First Cutaneous Branch of the Internal Pudendal Artery: An Anatomical Basis for the So-called Gluteal Fold Flap

By

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Summary: We investigated the cutaneous blood supply in the gluteal and perineal regions of 35 donated cadavers to provide an anatomical basis for reliable vulvo-vaginal reconstruction using a skin flap such as the so-called gluteal fold flap. The cutaneous areas along the gluteal cleft and sulcus were likely to be supplied by 3 routes: 1) the internal pudendal artery (IPA), especially its first cutaneous branch; 2) perforators running through the gluteus maximus muscle and arising from the inferior gluteal artery (IGA); and 3) a non-perforator running around and inferior to the ischial tuberosity and originating from the IGA. Route 1 supplied the skin along the gluteal cleft, route 2 the gluteal fold (i.e., a bulky skin fold along the upper edge of the gluteal sulcus), and route 3, just along the gluteal sulcus. In those 3 routes, we noted the consistent morphology of the thick and long, first cutaneous branch of the IPA.

The first arterial branch, 1.5 mm in diameter at its origin on average (ranging from 0.7-2.6 mm), usually originated from the IPA under the cover of or at the inferomedial or distal side of the sacrotuberous ligament (almost always less than 20 mm from the inferomedial margin of the ligament). The branch ran superomedially toward the coccyx or ran medially in the ischiorectal fat. It accompanied the vein and nerve at its distal (peripheral) course although the nerve often ran independently at its proximal course near the ligament. Therefore, the first branch of the IPA seems to provide a reliable pedicle using the skin along the gluteal cleft whether the incision for approach is conducted along the gluteal sulcus or not. However, if the gluteus maximus muscle extended much inferomedially, the pedicle would be very short. In this case, preparation of the pedicle seems to be necessary along the arterial course under the cover of the muscle.

Several arterial systems, whose origins and courses are quite different, are responsible for the cutaneous blood supply in the gluteal and perineal regions (Cormack and Lamberty, 1994). Recently, new trend of vulvo-vaginal and/or perineal reconstructions using a fasciocutaneous or skin flap has been established based on a cutaneous branch of the internal pudendal artery (IPA) under the cover of or at the inferomedial or distal side of the sacrotuberous ligament (almost always less than 20 mm from the inferomedial margin of the ligament). The branch ran superomedially toward the coccyx or ran medially in the ischiorectal fat. It accompanied the vein and nerve at its distal (peripheral) course although the nerve often ran independently at its proximal course near the ligament. Therefore, the first branch of the IPA seems to provide a reliable pedicle using the skin along the gluteal cleft whether the incision for approach is conducted along the gluteal sulcus or not. However, if the gluteus maximus muscle extended much inferomedially, the pedicle would be very short. In this case, preparation of the pedicle seems to be necessary along the arterial course under the cover of the muscle.
though both mother arteries are the IPA origin. Even in famous textbooks of anatomy (Toldt, 1903; Williams, 1995), the inferior rectal artery is described as the mother artery. However, it appears strange, for the visceral artery (i.e., the rectal artery) supplies other, parietal structures such as the gluteal skin (not around the anus) and the gluteal maximus muscle. In the present study, we simply regarded the IPA as the mother artery of the cutaneous branch. Consequently, we use terms such as the cutaneous branch of the IPA and/or the first, second (and so on) branch of the IPA.

Materials and Methods

We dissected the gluteal and perineal regions using the naked eye to investigate the morphology of the cutaneous vessels, especially those originating or draining in the ischirectal fossa, in 68 sides (left, 34; right, 34) of 35 formalin-fixed cadavers (20 males and 15 females; age range 51–97 years; mean age 77.9 years). They had been donated to Tokushima University School of Medicine (23 cadavers) or Sapporo Medical University (12 cadavers) for medical education and research. These 23 cadavers in Tokushima University had been used for the students’ dissection practice and, thus, the gluteus maximus muscle as well as the skin in the region had been removed or reflected by students before the present investigation. However, even in the 23 cadavers, the skin along the gluteal cleft and ischiorectal fat, which includes the IPA and its cutaneous branches, had been preserved. The ischiorectal fossa was dissected to reach the levator ani muscle. In the other 12 cadavers in Sapporo, we observed perforators and non-perforators of the inferior gluteal artery in the gluteal region as well as branches of the IPA in the ischirectal fossa. In these, during the gradual removal of the gluteus maximus muscle, the perforator and non-perforator were dissected. The posterior femoral cutaneous nerve, which gives off the perineal branches running along the gluteal sulcus, was also preserved in the 12 cadavers.

We depicted cutaneous arterial branches more than 0.5 mm in diameter at their origins and their concomitant veins and nerves. Measurements of the origin of the cutaneous branch of the IPA were also conducted. The site of the origin was estimated as follows: 1) the distance along the IPA from the inferomedial margin of the sacrotuberous ligament (i.e., negative distance when superolateral or under the cover of the ligament); 2) distances from the most dorsal points on the bony surfaces of the ischial tuberosity and coccyx.

Results

General Observations

The cutaneous areas along the gluteal cleft and sulcus were supplied by 3 routes (Fig. 1): 1) the internal pudendal artery (IPA), especially its first cutaneous branch; 2) perforators running through the gluteus maximus muscle and arising from the inferior gluteal artery; and 3) a non-perforator running around and inferior to the ischial tuberosity and originating from the inferior gluteal artery. Route 1 supplied the skin along the gluteal cleft, and route 2 the gluteal fold (i.e., a bulky skin fold along the upper edge of the gluteal sulcus), while the territory of route 3, in association with the perineal branches of the posterior femoral cutaneous nerve, almost corresponded to the gluteal sulcus. Route 1 contained a direct cutaneous supply, whereas routes 2 and 3 tended to run along the fascia covering the superficial (route 2) or deep (route 3) side of the gluteus maximus muscle. The fascia covering the deep side of the gluteus maximus thickened much, and was often even ligamentous, along the inferomedial margin of the muscle. There was another, subcutaneous fascia, maybe the so-called Colles’ fascia, along route 3.

Route 3 was unstable and often thin or composed of only veins, although the vein(s) was usually very thick (2–3 mm in diameter at almost the midpoint of the gluteal sulcus). The vein(s) drained into the inferior gluteal vein. Route 3, at its proximal course, sometimes received and joined the peripheral portion of the medial circumflexus femoris artery on the upper margin of the quadratus femoris muscle. Since the inferomedial edge of the gluteus maximus muscle did not run along the gluteal sulcus but crossed it, route 3 was, largely or partly, covered by the muscle. Moreover, the gluteus maximus sometimes extended inferomedially far beyond the inferomedial margin of the sacrotuberous ligament (Fig. 2C).

In contrast, routes 1 and 2 were consistently found. However, route 2 (i.e., perforators) varied in its thickness and course: often penetrating the sacrotuberous ligament with or without accompaniment of “the perforating nerve of the ligament” (Nakanishi 1967; Inagaki, 1983). Moreover, numerous thin perforators (less than 0.5 mm in diameter) were also observed all over the muscle, especially near the insertions onto the sacrum, coccyx and sacrotuberous ligament. The morphology of the perforator was similar to that of the superior gluteal artery as reported by Kida et al. (1992). The concomitant vein was usually found along route 2.

Route 1 consisted of cutaneous branches of the IPA. We consistently found a thick and long first
branch of the IPA (68/68 sides). It ran medially and/or caudally (to the coccyx) through the ischiorectal fat and supplied the skin near the gluteal cleft (Figs. 1 and 2). The first branch often issued 1 or 2 thin recurrent and/or lateral branches to the gluteus maximus muscle. Although the first branch looked like "the inferior rectal artery" drawn in figures of textbooks (see Introduction), usually, the branch did not reach the rectum but finished as fine terminal twigs supplying the levator ani muscle. On the other hand, we also dissected the second branch in 61 of the 68 sides (average diameter, 1.2 mm at its origin). In 7 sides, the branch might have originated far from the first one, i.e., over 50 mm inferomedial (distal) from the first, or it might have been too thin to be depicted. Moreover, the thickness of the second branch varied much more than that of the first branch (Table 1). Consequently, we noted the consistent morphology of the first cutaneous branch of the IPA.

Although morphological laterality in the first and second branches of the IPA was sometimes observed, it was not always evident (laterality in thickness and location of the origins: see the legend of Fig. 3 and footnote of Table 1). We also found no laterality in the number and thickness of the perforator through the gluteus maximus muscle, but the non-perforating branch of the inferior gluteal artery often appeared unilaterally.

First Cutaneous Branch of the IPA

The thickness of the first (cutaneous) branch was almost always more than 1.0 mm at its origin: 1.5 mm on average and ranged from 0.7–2.6 mm (Table 1). The cutaneous territory was consistently much larger than and located dorsal (caudal) to that of the second branch. However, since the first branch originated at the proximal (or superolateral) side of or under the cover of the sacrotuberous ligament in more than half of the specimens (37/68, Fig. 3), we often found it as a thinner artery in the ischiorectal fat than at its origin. In the other half of the specimens (31/38, Fig. 3), the first branch originated at the inferomedial side of the sacrotuberous ligament. In these cases, the origin was almost always located at a point 15–35 mm deep and superomedial from the ischial tuberosity (Table 2). However, if the origin was estimated as the distance from the coccyx, the range of measured data fluctuated significantly in specimens, i.e., from 20 mm to 65 mm. However, this distance almost corresponded to the shortest length of the first cutaneous arterial courses of the IPA in the specimens, i.e., from its origin to the skin, since the cutaneous branch toward the coccyx was usually the shortest. Along the ischiopubic ramus, the IPA and its concomitant vein were fixed strongly by a ligamentous structure covering the Alcock's canal (the pudendal canal: see Williams, 1995). However, the pudendal nerve was liable to be separated

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<th>Table 1. Thicknesses of the first and second cutaneous branches of the IPA at their origins</th>
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<td>Thickness (mm)</td>
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<td>First cutaneous branch*</td>
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<td>Second cutaneous branch**</td>
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* Total of 68 first branches in 68 sides; ** Total of 61 second branches in 61 sides. Averages, 1.5 mm in the first branch and 1.2 mm in the second branch. Maximums, 2.6 mm in the first branch and 2.5 mm in the second branch. The difference in thickness between the right and left sides ranged from 0 to 1.0 mm (average, 0.55 mm) for the first branch and from 0 to 1.0 mm (average, 0.30 mm) for the second branch.

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<th>Table 2. Distance from the ischial tuberosity or coccyx to the origin of the first cutaneous branch of the IPA when the branch origin was distal or inferomedial to the sacrotuberous ligament</th>
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<tr>
<td>Distance (mm)</td>
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<td>From the ischial tuberosity*</td>
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<td>From the coccyx*</td>
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In 31 first cutaneous branches (sides) originating at the distal or medial side of the ligament, when the other branch originated just at the level of the distal or inferomedial margin of the sacrotuberous ligament (5 sides), the paired distances were measured as follows: 20 (mm from the ischial tuberosity) and 20 (from the coccyx), 15 and 45, 10 and 35, 20 and 50, 15 and 40.

* Distances from the most dorsal points of the ischial tuberosity and coccyx at their bone surfaces.
easily from the vessels although the nerve was also enclosed in the canal.

The first arterial branch consistently accompanied the vein and nerve at its distal (peripheral) course. Notably, however, the nerve often ran independently at its proximal course near the ligament (Figs. 2B and 2C). The gluteus maximus muscle sometimes extended so far inferomedially that the proximal majority of the arterial courses was not observed without removal of the muscle (Fig. 2C). Peripheral anastomosis between the first branch and other branches, such as perforators from the inferior gluteal artery, was not found in the present study if it was limited to more than 0.5 mm in diameter.

Discussion

The first, perhaps thickest and longest, branch of the IPA, encountered the large cutaneous territory along the gluteal cleft. The first branch seems to be consistent with the “perineal superficial transverse artery” in Giraldo et al. (1997) although their observations were concentrated on the anterior perineal region. In contrast to the usual anatomical figures (Toldt, 1903; Williams, 1995), the present results supported the idea that the first branch should be regarded not as “the rectal artery” but as the proper cutaneous and muscular branch. Therefore, surgeons need not pay attention to preserve the classical “rectal blood supply” during the use of the first (perhaps also the second) branch of the IPA. In previous investigations, the terms, “lateral and medial branches of the IPA”, have often been used for descriptions of the IPA (Yii and Niranjan, 1996; Moschella and Cordova, 2000). We speculated that this classification, i.e., the medial and lateral branches, is based on not only the territory but also a general concept for description of the pelvic vessels, i.e., visceral vessels including those supplying the rectum and parietal vessels including muscular branches to the gluteus maximus. However, in the present results, the lateral, muscular branch was very thin (not shown in figures), while the medial branch also supplied a muscle (i.e., the levator ani) as well as the ischiorectal fat and the skin of the region.

Since the origin of the first arterial branch was often superolateral to the sacrotuberous ligament and since the fascia inside of the gluteus maximus muscle is hard and ligamentous just along the superolateral margin of the ligament, surgeons, even if they are orthopedic surgeons, can not approach the actual arterial origin. However, the branch appeared in a limited area in the inferomedial side of the ligament: 15–35 mm deep and superomedial to the ischial tuberosity. The coccyx seemed not to be a good landmark for the estimation of the point since the distance varied significantly. Thus, according to the 15–35 mm depth, it is better to approach this point along the ligament or to approach the origin itself along the cutaneous branch. However, if the gluteus maximus muscle is greatly extended to the inferomedial side, the pedicle would be limited to a very short one. In this case, preparation of a long pedicle seems to be necessary under the cover of the muscle as well as in the ischiorectal fat.

Explanation of Figures

Plate I

Fig. 1. Cutaneous blood supply to the gluteal and perineal regions.

A. The main figure is an anatomical representation of the dorsolateral view in the left side, whereas the insert at the upper left demonstrates, using the same specimen, the orientation of the major figure if observed in the usual position of the patient for vaginal operation. In the insert, the wide arrow indicates the dissected area shown in the major figure. The gluteal cleft (GC) was extended and made deep by long preservation of the cadaver in the supine position. GM, gluteus maximus muscle; GS, gluteal sulcus; IT, ischial tuberosity. In the major figure, the GM was reflected or partly removed to show the sacrotuberous ligament (STL). The ischiorectal fossa was dissected to reach the levator ani muscle (LA). The internal pudendal artery (IPA with a long arrow) issues the first cutaneous branch (small white arrows) at the level of the inferomedial margin of the STL. Two cutaneous perforator branches (open stars, supported by pins) of the inferior gluteal artery (IGA) are exposed near the IT after removal of the GM. Note another cutaneous branch (black star) of the IGA, running immediately inferior to the IT and supplying the area along the gluteal sulcus (GS). The posterior femoral cutaneous nerve (PFCN) gives off perineal branches (PB) to the GS area. The sciatic nerve (SN) was cut and removed at its proximal portion for other research.

B. Schematic representation of the cutaneous blood supply to the gluteal and perineal regions. The internal pudendal artery (IPA) shows a characteristic course running between the sacrotuberous (see Fig. 1A) and sacrospinous ligaments to come into the ischiorectal fossa. The cutaneous areas along the gluteal cleft and sulcus (see Fig. 1A) can be supplied by 3 routes: 1) the IPA, especially its first cutaneous branch; 2) perforators of the inferior gluteal artery (IGA); and 3) a non-perforator caudal to the ischial tuberosity and originating from the IGA and/or the peripheral portion of the medial circumflexus femoris artery (asterisk).
The post-surgical functional loss of the gluteus maximus muscle seems to be slight since the muscle bundle is loose and tortuous at the inferomedial portion. However, because of the rich venous distribution along the inferomedial margin of the gluteus maximus muscle, a deep approach along the cutaneous branch may lead to a severe bleeding.

As for the perforators and/or non-perforators from the inferior gluteal artery, if found showing an adequate thickness during the surgical procedure, there seems to be no reason to eliminate these branches for the pedicle. In particular, under the approach from the gluteal sulcus such as the gluteal fold flap (Hashimoto et al., 1999), not only those branches of the inferior gluteal artery but also the second (not first) cutaneous branch of the IPA should be found before making sure of the thicker first branch. We consider that the flap base should be located in the triangle formed by the ischial tuberosity, anus and vaginal orifice. Therefore, in
the cutaneous branches of the IPA, the second one is most likely to be found. Consequently, selection of the cutaneous artery depends on individuality in anatomy as well as on technical demands.

Nevertheless, overall, the first branch of the IPA would seem to provide a reliable pedicle using the skin along the gluteal cleft regardless of whether the incision for approach is conducted along the gluteal sulcus. This arterial branch seems not to be a fasciculocutaneous artery but a direct cutaneous feeder. We believe that a flap using the cutaneous branch of the IPA is not a fasciculocutaneous flap, in contrast to the previous concept (Yii and Niranjan, 1996).

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References


Plate II

Fig. 2. Anatomical representations of the right ischiorectal fossa.

Dorsolateral views. A and B show the same specimen, while C shows another. The gluteus maximus muscle (GM) was largely removed.

A. The cutaneous branches of the internal pudendal artery are observed running caudally. The first branch (IPA) is the thickest.

B. The sacrotuberous ligament (STL) was reflected upward. The first cutaneous branch originates under the cover of the ligament (white arrow, −10 mm case: see Fig. 3). Each cutaneous artery accompanies the concomitant vein and nerve along its peripheral course. The pudendal nerve (PN) is retracted and fixed by a pin. Note that the concomitant nerve (arrowheads) joins the first arterial branch at a point almost 10 mm peripheral from the origin (white arrow).

C. The inferomedial portion of the GM remains to show how much the muscle covered the ischiorectal fossa. The concomitant nerve (arrowheads) joins the first arterial branch (IPA) at its midcourse. A perforator of the inferior gluteal origin (small arrows) was dissected and cut on the STL. IT, ischial tuberosity; PFCN, posterior femoral cutaneous nerve.
Fig. 3. Distributions of origins of the first and second cutaneous branches along the internal pudendal artery.

A. Origins (1 star, 1 branch) of the 68 first cutaneous branches of the internal pudendal artery (IPA) were frequently restricted near the sacrotuberous ligament (STL). Stars drawn in the STL indicate that the origin is covered by the ligament (invisible from the dorsal view without removal of the ligament). The distance from the inferomedial margin of the ligament along the IPA ranged from −30 mm (i.e., laterosuperior to the ligament) to 40 mm (average, 1.5 mm, i.e., almost at the inferomedial margin of the ligament). In 26 of 68 sides (i.e., 26 of 68 branches), the origin was located under the cover of the ligament. Although, in 31 of the 68, the origin was inferomedial to the margin of the ligament, the distance from the inferomedial margin of the ligament along the IPA was restricted to within 19 mm in 20 of the 31 (cf: 20–29 mm, 9 sides or 9 branches; 30–40 mm, 4). The difference in locations of the origins between the right and left sides ranged, if represented by the length along the mother artery from the inferomedial margin of the ligament, from 0 to 50 mm (average 15.6 mm). In addition, the most dorsal points on the ischial tuberosity and coccyx were usually located at the points indicated by asterisks.

B. Origins of the 61 second cutaneous branches were almost always located inferomedial (or distal) to the margin of the STL. The distance from the margin of the ligament along the IPA ranged from −10 mm to 60 mm (average, 26.1 mm). The difference in locations of the origins between the right and left sides ranged, if represented by the length along the mother artery from the inferomedial margin of the ligament, from 0 to 45 mm (average 13.7 mm).