

# Morphology of Quadriceps Femoris Muscle, a Cadaveric Study with Emphasis on its Neurovascular Pedicles

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## ABSTRACT

**Introduction:** The components of quadriceps femoris muscle are used as musculocutaneous flap and pedicled flap to fill the large defects created by the pressure sores, which communicate with the hip joint. In this context, the objective was to measure the lengths of the quadriceps femoris muscle components, which include rectus femoris and three vasti muscles.

**Material and Methods:** formalin fixed 30 cadavers of lower limb specimens were meticulously dissected to find the neurovascular pedicles of all the components of quadriceps femoris muscles. Among them 22 were male and 8 were female. Distance at which neurovascular pedicles enter the individual muscles since the prominent bony benchmarks namely pubic symphysis, anterior superior iliac spine and adductor tubercle. The parameters were studied using the measuring tape and digital vernier caliper.

**Results:** the present study observed that the mean length of rectus femoris muscle was  $42.9 \pm 3.38$ cm, vastus medialis was  $36.68 \pm 2.09$  cm, vastus intermedius was  $39.42 \pm 2.01$  cm, and vastus lateralis was  $41.1 \pm 2.63$  cm. The study observed that there wasn't much significant difference of muscle length between the male and female ( $p > 0.05$ ).

**Conclusion:** the present study provided important data of the components of quadriceps femoris muscle. These muscles are used for the pedicle flap in reconstructive surgeries like perforator flap to treat the defects around the knee and complicated pressure sores.

**Keywords:** Rectus femoris; Vastus medialis; Vastus intermedius; Vastus lateralis.

## Introduction

Quadriceps femoris muscle is a large muscle occupying most of front of the thigh. It is an extensor of the knee joint and composed of 4 components namely rectus femoris, vastus medialis, vastus intermedius and vastus lateralis. The combined tendon of all the four parts is attached to the base of patella and continues further to be inserted into the tibial tuberosity<sup>1</sup>. These muscles are used as musculocutaneous flap and pedicled flap to fill the large defects created by pressure sores communicating with the hip joint. Extensive soft tissue wounds around the knee joint are difficult to repair. Myocutaneous flaps from vastus lateralis and vastus medialis are used to reconstruct these defects<sup>2-5</sup>. Vastus lateralis and medialis can be used as flaps in anterior knee defects where there is loss of tendon of quadriceps, patella and ligamentum patellae compromising knee extension<sup>6</sup>. Rectus femoris muscle is often used as a pedicled flap in facial reconstructive surgery<sup>7</sup>. The rectus femoris, vastus intermedius and vastus lateralis muscles can be elevated as a single unit as a musculocutaneous flap to fill the large defects created by the pressure sores, which can communicate with the hip joint<sup>8</sup>.

All the muscle heads forming the quadriceps femoris are used as free or pedicle flaps individually or as a combination of one or two muscle heads. Identifying the main vascular supply to the flaps is most important

to ensure its viability. Identifying the point of entry of the nerve is necessary when it has to be connected to the nerves at the donor site as in facial reconstructive surgeries. The arterial supply to the quadriceps femoris is from either the deep femoral artery or from the lateral circumflex femoral artery. The 'artery of quadriceps' is the term given to the branch from the lateral circumflex femoral artery<sup>1</sup>. The descending branch of lateral circumflex femoral artery, usually supplies the superior part of the vastus lateralis and its inferior part is supplied by the profunda femoris artery. The branch from the femoral nerve supplied the muscle<sup>2,9</sup>. The vastus medialis receives direct branches from the femoral artery topographically either at the femoral triangle or Hunter's canal<sup>1,10</sup>. Rectus femoris is supplied by 2 or 3 pedicles either from the deep femoral artery or the lateral circumflex femoral artery at various distances from the bony landmarks like the anterior superior iliac spine. Nerve twig to the rectus femoris from the femoral nerve enters upper one third of the muscle from the posteromedial aspect<sup>7,11</sup>. The objective of this research was to measure the lengths of the quadriceps femoris muscle components, which include the three vasti and rectus femoris.

## Material and Methods

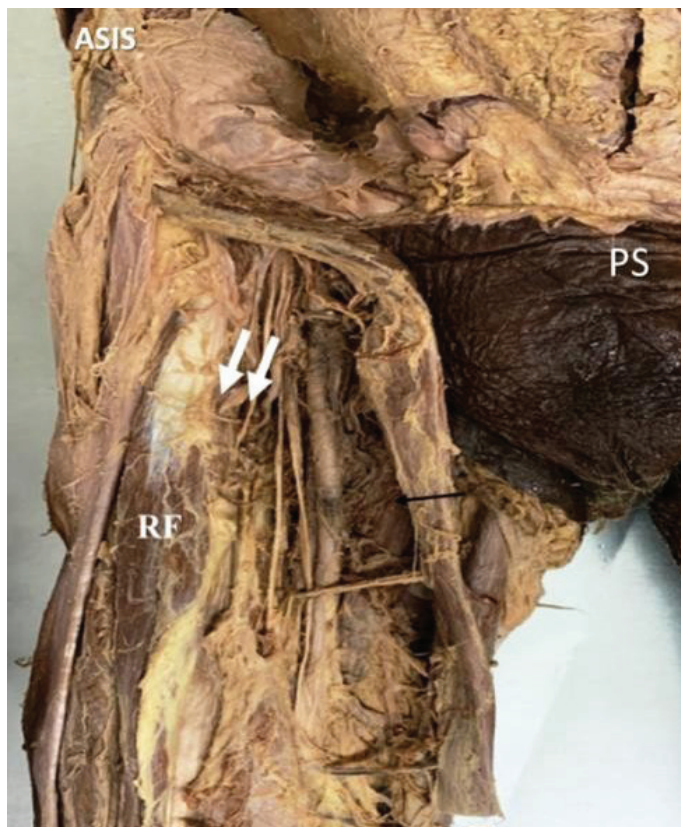
This present study was conducted on 30 cadaveric formalin fixed lower limb specimens. These were

meticulously dissected to find the neurovascular pedicles of all the components of quadriceps femoris muscle. Main artery and the nerve supplying these pedicles was identified. Distance at which neurovascular pedicles enter the individual muscles from the ASIS, pubic tubercle and the adductor tubercle was noted. The following parameters were studied using measuring tape and digital Vernier Caliper.

1. Length of quadriceps femoris muscle components from origin to its insertion point:
  - 1A. Length of rectus femoris.
  - 1B. Length of vastus medialis.
  - 1C. Length of vastus intermedius.
  - 1D. Length of vastus lateralis.
2. Distance between pedicle entry and prominent skeletal benchmarks namely anterior superior iliac spine (ASIS), pubic symphysis (PS) and adductor tubercle (AT).
3. Diameter of the neurovascular pedicles.

**Results**

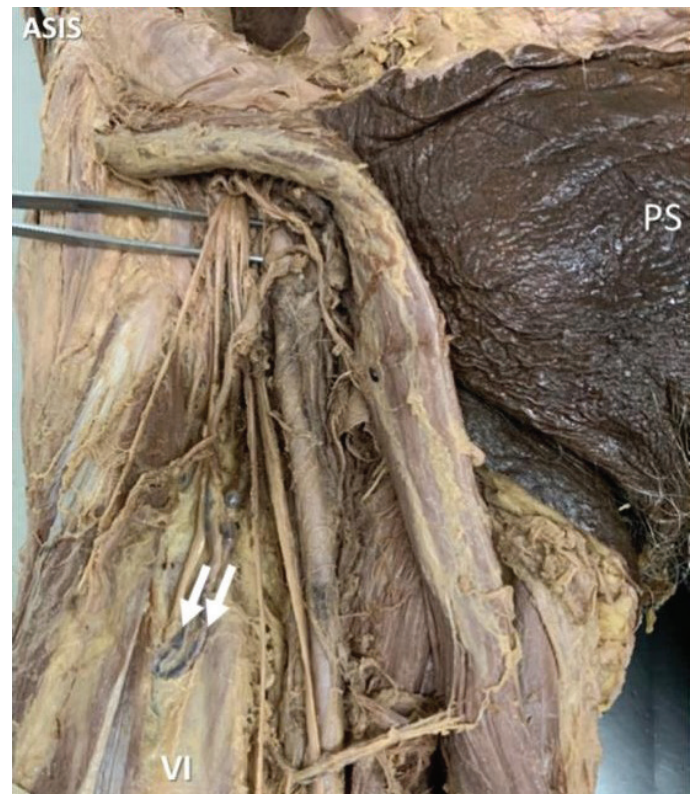
The present study observed all the four components of quadriceps femoris muscle in the specimens examined (100%). There were no anatomical variations observed with respect to the origin, insertion and nerve supply. The neurovascular pedicles entering the four individual muscles of the quadriceps femoris are represented in figures 1 to 4.



**Figure 1.** The cadaveric image showing the neurovascular pedicles (↯↯) supplying the RF muscle (ASIS- anterior superior iliac spine; PS- pubic symphysis; RF- rectus femoris).



**Figure 2.** The cadaveric image showing the neurovascular pedicles (↯↯) supplying the VM muscle (ASIS- anterior superior iliac spine; PS- pubic symphysis; VM- vastus medialis).



**Figure 3.** The cadaveric image showing the neurovascular pedicles (↯↯) supplying the VI muscle (ASIS- anterior superior iliac spine; PS- pubic symphysis; VI- vastus intermedius).



**Figure 4.** The cadaveric image showing the neurovascular pedicles (↓↓) supplying the VL muscle (ASIS- anterior superior iliac spine; PS- pubic symphysis; VL- vastus lateralis).

Table 1 shows the mean length of the different parts of quadriceps femoris muscle. The length of rectus femoris was  $64.14 \pm 6.36$  cm in male and  $6.46 \pm 4.34$  cm in female, and the mean length of vastus medialis was  $54.25 \pm 2.56$  cm in male and  $54.81 \pm 3.08$  cm in female. Whereas, mean length of vastus intermedius was  $58.6 \pm 2.28$  cm in male and  $58.2 \pm 3.58$  cm in female. The mean length of vastus lateralis was  $61.6 \pm 3.77$  cm in male and  $60.3 \pm 4.76$  cm in female.

**Table 1.** Showing the lengths of individual muscles of quadriceps femoris (n=30).

Muscle component	Male	Female
Rectus femoris	$64.14 \pm 6.36$	$60.46 \pm 4.34$
Vastus medialis	$54.25 \pm 2.56$	$54.81 \pm 3.08$
Vastus intermedius	$58.6 \pm 2.28$	$58.2 \pm 3.58$
Vastus lateralis	$61.6 \pm 3.77$	$60.3 \pm 4.76$

Measurements are in cms, mean±SD.

The table 2 shows the distance between the entry of nerve branch pedicle into the parts of the quadriceps femoris muscle from the different bony landmarks. The distance between the anterior superior iliac spine (ASIS) to the nerve pedicle of rectus femoris was  $17.94 \pm 2.66$  cm, from the pubic symphysis this was  $14.04 \pm 2.511$  cm and from adductor tubercle (AT), this was  $26.27 \pm 2.98$  cm. The distance between the ASIS to the nerve pedicle of vastus medialis was  $23.11 \pm 2.76$  cm, from the PS, this was  $20.13 \pm 4.33$  cm and from the AT, this was  $22.40 \pm 6.45$  cm. The distance between

the nerve pedicle entry point from the ASIS to vastus intermedius was  $20.47 \pm 4.58$  cm, from the PS, this was  $18.01 \pm 2.95$  cm and from AT, this distance was  $21.8 \pm 2.91$  cm. The distance of the nerve from ASIS to vastus lateralis was  $19.12 \pm 3.04$  cm, from PS, this was  $18.7 \pm 2.75$  cm and from AT, this was  $22.01 \pm 2.73$  cm.

**Table 2.** Distance of entry of femoral nerve branch to the quadriceps femoris from different bony landmarks.

Muscle	From ASIS	From PS	From AT
Rectus femoris	$17.94 \pm 2.66$	$14.07 \pm 2.511$	$26.27 \pm 2.98$
Vastus medialis	$23.11 \pm 2.76$	$20.13 \pm 4.33$	$22.40 \pm 6.45$
Vastus intermedius	$20.47 \pm 4.58$	$18.01 \pm 2.95$	$21.8 \pm 2.911$
Vastus lateralis	$19.12 \pm 3.04$	$18.7 \pm 2.75$	$22.01 \pm 2.73$

Measurements are in cms, mean±SD, ASIS- anterior superior iliac spine, PS- pubic symphysis, AT- adductor tubercle.

Table 3 shows the distance of mean length of the vascular pedicles of rectus femoris muscle from ASIS, this was  $18.54 \pm 2.63$  cm, from PS, this was  $14.84 \pm 2.49$  cm and from AT, this was  $23.81 \pm 3.14$  cm. The distance of vessels of vastus medialis from ASIS was  $20.40 \pm 5.05$  cm, from PS, this was  $18.53 \pm 3.41$  cm and from AT, this was  $21.67 \pm 3.91$  cm. The distance of the vessels of vastus intermedius from ASIS was  $21.61 \pm 4.49$  cm, from PS, this was  $18.25 \pm 2.83$  cm and from AT, this was  $21.12 \pm 3.58$  cm. The distance of the vessels of vastus lateralis from ASIS was  $21.06 \pm 2.55$  cm, from PS, this was  $19.11 \pm 3.09$  cm and from AT, this was  $21.19 \pm 2.28$  cm.

**Table 3.** Distance of entry of femoral vessel branches and tributaries to the quadriceps femoris from different bony landmarks.

	From ASIS	From PS	From AT
Rectus femoris	$18.54 \pm 2.63$	$14.84 \pm 2.49$	$23.81 \pm 3.14$
Vastus medialis	$20.40 \pm 5.05$	$18.53 \pm 3.41$	$21.67 \pm 3.91$
Vastus intermedius	$21.61 \pm 4.488$	$18.25 \pm 2.83$	$21.12 \pm 3.58$
Vastus lateralis	$21.06 \pm 2.55$	$19.11 \pm 3.09$	$21.189 \pm 2.28$

Measurements are in cms, mean±SD, ASIS- anterior superior iliac spine, PS- pubic symphysis, AT- adductor tubercle.

The table 4 shows the diameter of the different components of quadriceps femoris. The mean diameter of neurovascular pedicle of rectus femoris was  $4.6 \pm 1.4$  mm, vastus medialis was  $4.3 \pm 1.2$  mm, vastus intermedius was  $4.5 \pm 1.2$  mm and vastus lateralis was  $4.4 \pm 1.1$  mm.

**Table 4.** Showing the diameters of pedicles of different components of quadriceps femoris muscle.

Muscle	Pedicle Diameter
Rectus femoris	$4.6 \pm 1.4$
Vastus medialis	$4.3 \pm 1.2$
Vastus intermedius	$4.5 \pm 1.2$
Vastus lateralis	$4.4 \pm 1.1$

Measurements are in mm, mean±SD.

## Discussion

Quadriceps femoris is one of the muscles used for reconstruction surgeries, hence knowing about the morphology and morphometric data of the muscles, along with their neurovascular pedicles will be helpful for the orthopedic, plastic, and reconstructive surgeons<sup>12</sup>. This helps to plan out for the various flap surgeries. The rectus femoris takes origin from the anterior inferior iliac spine, vastus medialis from the lower part of the intertrochanteric line, vastus intermedius from the shaft of femur and vastus lateralis from the upper part of intertrochanteric line. All the four parts combine and form a tendon, which gets inserted into the base of the patella. The quadriceps femoris is supplied by either from the deep femoral artery or the lateral circumflex femoral artery<sup>1</sup>, along with the femoral nerve and femoral vein. This present study recorded the length of each muscle from its origin to its insertion point. Tayfur *et al.*<sup>9</sup> measured the mean length of the vascular pedicles for vastus lateralis, 119.4 mm situated distal to the pubic symphysis and pedicle entering the muscle at the distance of 213.7mm from the anterior superior iliac spine respectively. Whereas, in the present study the recorded data was  $19.11 \pm 3.09$  cm from the pubic symphysis and  $21.06 \pm 2.55$  cm from the anterior superior iliac spine. In addition, distance among the mean distance of the pedicle from adductor tubercle to the vastus lateralis was  $21.19 \pm 2.28$  cm. Zheng *et al.*<sup>10</sup> measured the distance between the pedicle and adductor tubercle was  $13.1 \pm 2.6$ cm with respect to the vastus medialis. Williams *et al.*<sup>7</sup> stated that the proximal pedicle inserts 10–15cm from the anterior superior iliac spine into the rectus femoris. In the present study, the recorded data was  $18.54 \pm 2.63$

cm from the anterior superior iliac spine. The present study observed that, there wasn't much significant difference of muscle length between the male and female.

All the four muscles of quadriceps femoris are used for the pedicle flap in reconstructive surgeries, as perforator flap to treat the defects around the knee, complicated pressure sores and many more. In this context, the goal of this anatomical investigation was to find the morphology and morphometry of the quadriceps femoris muscle, their vascular pedicles in relation to 3 bony points namely, anterior superior iliac spine, pubic symphysis, and adductor tubercle along with the diameter of the pedicles particularly from Indian population. This study included 30 cadaveric formalin fixed lower limb specimens, among them 22 were male and 8 were female. The present study observed that the mean length of rectus femoris muscle was  $42.9 \pm 3.38$  cm, vastus medialis was  $36.68 \pm 2.09$  cm, vastus intermedius was  $39.42 \pm 2.01$  cm, and vastus lateralis was  $41.1 \pm 2.63$  cm.

## Conclusion

The present study provided important morphometric data of the four sub muscles of quadriceps femoris. The data have clinical implications as these muscles are used for the pedicle flap in reconstructive surgeries like perforator flap to treat the defects across the knee region.

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