

Applied anatomy of the fasciocutaneous branch of the third perforator artery of the deep femoral artery

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A study of the anatomy of the fasciocutaneous branch of the third perforator artery of the deep femoral artery was performed to help the elaboration of a fasciocutaneous flap for the reconstruction of skin and subcutaneous and deep fascia of the knee and popliteal region.

Forty thighs in 27 fresh cadavers were dissected. In all of the thighs, the third perforator artery was found to arise from the deep femoral artery and reach the posterior aspect of the thigh after perforating the adductor magnus muscle. At that point it was also found that the third perforator artery gives off a branch that emerges through the intermuscular septum between the vast lateral muscle and the long head of the biceps femoral muscle, then crosses the posterior cutaneous nerve and moves directly on to perforate the deep fascia and then to bifurcate into two other branches: one ascending and one descending.

The cutaneous area of the flap of the thigh's posterior region, nourished by the fasciocutaneous branch, was evaluated through the injection of dye. Dying of the upper medial, middle medial, lower medial and lower lateral areas of the flap was not successful in all of the dissected thighs. Nevertheless, the upper lateral and the middle lateral areas were dyed successfully in all 40 dissected thighs of the 27 cadavers.

Key Words: *Blood irrigation; Femoral artery; Surgical flaps; Thigh*

The popliteal region and the knee can be exposed to extensive lesions that require the use of flaps in their repair. The most frequent etiologies are trauma, although infections, tumour ablations and retraction scars (the latter caused mainly by burns) may lead to large cutaneous losses in the region.

The thigh's posterior region is well irrigated, which allows for the provision of musculocutaneous and fasciocutaneous flaps for the closing of wounds.

After the conceptualization of the fasciocutaneous flaps by Pontén (1) in 1981, several authors started to study the fasciocutaneous irrigation of the different corporal segments (2-8).

In the papers consulted, the authors described the third perforator artery as a branch of the deep femoral artery that arrives at the thigh's posterior region after crossing the adductor magnus muscle, proximal to its hiatus tendineus (2,8-10). In that region it gives off a fasciocutaneous branch that emerges through the septum between the lateral vast muscle and the long head of the

Anatomie appliquée : Branche fascio-cutanée de la troisième artère perforante de l'artère fémorale profonde

RÉSUMÉ : Nous avons étudié l'anatomie de la branche fascio-cutanée de la troisième artère perforante de l'artère fémorale profonde pour nous aider à façonner un lambeau fascio-cutané en vue de la reconstruction de la peau ainsi que du fascia profond et sous-cutané des régions du genou et du jarret.

Nous avons procédé à la dissection de 40 cuisses prélevées sur 27 cadavres frais. Dans tous les cas, la troisième artère perforante naissait de l'artère fémorale profonde et atteignait la face postérieure de la cuisse après avoir traversé le grand muscle adducteur. À partir de là, la troisième artère perforante forme une branche qui trouve passage dans le septum intermusculaire entre le muscle vaste externe et la longue portion du muscle biceps crural, traverse le nerf cutané postérieur et se dirige directement vers le fascia profond, le perfore et se divise ensuite en deux autres branches : l'une ascendante, l'autre descendante.

Nous avons ensuite étudié la région cutanée du lambeau de la région postérieure de la cuisse, nourrie par la branche fascio-cutanée en injectant un colorant. La coloration des régions médianes supérieure, moyenne et inférieure ainsi que de la région latérale inférieure du lambeau n'a pas été concluante dans tous les cas; par contre, celle des régions latérales supérieure et moyenne a réussi sur les 40 cuisses prélevées.

femoral biceps muscle. After perforating the fascia, it forks off into one branch of ascending trajectory and another of descending trajectory, anastomosing with the descending fasciocutaneous branch, which originates in the second perforator artery, and with the ascending fasciocutaneous branch, which arises in the popliteal artery. It is part of a fasciocutaneous arterial net that irrigates the thigh's posterior cutaneous region, from the gluteal line to the popliteal depression.

The aim of this paper is to describe an anatomical study of the fasciocutaneous branch of the third perforator artery from the deep femoral artery to aid in the planning of a fasciocutaneous flap from the thigh's posterior region that may be used in repairing the popliteal region and the knee.

MATERIALS AND METHODS

The material used in this research consisted of 40 dissected thighs from 27 fresh adult male cadavers (time of death less than 12 h).

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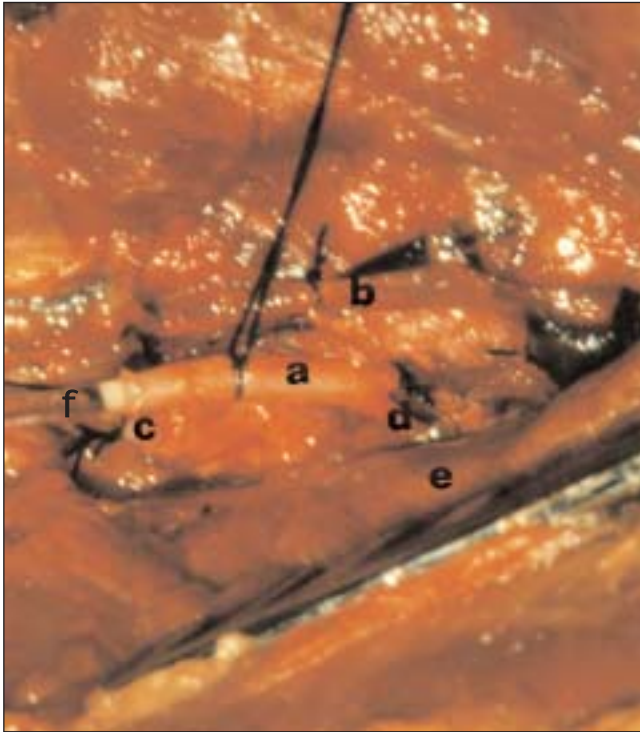


Figure 1) View of the deep aspect of the thigh's anterior region (catheterization of the deep femoral artery). *a* deep femoral artery; *b* deep femoral vein; *c* second perforator artery; *d* third perforator artery; *e* adductor magnus muscle; *f* catheter

The dissections were done in the anterior and posterior regions of the thighs with the purpose of studying the fasciocutaneous branch of the third perforator artery of the deep femoral artery and its territory of cutaneous irrigation.

All specimens were studied according to the following established routine:

1. dissection of the third perforator artery and catheterization of the deep femoral artery soon after the origin of the second perforator artery (Figure 1).
2. demarcation of the thigh's length and the posterior flap (Figure 2).
3. Measuring the following characteristics of the fasciocutaneous branch: distance from origin to penetration into the fascia and up to the point corresponding to the lateral condyle of the femur; distance from penetration into the fascia up to the point corresponding to the lateral condyle of the femur; and external diameter at its origin and at the level of penetration into the fascia.
4. use of methylene blue 1%, diluted in the proportion of 1:1 in sodium chloride 0.9% for dying of the fasciocutaneous branch, identification of its anatomical relationships (Figure 3), and visualization in the skin of its irrigated area (Figure 4).

RESULTS

Data from the fasciocutaneous branch and the fasciocutaneous flap were analyzed separately to provide two distinct sets of

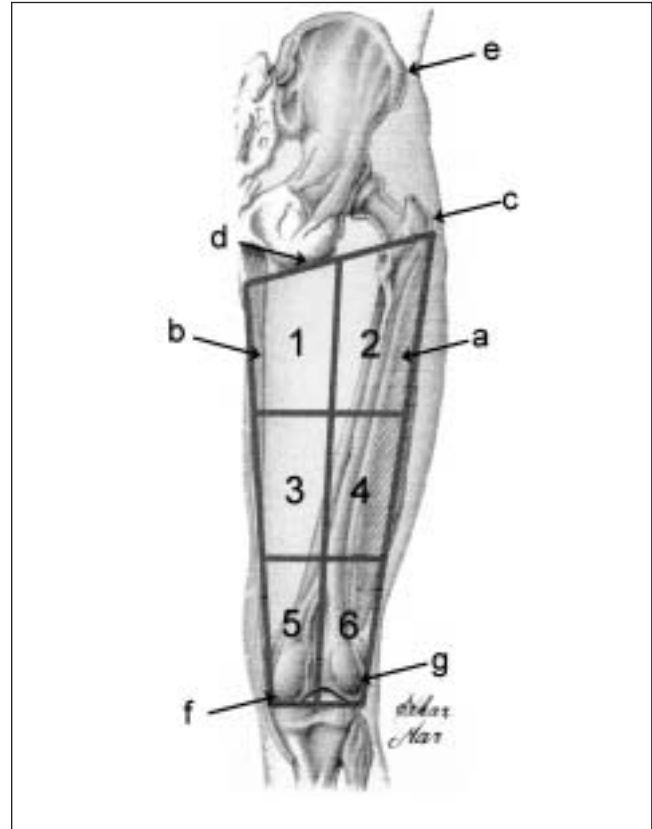


Figure 2) Schematic drawing of the thigh's posterior region. *a* lateral vast muscle; *b* gracilis muscle; *c* greater trochanter of the femur; *d* ischial tuberosity; *e* Iliospinale anterior; *f* tibia; *g* lateral condyle of the femur; 1 upper medial area; 2 upper lateral area; 3 middle medial area; 4 middle lateral area; 5 lower medial area; 6 lower lateral area

results. There were 13 bilateral cases (26 thighs), eight right thighs and six left thighs.

Data of the fasciocutaneous branch

As the thigh's length varied, so did the dimensions of the flap; therefore, the values corresponding to the distances between the lateral condyle of the femur and the origin of the fasciocutaneous branch, and the distances between the lateral condyle of the femur and its penetration of the fascia were transformed into percentages relative to the vertical length of the posterior flap.

For the bilateral cases, the Mann Whitney (11) statistical test was used to compare values for right and left thighs from the white and nonwhite cadavers and did not show any significant difference for all measurements taken.

In the bilateral cases, the Student's *t* test (11) was also used to compare measurements from the right and left thighs of the white and nonwhite cadavers for the external diameter of the fasciocutaneous branch at the origin, at the penetration into the fascia, and the distance from the origin to the penetration into the fascia. There was no significant difference for all measurements taken.

Data of the fasciocutaneous flap

In the 40 dissected thighs, the thigh's length varied between a minimum of 47.0 cm and a maximum of 57.0 cm, with an average of 51.17 cm. The horizontal upper width of the flap varied between a minimum of 13.0 cm and a maximum of 21.0 cm,

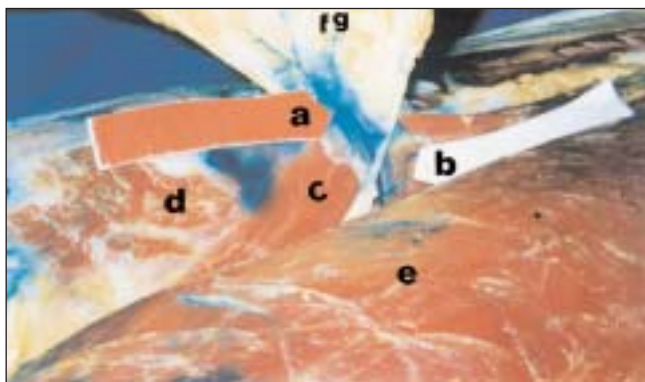


Figure 3) View of the fasciocutaneous branch and its anatomical relationships. **a** fasciocutaneous branches (artery and vein); **b** posterior cutaneous femoral nerve; **c** adductor magnus muscle; **d** long head of the femoral biceps muscle; **e** lateral vast muscle; **f** bifurcation of ascending trajectory of the fasciocutaneous branch; **g** bifurcation of descending trajectory of the fasciocutaneous branch

with an average of 16.22 cm. The horizontal lower width of the flap varied between a minimum of 12.0 cm and a maximum of 17.0 cm, with an average of 14.15 cm. The vertical length of the flap varied between a minimum of 30.0 cm and a maximum of 42.50 cm, with an average of 35.72 cm.

The Student's *t* test (11) was used to compare measurements in the bilateral cases for the right and left thighs of the white and nonwhite cadavers and did not show any significant differences between the measurements taken.

For the bilateral cases the dyed and not dyed surface areas of the posterior flap (right and left thighs) of the white and non-white cadavers were compared by using Fisher's exact test (11). There were no significant differences in the regions studied.

DISCUSSION

In their anatomy treatises, the authors did not use any specific nomenclature for the fasciocutaneous branches of the perforator arteries of the deep femoral artery (12-19). Manchot (20), however, published specific anatomical research about cutaneous irrigation. The research identifies the perforator cutaneous arteries and the origin of each one of them, dividing into 40 corresponding cutaneous territories.

Salmon (21) affirmed that the deep femoral artery is responsible for almost the entire cutaneous irrigation of the thigh's posterior region, except for small areas irrigated by the femoral, popliteal and ischiatic arteries. He distinguished three categories of cutaneous arteries responsible for the irrigation of the thigh's posterior region: the external, internal and middle cutaneous arteries.

Other authors (19,22) stated that the name 'perforator' is given to the arteries that originate in the deep femoral artery and perforate the thigh at the insertion of the tendon of the adductor magnus muscle along the rough line of the femur.

After anatomical study of the arteries of the thigh's posterior region, Rubin, Whetzel and Stevenson (10) divided the branches of the perforator arteries of the deep femoral artery into three types: muscular, anastomotics and fasciocutaneous. We agree with these authors. In our observation, the branch that arises in the third perforator artery, heads for the fascia of the thigh's posterior region and penetrates it there should be called the 'fasciocutaneous branch of the third perforator



Figure 4) General view of the thigh's posterior region. **a** flap; **b** dyed area; **c** gluteus region

artery' because of its origin in this artery and for its direct trajectory to the fascia.

Cormack and Lamberty (2) observed that the thigh's posterior region is nourished both by fasciocutaneous and musculocutaneous arteries that arise from the deep femoral artery. The authors demonstrated, through radiographical studies, that the fasciocutaneous arteries form one arterial plexus.

Laitung (9), based on dissections of lower limbs of human cadavers, concluded that the principal cutaneous vessels of the thigh's posterior region emerge from the intermuscular lateral septum between the lateral vast muscle and the femoral biceps muscle.

In the cases analyzed, the third perforator artery travelled from the previous area to the thigh's posterior region, perforating the adductor magnus muscle proximal to its hiatus tendineus, and at this level emitted a fasciocutaneous branch after supplying branches to the femoral biceps muscle head. This fasciocutaneous branch, after penetrating the posterior region of the thigh and before reaching the fascia, crossed the posterior cutaneous femoral nerve. Then, after penetrating the fascia, it became forked into a branch of ascending trajectory and another one of descending trajectory.

Esser (23) and Gillies (24) were the first to suggest the inclusion of the fascia in the cutaneous flaps for the purpose of improving the blood nourishment to those flaps.

After the paper published by Pontén (1) in 1981, the use of fasciocutaneous flaps became much more safe.

According to Baek (25), the third perforator artery can be used as an axial artery from a fasciocutaneous microsurgical flap of the thigh's lateral region.

According to Song et al (26), the thigh's posterior region can be used safely from an uppermost limit of the gluteal line to a lower limit of the popliteal depression. The lateral and medial limits are the posterior margin of the lateral vast muscle and that of the gracil muscle, respectively.

Taylor and Palmer (7) verified the presence of two angiosomes in the thigh's posterior region: the inferior gluteal and the deep femoral. They also affirmed that a flap based on the vessels of an angiosome can usually safely capture the tissues of the adjacent angiosome. This, presumably, is due to the pressure gradient that can occur when the blood flows, crossing the small vessels that unite adjacent arterial territories.

The thigh's posterior region can be used in the reconstruction of the knee and popliteal area through the elaboration of fasciocutaneous island flaps supplied by direct cutaneous

branches of the popliteal artery, as demonstrated by Maruyama and Iwahira (27).

Calil (28) performed an anatomical study of the fasciocutaneous branches of the inferior gluteal artery and of the first and second perforators through the dissection of 40 thighs of fresh cadavers within 12 h of death. That study sought to aid in the elaboration of a flap for the reconstruction of substantial loss in the gluteal and perineal areas.

According to Shimizu et al (29), one microsurgical flap can be made in the thigh's posterior region, nourished by cutaneous perforator vessels (branches of the deep femoral artery) that reach the fascia lata and then emerge between the long head of the femoral biceps muscle and the semimembranosus muscle.

According to the anatomy treatises (12-19) and the studies of the authors (2,6,7,8,10,22,26,29), the arterial plexus formed by fasciocutaneous branches of the perforator arteries of the deep femoral artery and its anastomoses (uppermost to the gluteal inferior artery and lowermost to the popliteal artery) are responsible for the fasciocutaneous irrigation of all of the posterior region of the thigh. Thus, there could be a fasciocutaneous flap of the posterior region of the thigh supplied by a principal fasciocutaneous branch of any plexus forming artery.

Our research cannot affirm the safety of using the fasciocutaneous branch of the third perforator artery, being part of the fasciocutaneous arterial net of the thigh's posterior region, for the irrigation of all of the skin of this area, because only the superior lateral and mid lateral areas of the fasciocutaneous flap were dyed in all of the 40 thighs of the 27 cadavers we dissected.

Studies by Cormack and Lamberty (2) indicate that there is a fascial plexus that is very important in the anterior medial region of the thigh, of little importance in the anterior lateral region of the thigh and of intermediate importance in the posterior region of the thigh. However, the studies of Taylor and Palmer (7) proved that in the thigh, the dominant blood vessels go to the skin after they penetrate the fascia and then travel adjacent to the deep face of fascia, not inside its structure. Therefore, future studies of the thigh's fascial irrigation would contribute greatly to reparative plastic surgery.

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CONCLUSION

From this study it can be concluded that:

- The area irrigated by the fasciocutaneous branch of the third perforator artery can safely provide a fasciocutaneous flap that covers the superior lateral and middle lateral areas of the thigh's posterior region.
- One cannot affirm that the accomplishment of a fasciocutaneous flap of the whole posterior region of the thigh, based separately in the fasciocutaneous branch of the third perforator artery, will occur with safety.
- The fasciocutaneous branch of the third perforator artery was present in the 40 dissected thighs.
- The average external diameter of the fasciocutaneous branch at its origin was 1.07 mm.
- The average external diameter of the fasciocutaneous branch at its penetration of the fascia was 0.83 mm.
- The average length of the fasciocutaneous branch, corresponding to the average distance between its origin and its penetration in the fascia, was 4.80 cm.
- The average percentile distance between the fasciocutaneous branch at the level of its origin and the lateral condyle of the femur, in relation to the vertical length of the thigh's posterior flap, was 44.45%.
- The average percentile distance between the fasciocutaneous branch at the level of its penetration into the fascia and the lateral condyle of the femur, in relation to the vertical length of the thigh's posterior flap, was 41.51%.
- The fasciocutaneous branch emerged from the thigh's posterior region after crossing the adductor magnus muscle in the 40 dissected thighs.
- The fasciocutaneous branch, after penetrating the thigh's posterior fascia, emitted a branch of ascending trajectory, and another of descending trajectory, in all 40 dissected thighs.

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