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The arterial anatomy of the saphenous flap: a cadaveric study

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The saphenous flap is a fasciocutaneous flap generally used for knee and upper third of the leg coverage. Due to various descriptions of the saphenous flap, such as venous, sensory, and free flap, the origin and distributing characteristics of the saphenous artery are important for plastic surgeons. The aim of this cadaveric study was to evaluate the anatomical features of the saphenous flap. The pedicles of the saphenous flap were dissected under 4× loop magnification in thirty-two legs of 16 formalin-fixed adult cadavers. The findings of this anatomic study were as follows: Descending genicular artery originated from the femoral artery in all of the cases. The first musculoarticular branch, which arose from descending genicular, to the vastus medialis muscle existed in all dissections. The second branch was the saphenous artery which seperately originated from the descending genicular artery in all of the cases. At the level of origin the mean diameter of the saphenous artery was found to be 1.61 mm. The muscular branches to the anterior or posterior sides of the sartorious muscle existed in all of the dissections. Two vena comitantes and a saphenous nerve were accompanying the saphenous artery in all cadavers. The mean distance between the origin of the artery and interepicondylar line of tibia was 115 mm. The muscular branches of the saphenous artery to the gracilis muscle were encountered 6.66% of the cases. The cutaneous branches numbered between one and four, and arose 3.5 to 9.5 cm from the site of origin of the saphenous artery. The distal end of the saphenous artery reached approximately 122 mm distally to the knee joint in all cases. Due to variations of the arterial anatomy and limited number of anatomic studies of the saphenous flap, we studied the topography and anatomy of the saphenous artery for increasing reliability of the saphenous flap. (Folia Morphol 2012; 71, 1: 10–14)

Key words: saphenous artery, anatomy, flap, reconstruction

INTRODUCTION

The saphenous artery is an embryological remnant in humans and is dominant in other mammalian species [10]. During routine dissection some variations of the artery and the other arteries on the lower limb have been revealed by a number of authors [16, 18]. It is known that a different branching pattern may occur as a function of the development of the arteries of the lower limb. The variations are discussed on the basis of the possible embryological development of the lower limb arteries. The existence of variations of the arteries of the lower limb is only be explained

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in the literature as an abnormal development of the vascular architecture of the lower limb [16].

In humans, it arises from higher in the thigh region, from the lateral circumflex femoral artery, and lies down with the saphenous nerves as the arteria saphena magna. The distal continuation of the artery is called the saphenus ramus [6]. Acland et al. [1] gave the named of sapzhenous artery to this branch. The saphenous flap was also firstly described by Acland et al. [1] as a free neurovascular flap based on the saphenous artery in 1981. It was later given different names such as medial genicular flap, Acland's flap, or often saphenous flap. Although a pedicled, reversed pedicled, or free transfer of the flap have been described [4, 7, 15, 19], the use of saphenous flap in clinical practice is more limited than other similar fasciocutaneous flap options of the lower extremity due to variations in the vascular anatomy [6, 7, 12, 13]. It is also impotant to preserve the distal end of the artery because of the neighbourhood with the knee joint during operation. Thhis is because the flap supplying from the saphenous artery should be preserved carefully while dissecting, elevating, and transferring to avoid major complications.

Some authors have used the saphenous flap model to research the effect of some drugs on skin flap viability or microvascular anastomoses in experimental animal models [8, 14]. In the literature there is a limited amount of anatomical knowledge about saphenous artery-based flaps [2, 6, 7, 11, 12]. A good understanding of arterial anatomy and its variations are important in order to raise the saphenous flap safely. Although the saphenous fasciocutaneous flap is a well known flap, easy to erase, and safe respecting the traditional measures and length/ /width ratio, and a lot of papers are available in the literature with some significant anatomical details, this anatomical study adds different and impressive new data that may support the surgical procedure.

Owing to these data, the flaps can be removed safely by the supplementary saphenous artery or its branches, which might increase postoperative survival. We thought that great care should be taken during operation to transfer the artery and the branches completely. For these reasons we investigated the anatomical features of the saphenous artery and its branches in the present cadaveric study.

MATERIAL AND METHODS

Cadaveric design

Bilateral saphenous flap dissections of 32 legs from 16 formalin-fixed cadavers (14 male, 2 female; age range 50 to 82 years) were performed under 4× loupe magnification. Latex injection via external iliac artery was performed to reveal the arteries of the lower extremity easily. The measurements were made with the aid of a fine microcaliper and were expressed in milimeters. Because the saphenous flap is designed as arterial, only the arterial territories were evaluated; the anatomical relationships between the artery and saphenous nerve and vein are not evaluated in the paper. The descending genicular artery and the origin saphenous artery perforators were exposed in all cadavers. The following parameters regarding the saphenous artery were evaluated and indicated (Figs. 1–4): (1) the location; (2) the origin; (3) the diameter of the artery at its origin; (4) the course; (5) the distance between the origin of the artery and the interepicondylar line; (6) the location of the muscular branches of the artery; (7) the cutaneous branches of the artery; and (8) the features of the distal end of the artery. The saphenous fasciocutaneous flaps of the medial legs were elevated bilaterally.

Flap design

A line drawn from the anterior superior iliac spine to the medial epicondyle of the tibia approximated the course of the sartorius muscle. The proximal flap margin was located over the flap axis, approximately 10 to 15 cm above the knee joint. Flap lengths about 20 cm and width about 6–7 cm were planned. A linear incision was made in the medial thigh to identify the anterior border of the sartorius muscle. The anterior border was reflected posteriorly; the saphenous artery and and its cutaneous perforators were identified. The flap was raised based on the anterior or posterior perforators according to their dominance. The greater saphenous vein located about the posterior border of the sartorius muscle was ligated and divided. The final elevation of the flap and its pedicle proceeded from a distal to a proximal direction. The pedicle could be traced easily to the point where it pierced the roof of the adductor canal.

RESULTS

Descending genicular artery arose from the superficial femoral artery in all of the cases. The descending genicular artery divided into two branches named as a musculoarticular and a saphenous branches, within 3 cm distance of its origin in all of the cases. Then, the musculoarterial branch divided into two branches as a musculoarterial and as osteoarterial branches. The

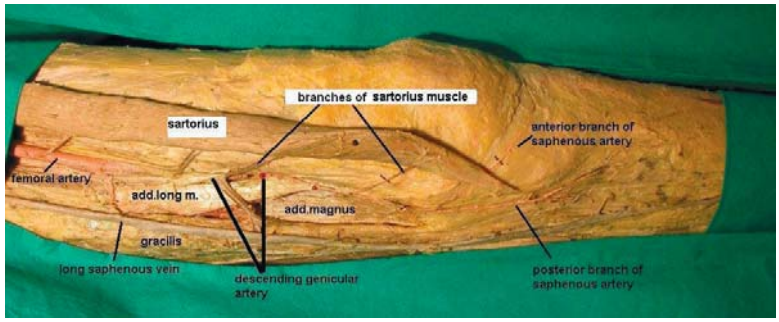

Figure 1. Muscular branches of the saphenous artery to the sartorious muscle.

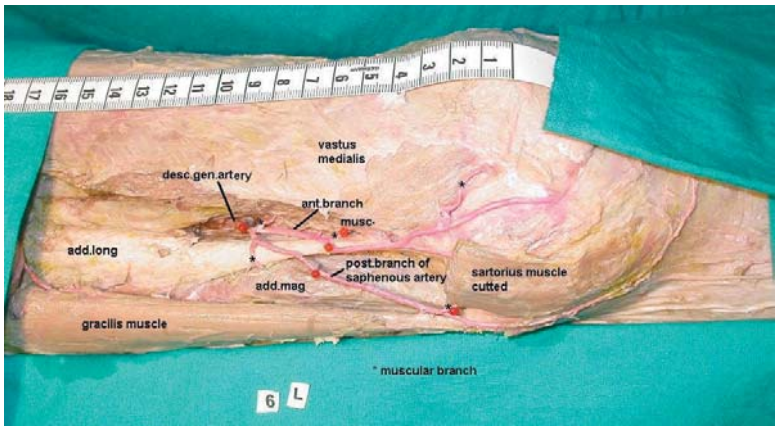

Figure 2. Branching pattern of the saphenous artery after latex injection.

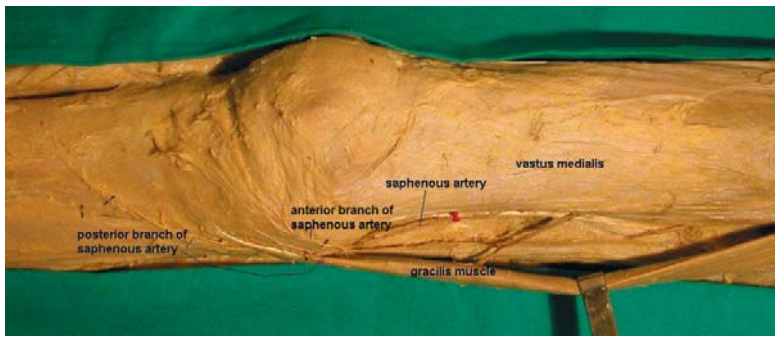

Figure 3. Muscular branches of the saphenous artery and their relations to adjacent structures.

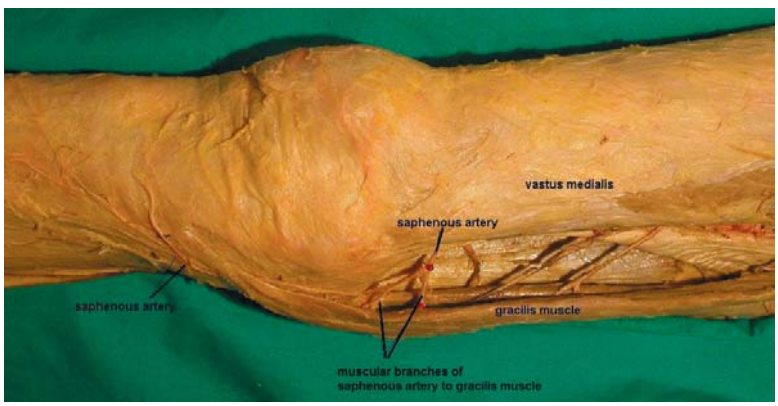

Figure 4. Muscular branches of the saphenous artery to the gracilis muscle.

musculoarterial branch supplied to the vastus medialis and osteoarterial branch supplied to capsule of the genicular joint. The saphenous artery originated from the descending genicular artery separately in all of the cases. The distance between the origin of the artery and interepicondylar line was 115 mm (ranging from 42 to 148 mm). At the level of the origin the size of the saphenous artery was 1.61 mm (ranging from 1 to 2.34 mm). Two vena comitantes and the saphenous nerve accompanyed the saphenous artery in all of the cadavers. The route of the saphenous artery was also evaluated: Initially located deep in the roof of the adductor canal, the saphenous artery ran in a distal and superficial direction. The vessel coursed distally within a loose fascial space bounded superficially by the sartorius muscle, posteriorly by the tendon of the adductor magnus muscle, and anterolaterally by the vastus medialis muscle. The saphenous artery ran distally in this plane for 12 to 15 cm until it passed into the medial aspect of the leg from beneath the tendinous portion of the distal part of the sartorius muscle. The muscular branches to the sartorius muscle (between 5 and 7 perforator branches) existed in all dissections, but the muscular branches reached the gracilis muscle in just 6.66% of the dissections. The number and location of the cutaneous branches showed great anatomical variability. The cutaneous branches numbered between one and four and arose 3.5 to 9.5 cm from the site of origin of the saphenous artery. These perforating branches passed anterior and/or posterior to the borders of the sartorius muscle in a variative manier. The terminal portion of the saphenous artery distal to the sartorius muscle ran adjacent to the deep fascia, and sent branches into the subcutaneous tissues below the medial condyle of the tibia and formed a plexus. The distal end of saphenous artery reached approximately 122 mm distally to the knee joints in all of the cases. In terms of the course of the saphenous artery there was no asymmetry between the right and left legs.

DISCUSSION

The medial aspect of the upper leg and knee nourishing by the saphenous artery can be raised as a fasciocutaneous flap, and this flap is known as the saphenous flap. Acland et al. [1] declared that the saphenous flap was preferable for plastic surgeons because it was thin and had a long vascular pedicle and a dependable nerve supply. The flap has a reliable supporting artery like the saphenous artery. However, the flap requires careful dissection, and details of the vascular anatomy are crucial if the flap is to be developed correctly as the dissection proceeds [1, 2]. According to Mathes and Nahai [9], the saphenous flap is one of the Type A fasciocutaneous flaps have the vascular pedicle of which is coursing initially beneath the deep fascia and eventually superficially to the deep fascia. This pedicle provides numerous fasciocutaneous perforators to the skin during its course. The saphenous flap is used to cover the defects of upper extremities, the knees and upper half of the legs and was most effective when covering the stump in through-knee or below-knee amputations [4, 7, 9, 15, 19]. Karamursel et al. [6] claimed that this flap might be suitable for knee defect coverage if used as an island flap because the flap has a long, wide arterial pedicle. The results of our study will be helpful for better understanding of the arterial territory of saphenous flaps.

Pedicled saphenous flaps are used for coverage of the exposed tibia after severe burns. Surgeons should also be cereful during harvesting of the saphenous vessels in coronary revascularisation operations [5]. It is also important to choose the incision type or to determine boundries of the flap and the course of the branches during a dissection [2, 9]. Consequently, finding variations of this artery or the branches and understanding the anatomical characteristics of the adjacent region are valuable for elevating and moving saphenous flaps safely.

In literature there are limited studies about the anatomy of the saphenous artery and its importance for flap surgery. Scheibel et al. [17] declared that the descending genicular artery was absent in 8 of 24 cadaveric thighs; Karamursel et al. [6] found that the artery was absent in only one cadaver and one clinical case. In these cases, the medial side of the knee was supplied by a direct cutaneous branch from the femoral artery. Acland et al. [1] reported the saphenous branch to be absent in 5% of cases. In the present study we found the saphenous artery in all dissections. The artery was found to be a second branch, which originated seperately from the descending genicular artery in all of our cases.

According to classical texbooks, the diameter of the saphenous artery at the origin is 1.80–2 mm [3] and 1.5–2 mm [2]. In our study, we measured the diameter at the level of its origin as 1.61 mm. Our finding was similar to Cormac and Lamberty's data [2]. The cutaneous vessels of the lower medial thigh and knee were studied by Karamursel et al. [6] using dissection in six lower extremities of six preserved cadavers and during the course of six clinical free flap cases. According to the authors' data, the descending genicular artery immediately divided into two or three branches, namely the muscular, articular, and

saphenous branches. The muscular and articular branches originated from the descending genicular artery as a common trunk in four of the specimens. The muscular branch supplied the distal vastus medialis, and the articular branch ran alongside the adductor magnus tendon and reached the internal condyle of the femur. Contrary to these results, we found that the descending genicular artery divided into two branches, separately, as the musculoarticular and the saphenous branch within 3 cm of its origin. Subsequently, the first musculoarticular branch, as the common branch, divided into two main branches as the musculoarterial and osteoarterial. We also found that the muscular branches reached the sartorious muscle in all of the cases and reached the gracillis muscle in 6.66% of the cases. In addition, unlike Karamursel et al. [6], we determined the distance between the origin of the artery and significant surgical referance points such as interepicondylar line and pubic tubercle, to prevent arterial injury during the dissection. It was measured that the distal end of the saphenous artery reached approximately 122 mm distally to the knee joints in all of the cases. Using these data, surgeons can prevent intraoperative complications such as bleeding. Karamursel et al. [6] declared a large cutaneous perforator originating from the saphenous branch 2 to 2.5 cm distal to its origin in eight of the legs that they investigated. According to our determination, the number and location of cutaneous branches had great anatomical variability. Contrary to the results of Karamursel et al. [6], the number of cutaneous branches was between one and four, and arose 3.5 to 9.5 cm from the site of origin of the saphenous artery.

The saphenous artery is important in fasciocutaneous flap surgery. In this study, ambiguity about the ascending branch, origin, localisation, size, and adjacent relationships was investigated. We tried to eliminate the deficiency regarding this subject. Our findings will also provide anatomical information and guidance and can support the literature and clinical contribution for the design of reliable flap surgery.

In the present study we thought that the results can make a contribution to surgical procedures of the lower part of the medial thigh, lower leg, and knee defects by providing easy anastomosis, normal anatomical reorganisation, and easy operative period.

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