inserts into the gluteal tuberosity of the femur and the iliotibial band.

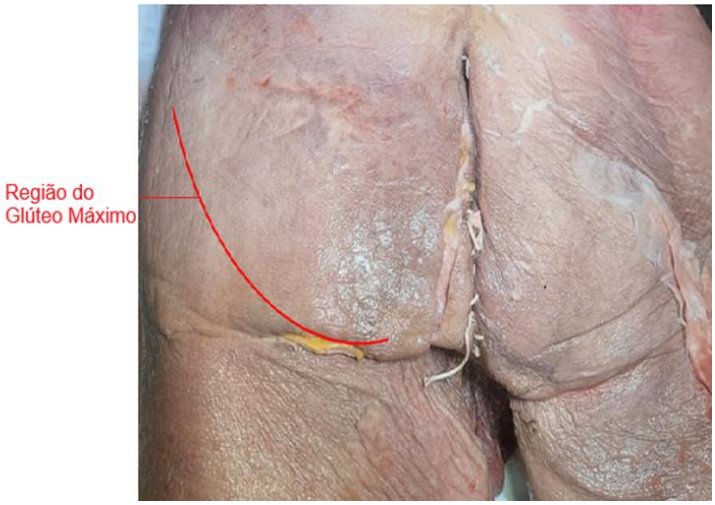

Figure 3: Gluteus maximus region in a fresh frozen anatomical specimen.
Source: Author's personal archive.

It originates in the posterior gluteal line of the ilium, immediately superior and posterior to it, in the aponeurosis of the erector spinae, in the dorsal aspect of the inferior portion of the sacrum and the lateral aspect of the coccyx, in the sacrotuberous ligament and in the fascia covering the gluteus medius (gluteal aponeurosis).

Figure 4: Gluteus maximus region - internal view in fresh frozen anatomical specimen.
Source: Author's personal archive.

The muscle may also be bilaminar. The fibers descend laterally, with the upper portion terminating in a thick tendinous lamina that passes laterally to the greater trochanter and inserts into the iliotibial tract of the fascia lata. 19,20 The deeper fibers of the lower portion of the muscle insert into the gluteal tuberosity, between the vastus lateralis and the adductor magnus. 21

A thin fascia separates the superficial surface of the gluteus maximus from the adjacent subcutaneous adipose tissue (Figure 4).

The deep surface of the muscle is connected to the ilium, sacrum, coccyx, sacrotuberous ligament, gluteus medius, piriformis, gemelli, obturator internus, quadratus femoris, ischial tuberosity, greater trochanter, and insertions of the biceps femoris, semitendinosus, semimembranosus, and adductor magnus muscles on the ischial tuberosity. The synovial bursa is located deep to the gluteus maximus: the trochanteric bursa, over the greater trochanter; the gluteofemoral bursa, between the tendons of the gluteus maximus and vastus lateralis; and the ischiofemoral bursa, over the gluteal tuberosity.22

The superficial division of the superior gluteal artery reaches the deep surface of the muscle, between the piriformis and gluteus medius. The inferior gluteal and internal pudendal vessels, the sciatic nerve, the pudendal and posterior femoral cutaneous nerves, the muscular branches of the sacral femoral cutaneous nerves, and the muscular branches of the sacral plexus all exit the pelvis below the piriformis. 22

The first perforating artery and the terminal branches of the medial circumflex femoral artery are also deep to the inferior portion of the gluteus maximus. Its upper border is thin and overlaps the gluteus medius. Its lower border is free, running laterally and posteriorly.

Vascular Supply

The dominant vascular pedicle is usually that of the inferior gluteal artery, which supplies approximately two-thirds of the muscle. The remainder is supplied primarily by the superior gluteal artery. The lateral and distal margins of the muscle receive blood supply from the first deep perforator and the medial femoral circumflex artery.

The musculocutaneous regions of the gluteus maximus may be supplied by gluteal vessels or the first deep perforator. Innervation: The gluteus maximus is innervated by the inferior gluteal nerve, L5, S1, and S2.

Gluteus Medius

If the gluteus maximus is removed, the next muscle we see is the gluteus medius, which originates on the gluteal surface of the ilium and inserts on the greater trochanter.

Gluteus Medius and Minimus: Both are abductors and medial rotators of the thigh. However, the gluteus medius muscle has anterior fibers (medial flexors and rotators), middle fibers (abductors), and posterior fibers (extensors and lateral rotators).

The most important function of the gluteus medius is maintaining the level of the pelvis when one leg remains supported on the ground while the other is elevated.24

The gluteus medius is a broad, thin muscle that arises on the external surface of the ilium, between the iliac crest and the posterior gluteal line (superiorly) and on the anterior gluteal line (inferiorly), forming the superficial fascia of its upper part. The fibers form the tendon that inserts on the lateral surface of the greater trochanter.

A deep bundle of the muscle may insert on the superior margin of the trochanter. The posterior border of the gluteus medius sometimes intertwines with the piriformis.

The posterior third of the gluteus medius is covered by the gluteus maximus, and its anterior two-thirds are superficial, covered by the deep fascia. Its deep surface is related to the gluteus minimus. The branches of the deep divisions of the superior gluteal artery and nerve run between the gluteus medius and minimus, making them vulnerable in procedures in the anterolateral and lateral directions of the hip, which involve the separation of the gluteus medius. At the tendon site, on the anterosuperior aspect of the lateral surface of the trochanter, a bursa (trochanteric bursa or gluteus medius) is observed, separating the muscle from the bone.

Vascular supply: The main blood supply to the gluteus medius comes from the deep branch of the superior gluteal artery. The distal part of the muscle is supplied by the trochanteric anastomosis. Innervation: The gluteus medius is innervated by the superior gluteal nerve, L4, L5, and S1.

Gluteus Minimus

The gluteus minimus also originates on the gluteal surface of the ilium and inserts on the greater trochanter of the femur. The fan-shaped muscle arises between the anterior and inferior gluteal lines and posteriorly from the margin of the greater sciatic notch. The fibers converge inferiorly to the deep surface of an aponeurosis that terminates in a tendon that attaches to an anterolateral ridge on the greater trochanter, contributing to the expansion of the hip joint capsule. 25

The muscle can divide into two parts, named anterior and posterior. Separate bundles may pass to the piriformis, superior gemelli, or vastus lateralis.

The branches of the deep division of the superior gluteal artery and nerve run on the superficial surface of the muscle. The bursa (trochanteric bursa or gluteus minimus) separates the tendon from the medial part of the anterior surface of the trochanter. Rocanter major.

Vascular supply: The gluteus minimus receives blood from both sides, from the main trunk and the deep branch of the superior gluteal artery, with a contribution at its femoral insertion from the trochanteric anastomosis. Innervation: The gluteus minimus is innervated by the superior gluteal nerve, L4, L5, and S1.

Tensor Fascia Lata Muscle

The fourth and final superficial muscle is the tensor fascia lata muscle, which extends from its origin in the anterosuperior iliac line to its insertion on the iliotibial band, which is a band of connective tissue that connects the tensor fascia lata and the gluteus maximus to the tibia in the leg.

Located in the upper and lateral region of the gluteal region, the tensor fascia lata muscle produces flexion and medial rotation of the thigh. The tensor fasciae latae muscle inserts into the fascia of the thigh (fascia lata), along with the gluteus maximus muscle. The synergistic action of both muscles produces thigh abduction and is known as the gluteal deltoid. 26

The piriformis, obturator internus, superior and inferior gemelli, and quadratus femoris muscles produce lateral rotation of the thigh and fix the femoral head in the acetabulum. The piriformis muscle is in a key position in the gluteal region, originating on the pelvic surface of the sacrum (between the IBS and IVBS), traversing the greater sciatic foramen, and inserting into the greater trochanter. Its position determines the names of the blood vessels and nerves. Some blood vessels (superior gluteal arteries and veins) emerge above this muscle, while others (inferior gluteal arteries and veins) emerge below it with the sciatic nerve.

A common anatomical variation is the passage of the sciatic nerve above the piriformis muscle, sometimes traversing its muscle fibers.

Inferior Gluteal Nerve

The inferior gluteal nerve arises from the dorsal rami of the fifth lumbar nerve and the first and second ventral sacral rami and divides into branches that penetrate the deep surface of the gluteus maximus.

Superior Gluteal Nerve

The superior gluteal nerve arises from the dorsal rami of the fourth and fifth lumbar nerves and the first ventral sacral rami. Accompanied by the superior gluteal vessels, the nerve exits the pelvis through the greater sciatic foramen, above the piriformis, dividing into superior and inferior branches.

The superior branch accompanies the superior branch of the deep division of the superior gluteal artery to supply the gluteus medius and, occasionally, the gluteus minimus. The inferior branch runs with the inferior branch of the deep division of the superior gluteal artery through the gluteus minimus, supplying the gluteus medius and minimus muscles to terminate in the tensor fasciae latae. 27

Perforating Cutaneous Nerve

The perforating cutaneous nerve pierces the sacrotuberous ligament, curves around the inferior border of the gluteus maximus, and supplies the skin over the inferomedial aspect of this muscle. The nerve may arise from the pudendal nerve or may be absent. 26

Sciatic Nerve

The sciatic nerve is formed by the anterior branches of LIV to SIII. It is the nerve with the longest trajectory, traversing the gluteal region, the posterior aspect of the thigh, and, as it approaches the popliteal region, it divides into the tibial and common peroneal nerves. The sciatic nerve can be located and palpated in the gluteal region.

The tibial and common peroneal nerves may have a proximal division, that is, before the popliteal region. 27

Psoas Major Muscles

The psoas major muscle is the largest muscle of the hip, located in the lumbar region, lateral to the lumbar vertebrae and medial to the quadratus lumborum muscle. Origin: Vertebral bodies T12, L4, and costal processes of vertebrae L1–L5.

Iliacus Muscle

Originating from the iliac fossa, the psoas major and iliacus are generally considered a single muscle, known as the iliopsoas muscle. These muscles have different origins; however, they join to pass beneath the inguinal ligament and in the thigh region to insert on the greater trochanter of the femur. 29

Psoas Minor Muscle

The psoas minor muscle, also known as the anterior hip muscle, is a small muscle that runs along the psoas major. In some cases, it is not mentioned because it is missing, and 40% to 70% of people lack this muscle.

Iliopsoas Muscle

It is the most powerful anterior hip muscle and its function is to flex the thigh and the hip joint. It receives innervation from the femoral nerve for movement. It receives blood supply from the iliolumbar artery and the medial circumflex femoral artery. 30,31

Fillers for Gluteal Harmonization

For aesthetic buttock harmonization procedures, Frank K et al.31 described that a 1 kg/m increase corresponds to a 3 mm increase in the thickness of gluteal adipose tissue in men and a 4 mm increase in women.

With increasing age, the thickness of the deep fat layer increases. With increasing BMI, the superficial fat layer increases.

The gluteal muscles atrophy and present fatty infiltration with advancing age. According to Hexsel et al.32, subcutaneous adipose tissue has a moderate correlation with BMI, especially in patients under 30 and over 46 years of age.

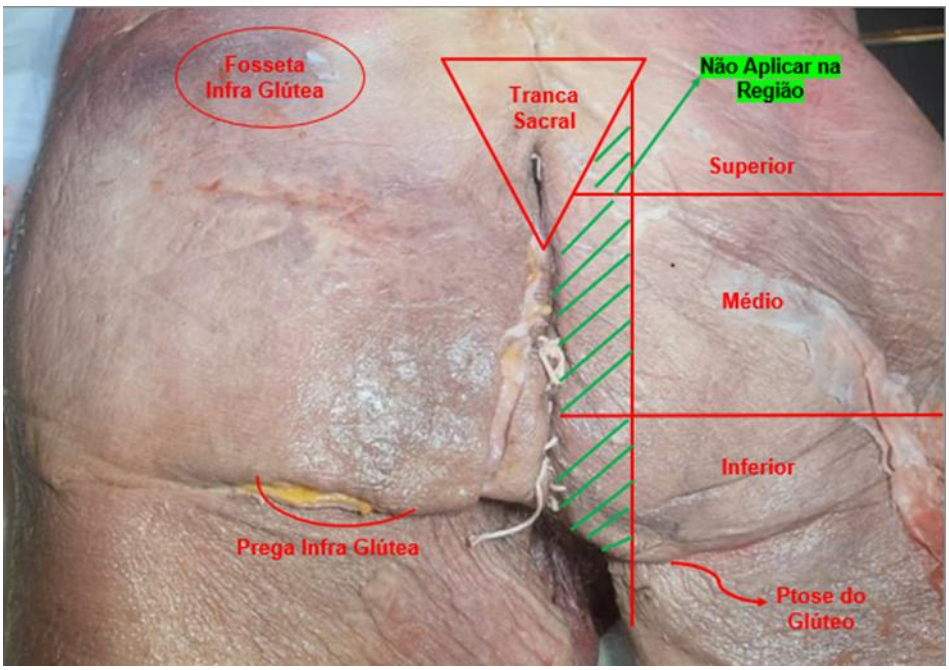

Figure 5: Gluteal areas for filler application.
Source: Author's personal archive.

With weight gain, there is a tendency for the height and width of the glutes to increase, which leads to a widening of the intergluteal fold and a narrowing of the infragluteal fold.
With aging, however, an increase in gluteal height, the intergluteal fold, and the infragluteal fold are observed.

Thus, aging and weight gain are associated with ptosis of the gluteal region above the infragluteal fold. Although weight gain increases gluteal width, this measurement tends to decrease with aging, regardless of weight (Figure 5).

Buttock harmonization fillers are part of a set of tools available for aesthetic and functional approaches to the gluteal region. Notable among these are biostimulators, which promote collagen production and improve skin quality; muscle toning procedures, which contribute to a more defined contour; deflators, used in cases of localized fat accumulation; and subcision, indicated for treating irregularities such as cellulite and scar retractions. Furthermore, plastic surgery offers more invasive structural solutions when necessary. Fillers with hyaluronic

acid or autologous fat complement this arsenal, allowing for the design, shaping, and balancing of volumes, promoting effective and personalized gluteal harmonization. 35

The use of ILIKIA® fillers has its own characteristics and advantages, with personalized indications for each case. The monophasic gel has smaller molecules, with lower viscosity and, therefore, greater ease of application. 36 It has greater cohesiveness and, therefore, greater tissue integration. 37 It is less palpable under the skin. 36 Meanwhile, the biphasic gel has larger molecules, which confers a higher G' and, consequently, greater lifting and tissue volumization capacity. 36 It also has a higher Modulus Complex, therefore, greater resistance to deformation. R2 technology combines the best of monophasic and biphasic fillers in a single innovative product. UP® is the first 100% cross-linked multiphasic hyaluronic acid filler, developed with exclusive R2 technology (Figure 6), resulting in a multiphase product with superior properties. Its main characteristics include high tissue lifting capacity, ease of application and molding, excellent tissue integration, and a remarkable affinity with CD44 receptors. This affinity contributes to local biostimulation, also promoting collagen production, which enhances clinical results in terms of both volumization and skin quality. 35

Figure 6: Hyaluronic acid molecules (large and small). Source: Dr. Renato Pazzini.35

Our patients are not all the same, and we can base our treatment on four types of buttocks, as shown in Figure 7. Therefore, we also have application techniques for each type. 35

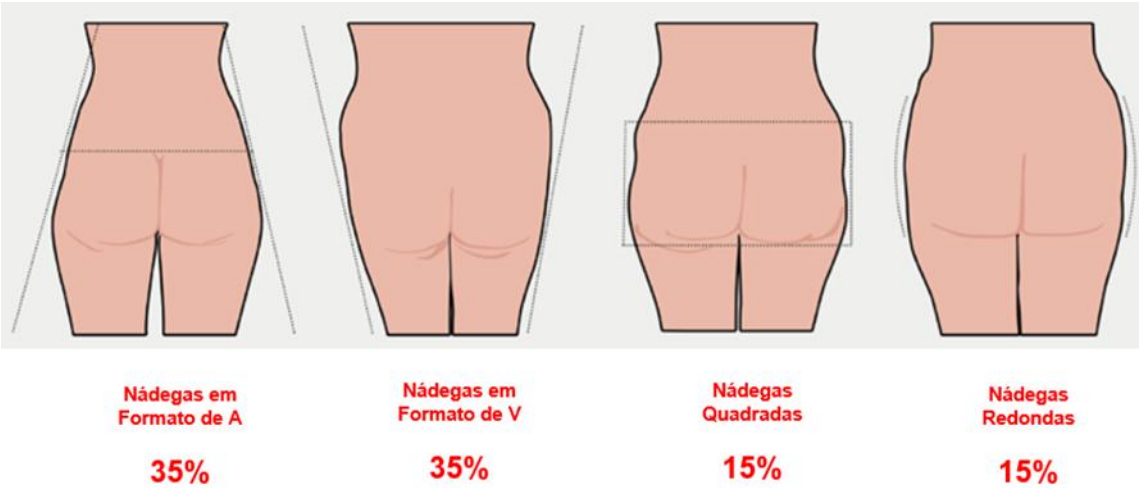

Figure 7: Shape of the buttocks. Source: Dr. Renato Pazzini 35.

Below are some application techniques according to the specific shapes of each buttock type.

A-Shaped Buttocks:
• Gynecoid (pear) pattern.
• Prioritize filling areas 2 and 3.
• Trochanteric depression (6) if the patient experiences discomfort.

V-Shaped Buttocks:
• Postmenopausal woman pattern.
• Assess the need for filler - What is this patient's desire?

• Prioritize areas 3 and 6.
• Combine biostimulator.

Square Buttocks:
• Male pattern.
• Maintain the square shape and trochanteric depression in men.
• Prioritize 2, 3, and 4.

Round Buttocks:
• Rounded pattern.
• Maintain the shape.
• Give more projection. • Distribute equal parts 1, 2, 3, and 535.

Figure 8 illustrates the main application areas of hyaluronic acid (HA), reinforcing its importance as a multifunctional compound with high biotechnological value.

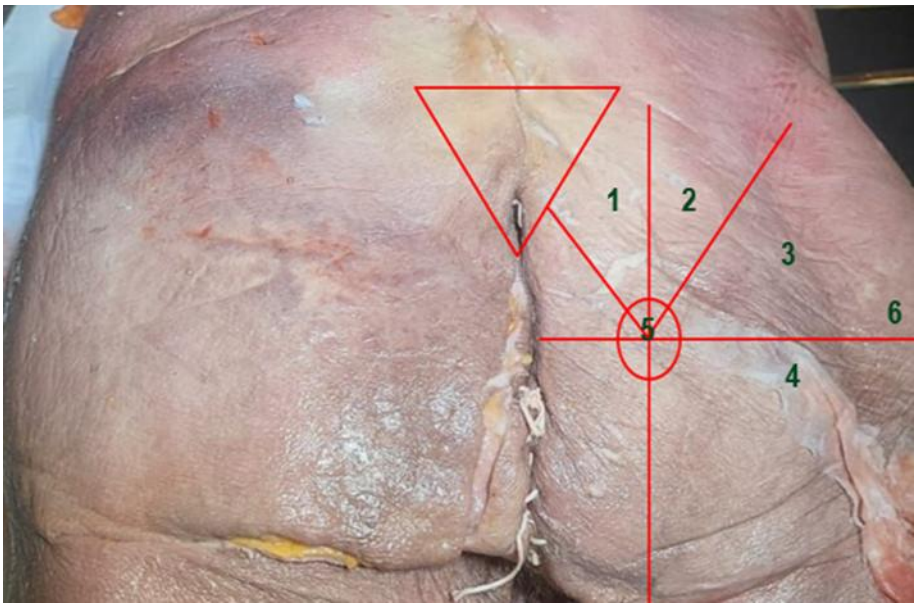

Figure 8: Gluteus with markings for HA application.
Source: Author's personal archive

III. Final Considerations

Thus, we conclude that hyaluronic acid represents a valuable and promising resource in the treatment of gluteal harmonization. The standardization of the protocols discussed throughout this paper not only reinforces its efficacy and versatility but also highlights the need for more in-depth studies that consider the specificities of this field. Thus, continued advancement of research can contribute to safer, more personalized, and effective practices, further expanding the potential of hyaluronic acid for aesthetics.

IV. Conclusion

This article objectively demonstrates the anatomy of the gluteal region in Fresh Frozen Cadavers, with a solid, technical, and up-to-date conceptual foundation capable of supporting the application of anatomical knowledge in clinical, surgical, and therapeutic contexts, and in the aesthetic harmonization of glutes. Demonstrating where we should safely apply biostimulators, which promote collagen production and improve skin quality, as well as lipolytic actives used in cases of localized fat accumulation; and subcision, indicated to treat irregularities such as cellulite and scar retractions.

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