Topographical Relationship between the Human Lateral Circumflex Femoral Artery and Saphenous Nerve

By

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Summary: This study was performed to investigate causes of various types of topographical relationship between the lateral circumflex femoral artery (L) and the saphenous nerve (S).

Femoral artery (F), deep femoral artery (P), L and S of 186 legs of 93 Japanese adult cadavers were submitted to anatomy. Further, the levels of origin of L in thigh were measured. L were classified into nine types by the origins of L and topographical relationship between L and S.

The incidence of various types of L is different among researchers. Our findings proved that these differences were caused by the differences in evaluations of twig from ascending branch (AB) or descending branch (DB) of L.

In cases of L originating from F, incidence of L positioned in front of S is significantly higher than L originating from P (p<0.01). In cases of L originating from F, L positioned in front of S originates from F at the significantly more proximal level compared to L positioned posterior to S (p<0.001). Furthermore, also in cases of L originating from P, L positioned in front of S originates from P at the significantly more proximal level compared to L positioned posterior to S (p<0.001). It is supposed that the topographical relationship between L and S changes depending on the artery where L originates and the level of origin of L.

According to Adachi (1928)¹, the lateral circumflex femoral artery (L) is generally positioned posterior to the saphenous nerve (S), and in some cases, it is positioned in front of S. He also reported that there are cases where the ascending branch (AB) and descending branch (DB) of L are positioned posterior to and in front of S, respectively, or, in front of and posterior to S, respectively. Since the report of Adachi, many researchers have studied on the topographical relationship between L and S. Like Adachi, they have researched only the incidence of various types of topographical relationship between L and S.

We know no researcher who has investigated whether the topographical relationship between L and S changes depending on the unpredictable running of S or behavior of L. This study was conducted to elucidate this question.

Materials and Methods

Femoral artery (F), lateral circumflex femoral artery (L), deep femoral artery (P) and saphenous nerve (S) of 186 thighs of 93 Japanese adult cadavers (57 males and 36 females) were randomly selected from cadavers stored in the Fukuoka University School of Medicine to be submitted to anatomy.

The distance (X) between the intersection of F with the line linking the anterior superior iliac spine and the lower end of pubic tubercle and the inferior extremity of origin of L, and the distance (Y) between the intersection and the upper rim of medial condyle of the tibia were measured to obtain the level of origin of L in the thigh. Then, Z (X/Y × 100) was obtained (Fig. 1).

¹ Adachi (1928)
Statistical Analysis

Chi-square tests were calculated to evaluate the incidence of various types of L.

The statistical differences in measurements between males and females, and those in the levels of origins of L, between L groups positioned in front of and posterior to S were assessed by Student’s *t*-test. Statistical significance was defined as *p* < 0.05.

Results

Origin of L and topographical relationship between L and S

Observed L (186 cases) can be classified into the following four types depending on their origins. They are called types A, B, C and D respectively in this report, as follows;

- type A: L originating from F
- type B: L originating from P
- type C: L with the descending branch (DB) originating from F and with the ascending branch (AB) originating from P, and
- type D: L with AB and DB originating independently from P

Further, the four types of L can be classified into the following nine types of L by the topographical relationship with S. In this report, they are called type A-1 (Fig. 2), type A-2 (Fig. 3), type A-3 (Fig. 4), type B-1 (Fig. 5), type B-2 (Fig. 6), type B-3 (Fig. 7), type C-2 (Fig. 8), type C-3 (Fig. 9) and type D (Fig. 10).

More specifically,

- type A-1 and type B-1: L positioned in front of S,
- type A-2, type B-2 and type C-2: L positioned posterior to S,
- type A-3, type B-3 and type C-3: L with DB and AB positioned in front of and posterior to S, respectively, and
- type D: L with AB and DB positioned posterior to S and originating independently from P

Table 1 shows the number of cases of these nine types of L.

The level of origin of L in thigh

The length of X and Y was measured in order to investigate the level of origin of L in thigh. Further, the level of origin of L in thigh was categorized into the following nine types of L by the topographical relationship with S. In this report, they are called type A-1 (Fig. 2), type A-2 (Fig. 3), type A-3 (Fig. 4), type B-1 (Fig. 5), type B-2 (Fig. 6), type B-3 (Fig. 7), type C-2 (Fig. 8), type C-3 (Fig. 9) and type D (Fig. 10).

More specifically,

- type A-1 and type B-1: L positioned in front of S,
- type A-2, type B-2 and type C-2: L positioned posterior to S,
- type A-3, type B-3 and type C-3: L with DB and AB positioned in front of and posterior to S, respectively, and
- type D: L with AB and DB positioned posterior to S and originating independently from P

Table 1 shows the number of cases of these nine types of L.

Abbreviations and Symbol


Fig. 1. Anterior view. The F is displaced medially. The Sa and RF are reflected. The X indicates the distance between the intersection of the line (linking the superior anterior iliac spine and the lower end of pubic tubercle) and the F, and the origin of L. The Y indicates the distance between the intersection and the upper rim of medial condyle of tibia. The black arrowheads indicate the S.

Fig. 2. Type A-1. Anterior view. The L originating from the F is positioned in front of the S. The black arrowheads indicate the S. The Sa and RF are reflected.

Fig. 3. Type A-2. Anterior view. The L originating from the F is positioned posterior to the S. The black arrowheads indicate the S. The F is cut and displaced medially. The Sa and RF are reflected.

Fig. 4. Type A-3. Anterior and medial view. The L originates from the F. The DB and the AB are positioned in front of and posterior to the S, respectively. The black arrowheads indicate the S. The Sa and RF are reflected.
Discussion

Origin of L

Quain (1884), Srb (1860), Auburtin (1905), Adachi (1928), William et al. (1934), Miyashita (1936), P’an (1937), Nakayama (1944), Shimada (1944), Sagara (1947), Kiyozumi et al. (1960), Chang et al. (1965) and Emura et al. (1985) reported many cases of origin of L, medial circumflex femoral artery and P. Most of them classified three kinds of origin of artery into eight types based on the classification method of Adachi (1928)\textsuperscript{1-13}.

The purpose of our study does not include the medial circumflex femoral artery. Therefore, by comparison of L classified by us to L classified by Adachi (1928) with exclusion of the item of origin...
Table 1. Origin of L and topographical relationship between L and S

<table>
<thead>
<tr>
<th>Type of L</th>
<th>Position of L (number of cases)</th>
<th>Positioned in front of S</th>
<th>Positioned posterior to S</th>
<th>DB and AB are positioned in front of and behind S, respectively</th>
<th>Total 186 (male: 114, female: 72)</th>
</tr>
</thead>
<tbody>
<tr>
<td>L originating from F (type A)</td>
<td>12 (male: 6, female: 6)</td>
<td>type A-1</td>
<td>type A-2</td>
<td>type A-3</td>
<td>41 (male: 18, female: 23)</td>
</tr>
<tr>
<td>L originating from P (type B)</td>
<td>15 (male: 11, female: 4)</td>
<td>type B-1</td>
<td>type B-2</td>
<td>type B-3</td>
<td>133 (male: 91, female: 42)</td>
</tr>
<tr>
<td>L with the DB originating from F and AB originating from P (type C)</td>
<td></td>
<td>type C-2</td>
<td>type C-3</td>
<td></td>
<td>6 (male: 4, female: 2)</td>
</tr>
<tr>
<td>L with AB and DB originating independently from P (type D)</td>
<td></td>
<td>type D</td>
<td></td>
<td></td>
<td>6 (male: 1, female: 5)</td>
</tr>
</tbody>
</table>

Table 2. Number of cases, measured values and rates (X/Y × 100)

<table>
<thead>
<tr>
<th>No.</th>
<th>X (cm)</th>
<th>Y (cm)</th>
<th>Z (X/Y × 100)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Min.</td>
<td>Max.</td>
<td>Mean ± SD</td>
</tr>
<tr>
<td>Male group</td>
<td>127</td>
<td>2.5</td>
<td>10.3</td>
</tr>
<tr>
<td>Female group</td>
<td>82</td>
<td>1.6</td>
<td>8.2</td>
</tr>
<tr>
<td>Type A-1 group</td>
<td>20</td>
<td>1.6</td>
<td>5.2</td>
</tr>
<tr>
<td>Type A-2 group</td>
<td>32</td>
<td>3.2</td>
<td>6.3</td>
</tr>
<tr>
<td>Type B-1 group</td>
<td>21</td>
<td>3.3</td>
<td>5.1</td>
</tr>
<tr>
<td>Type B-2 group</td>
<td>136</td>
<td>3.8</td>
<td>10.3</td>
</tr>
</tbody>
</table>

Fig. 11. Numbers of the X, Y and Z in male group (Total 127). The X, Y and Z are indicated by the clear bar, gray bar and horizontal hatched bar, respectively.
of medial circumflex femoral artery, it is cleared that our type A corresponds to Adachi’s types III, IV, VI and VIII, and our types B and D to Adachi’s types I and II, and our type C to Adachi’s types V and VII.

According to the previous reports, the incidence of type A was 24.0% at maximum (Miya-shita, 1936)\(^6\), 12.7% at minimum (Emura \textit{et al.}, 1985)\(^13\) and 20.0% on an average. Our result that provides incidence of type A (41/186: 22.0%) is similar to the result of the previous reports.

As for type B, the previous reports indicated the incidence of 82.5% at maximum (Srb, 1860)\(^3\), 68.2% at minimum (Adachi, 1928)\(^1\) and 76.8% on an average. In our study, its incidence (139/186, 74.7%) is similar to the result of the previous reports.

The previous reports indicated the incidence of type C as 11.4% at maximum (Quain, 1844)\(^2\), 0% at minimum (Srb, 1860)\(^3\), Auburtin, 1905\(^4\) and Nakayama, 1944\(^9\) and 3.2% on an average. The incidence (6/186, 3.2%) of our type C is similar to the results of the previous reports.

As mentioned above, the incidence of each of our types A, B (and D) and C can be considered to be general.

\textit{Topographical relationship between L and S}

Adachi (1928)\(^1\) classified the positional relationship among L, S and n.m. vasti medialis into six types. Many researchers other than Sirang (1972)\(^14\), Takeuchi \textit{et al.} (1977)\(^15\), Aizawa (1992)\(^16\) and Ogawa \textit{et al.} (2002)\(^17\) obeyed Adachi’s classification method. Adachi do not include the origin of L into the factors of the classification. Meanwhile, Sirang, Takeuchi \textit{et al.}, Aizawa and Ogawa \textit{et al.} investigated the topographical relationship between L and S, however, no origin of L.

Our study does not concern n.m. vasti medialis. Therefore, without consideration of n.m. vasti medialis, the results of Adachi’s research can be classified into four types such as 1) L positioned in front of S, 2) L positioned posterior to S, 3) L with DB and AB positioned in front of and posterior to S, respectively, and 4) L with AB and DB positioned in front of and posterior to S, respectively.

In this report, the above types are called type \(a\), type \(\beta\), type \(\gamma\) and type \(\delta\), respectively. Type \(a\) corresponds to our types A-1 and B-1, type \(\beta\) to our types A-2 and B-2, and type \(\gamma\) to our types A-3, B-3 and C-3, respectively. We could not find the type \(\delta\).

Table 3 shows the number of cases (incidence) of each type reported previously. As shown in Table 3, there are significant differences in the incidence of type \(\gamma\) and type \(\delta\) among researchers. The difference in the incidence of each type among researchers is discussed in our study. In Fig. 5 (type \(a\), which corresponds to our type B-1) in this paper, L is positioned in front of S. Meanwhile, a twigs (\(a\)in Fig. 5) that can be regarded to be one of DBs is
Table 3. Comparison of frequency of types by many investigators

<table>
<thead>
<tr>
<th>Investigators (total number)</th>
<th>Number of cases (%)</th>
<th>type α (type A-1 and type B-1)</th>
<th>type β (type A-2, type B-2, type C-2 and type D)</th>
<th>type γ (type A-3, type B-3 and type C-3)</th>
<th>type δ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adachi (94)</td>
<td>7 (7.4%)</td>
<td>59 (62.8%)</td>
<td>27 (28.7%)</td>
<td>1 (1.1%)</td>
<td></td>
</tr>
<tr>
<td>Miyashita (95)</td>
<td>6 (6.3%)</td>
<td>70 (73.7%)</td>
<td>16 (16.8%)</td>
<td>3 (3.2%)</td>
<td></td>
</tr>
<tr>
<td>Shimada (264)</td>
<td>17 (6.4%)</td>
<td>180 (68.2%)</td>
<td>16 (6.1%)</td>
<td>51 (19.3%)</td>
<td></td>
</tr>
<tr>
<td>Sagara (132)</td>
<td>6 (4.5%)</td>
<td>103 (78.6%)</td>
<td>20 (15.2%)</td>
<td>3 (2.3%)</td>
<td></td>
</tr>
<tr>
<td>Kiyozumi et al. (226)</td>
<td>14 (6.2%)</td>
<td>158 (70.0%)</td>
<td>51 (22.6%)</td>
<td>3 (1.3%)</td>
<td></td>
</tr>
<tr>
<td>Chang et al. (369)</td>
<td>16 (4.3%)</td>
<td>270 (73.2%)</td>
<td>79 (21.4%)</td>
<td>4 (1.1%)</td>
<td></td>
</tr>
<tr>
<td>Strang (66)</td>
<td>10 (15.2%)</td>
<td>51 (77.3%)</td>
<td>2 (3.0%)</td>
<td>3 (4.6%)</td>
<td></td>
</tr>
<tr>
<td>Takeuchi et al. (148)</td>
<td>13 (8.8%)</td>
<td>128 (86.5%)</td>
<td>7 (4.7%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Ogawa et al. (64)</td>
<td>12 (18.8%)</td>
<td>48 (75.0%)</td>
<td>4 (6.3%)</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>Present authors (186)</td>
<td>27 (14.5%)</td>
<td>145 (78.0%)</td>
<td>14 (7.5%)</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 13. Numbers of the X, Y and Z in the type A-1 group (total 20). Five cases of the type A-3 and 3 cases of the type C-3 are included in the type A-1 group. The X, Y and Z are indicated by the clear bar, gray bar and horizontal hatched bar, respectively.

Fig. 14. Numbers of the X, Y and Z in the type A-2 group (Total 32). Five cases of the type A-3 and 3 cases of the type C-2 are included in the type A-2 group. The X, Y and Z are indicated by the clear bar, gray bar and horizontal hatched bar, respectively.
Fig. 15. Numbers of the X, Y and Z in type B-1 group (Total 21). Six cases of the type B-3 are included in the type B-1 group. The X, Y and Z are indicated by the clear bar, gray bar and horizontal hatched bar, respectively.

Fig. 16. Numbers of the X, Y and Z in the type B-2 group (Total 136). The type B-2 group includes 6 cases of the type B-3, 3 cases of the type C-2, 3 cases of the type C-3 and 12 cases of the type D. The X, Y and Z are indicated by clear bar, gray bar and horizontal hatched bar, respectively.
originated from the base of L, and positioned posterior to S. Assuming that this twig is sufficiently tough, L in Fig. 5 can be regarded as type δ.

It is supposed that the differences in evaluations of the twig from AB or DB of L among researchers cause the differences in classification of L among researchers. As the result of such differences, there may be emerged differences in incidence of each type among researchers.

Incidence of types A and B (Table 1)
The incidence of respective types of A-1, A-2 and A-3 in the type A group, and that of respective types of B-1, B-2 and B-3 in the type B group were statistically analyzed. As the result, type A-1 showed significantly higher value than type B-1 ($p < 0.01$), and type B-2 showed significantly higher value than A-2 ($p < 0.01$). Further, there was no significant difference in incidence between types A-3 and B-3 ($p > 0.05$).

If a bold assumption is permitted, it can be considered that the topographical relationship between L and S is influenced by the differences in arteries from which L is originated. Not unpredictable running of S but the arteries from which L is originated may concern the change in the topographical relationship between L and S.

Level of origin of L in thigh (Table 2 and Figs. 13 through 16)
1) Level of origin of L in type A: Statistical differences between type A-1 group and type A-2 group were evaluated. As the result, type A-1 showed significantly shorter values for X ($p < 0.001$). No significant difference was observed in Y between type A-1 and type A-2 ($p > 0.05$). Further, type A-1 showed significantly smaller values for Z ($p < 0.001$).

Therefore, in cases where L originates from F, L positioned in front of S (type A-1) originates from F at the more proximal level of a thigh than L positioned posterior to S (type A-2).

2) Level of origin of L in type B: Statistical differences between type B-1 group and type B-2 group were evaluated. As the result, type B-1 showed significantly shorter values for X ($p < 0.001$). No significant difference was observed in Y between the both types ($p > 0.05$). Further, type B-1 showed significantly smaller values for Z ($p < 0.001$).

Therefore, in cases where L originates from P, L positioned in front of S (type B-1) is originated from P at the more proximal level of a thigh than L positioned posterior to S (type B-2).

If a bold theory is permitted, it can be supposed that the topographical relationship between L and S is influenced by the level of origin of L.

References