Anatomical Observation on Components Related to Foot Gworeum Meridian Muscle in Human

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Objectives: This study was carried out to observe the foot gworeum meridian muscle from a viewpoint of human anatomy on the assumption that the meridian muscle system is basically matched to the meridian vessel system as a part of the meridian system, and further to support the accurate application of acupuncture in clinical practice.

Methods: Meridian points corresponding to the foot gworeum meridian muscle at the body surface were labeled with latex, being based on Korean standard acupuncture point locations. In order to expose components related to the foot gworeum meridian muscle, the cadaver was then dissected, being respectively divided into superficial, middle, and deep layers while entering more deeply.

Results: Anatomical components related to the foot gworeum meridian muscle in human are composed of muscles, fascia, ligament, nerves, etc. The anatomical components of the foot gworeum meridian muscle in cadaver are as follows:

1. Muscle: Dorsal pedis fascia, crural fascia, flexor digitorum (digit.) longus muscle (m.), soleus m., sartorius m., adductor longus m., and external abdominal oblique m. aponeurosis at the superficial layer, dorsal interosseous m. tendon (tend.), extensor (ext.) hallucis brevis m. tend., ext. hallucis longus m. tend., tibialis anterior m. tend., flexor digit. longus m., and internal abdominal oblique m. at the middle layer, and finally posterior tibialis m., gracilis m. tend., semitendinosus m. tend., semimembranosus m. tend., gastrocnemius m., adductor magnus m. tend., vastus medialis m., adductor brevis m., and intercostal m. at the deep layer.

2. Nerve: Dorsal digital branch (br.) of the deep peroneal nerve (n.), dorsal br. of the proper plantar digital n., medial br. of the deep peroneal n., saphenous n., infrapatellar br. of the saphenous n., cutaneous (cut.) br. of the obturator n., femoral br. of the genitofemoral n., lateral cut. br. of the saphenous n., ant. cut. br. of the iliohypogastric n., lateral cut. br. of the intercostal n. (T11), and lateral cut. br. of the intercostal n. (T6) at the superficial layer, saphenous n., ant. division of the obturator n., post. division of the obturator n., obturator n., ant. cut. br. of the intercostal n. (T11), and ant. cut. br. of the intercostal n. (T6) at the middle layer, and finally tibialis n. and articular br. of the tibial n. at the deep layer.

Conclusion: The meridian muscle system seemed to be closely matched to the meridian vessel system as a part of the meridian system. This study shows comparative differences from established studies on anatomical components related to the foot gworeum meridian muscle, and also from the methodical aspect of the analytic process. In addition, the human foot gworeum meridian muscle is composed of the proper muscles, and also may include the relevant nerves, but it is as questionable as ever, and we can guess that there are somewhat conceptual differences between terms (that is, nerves which control muscles in the foot gworeum meridian muscle and those which pass nearby) in human anatomy.

Key Words: Foot gworeum meridian muscle, LR1-14, muscle, tendon, fascia, nerve.

Introduction

This paper follows a series of research papers which I have reported in various journals with relation to the twelve meridian muscles, most recently On Foot Taeyang Meridian Muscle, J. Korean. Oriental Med.,...
2009.

With relation to the study of meridian muscles, it is thought most important, even elementary to elucidate what the components related to the meridian muscle are, since the concept of meridian muscle (MM) has been shown in Ling Shu (Miraculous Pivot) of Huandi Neijing. For all divergent views it is a common view that MM is closely connected with the twelve (12) main meridians (TMM). Where the meridian muscle system is basically matched to the meridian vessel system as a part of the meridian system, it is different in that TMM are internally connected to one\(^1,2,3\) of the twelve organs (Zang Fu) but MM is not so. Meridian muscle is a general term of the muscular system distributed among the twelve (12) main meridians, and is composed of muscular components\(^1,2\) such as muscle (including tendon), fascia, ligament and so on, where \(gi\) (life energy) in TMM is collected or concluded or translated\(^1,4\) to the muscular system. According to these opinions, there are three Yin & Yang channels on each arm, and three on each\(^5,6\) leg\(^1\). Whereas the liver meridian is a negative meridian with energy running from the foot to the chest and this meridian is composed of fourteen bilateral acupoints, the foot gworeum meridian muscle is thought to be a colligated conception of body muscles distributed among this meridian.

Acupuncture theory, especially the theory of TMM or MM, although supported by numerous empirical studies, has received various criticisms. There is not yet a generally-accepted anatomical and histological basis for their existence or hypothesis. It also seems that the anatomical constituents of individual MM are wrongly known to the academic world of oriental medicine\(^1,7\). This may bring about a mistaken clinical application or a wrong diagnosis as well as misunderstanding of the mode of action of acupuncture, though the term of MM means a lot to myology, arthrology, rehabilitation, and the other clinics.

On the other hand, Korean standard acupuncture point locations were established on February 11\(^{th}\) 2006\(^8\) and STRICTA was revised on August 17\(^{th}\) 2010\(^9\). It is necessary for such situations to be considered when the meridian muscle is studied.

This study was carried out in order to investigate correct constituents related to the foot gworeum meridian muscle and to theoretically support the meridianology or the clinics of oriental medicine, following Lung MM\(^10\), pericardium MM\(^11\), and foot Taeyang MM\(^12\).

### Materials and Methods

1. Preservative preparations and injection

   1) The preparation of a preservative
   
   1 kg of Phenol was dissolved in 1 ℓ of methyl alcohol (The 1st solution). 500ml of glycerin was dissolved in 2 ℓ of methyl alcohol and thereafter an additional 500 ㎖ of glycerin was dissolved in this solution (the 2nd solution). The 1st and 2nd solutions were mixed well, and warmed (30min, 20 ℃). 1 ℓ of methyl alcohol was added to this mixed solution and stirred for 10 minutes. Finally 1.5 ℓ of formalin was added to the mixed solution.

   2) Injection to cadaver
   
   The sheath of the femoral artery & vein was exposed by vertical incision at the medial third of the inguinal ligament, and the femoral artery was carefully separated from the femoral vein. A preservative was injected into the femoral artery at a speed of 150 ㎖ per minute. After 6 ℓ of preservative was injected, the needle-inserted part was ligated, and subsequently an injector needle was inserted downwards for the preservation of the leg.

2. Embalmment of cadaver

   1) Cadaver was pending in the embalmment system for 40 hrs at 40 ℃.
   
   2) Cadaver was exposed for 1hr at room
temperature, and after that, kept in refrigerated storage (3 ℃, 30% humidity).

3. Experimental procedure

1) The foot gworeum meridian in the body surface was labeled with latex at the surface of the cadaver, subsequently being photographed.
2) Meridian points were based on standard Korean acupuncture point locations8).
3) Pores were made by a drill in the vertical direction at each meridian point.
4) Skin and superficial fascia were removed in order and the exposed deep fascia surface was thereafter labeled by latex, and photographed again.
5) Deep fascia was also removed.
6) Subsequently muscle, tendon, and nerve were investigated and photographed, being grouped into three layers (superficial, middle, and deep layers), herein first-exposed muscle layer was named superficial layer, while entering more deeply, named middle and deep layer in order.

Results

The foot gworeum meridian was labeled at the surface of the cadaver, and also relevant constituents were dissected with groupings in the order of the depth of the three layers (superficial, middle, deep layers).

The results were identified as follows:

1. Daedon (LR₁)

This point located at 0.1 chon lateral posterior to the angle of the toenail of the hallux. The dorsal pedis fascia is extended up to this place. Here are distributed the dorsal digital (digit.) branch (br.) of the deep peroneal nerve (n.) and the dorsal br. of the proper plantar digital n. (Fig. 1).

2. Haenggan (LR₂)

This point is located at the dorsal surface between the 1st and 2nd toes. At the superficial layer there is the dorsal pedis fascia, and right under it the dorsal interosseous muscle (m.) tendon (tend.). At the superficial layer there is the dorsal digital br. of the deep peroneal n. (Fig. 1).

3. Taechung (LR₃)

This point is located at the dorsal surface between the 1st and 2nd metatarsal bones. There are the dorsal pedis fascia at the superficial layer, the extensor (ext.) hallucis brevis m. tend. and the lateral margin of the ext. hallucis longus m. tend. The medial br. of the deep peroneal n. is distributed (Fig. 1).

4. Jungbong (LR₄)

This point is located at the recession medial to the tibialis anterior m. tend. There is the dorsal pedis fascia and medial margin of the tibialis anterior m. tend. in the superficial layer. Subcutaneously is situated the fascia saphenous n. (Fig. 1)

5. Yeogu (LR₅)

This point is located at 5 chon upward to the tip of the medial malleolus. At the superficial layer there are crural fascia and flexor (flex.) digit. longus m. and at the deep layer the posterior tibialis muscle. At the superficial layer the saphenous n. is situated, and at the deep layer the tibialis n. (Fig. 1, 2). The crural fascia, flexor (flex.) digit. longus m. and saphenous n. are situated in the superficial layer. The posterior tibialis m. and tibialis n. are situated in the deep layer.

6. Jungdo (LR₆)

This point is located at 7 chon upward to the tip of the medial malleolus. The superficial layer of
Fig. 1. Photograph shows the foot gworeum meridian points (LR1-LR5) at the level of the deep fascia of the leg (●: Meridian points, A: LR1, B: LR2, C: LR3, D: LR4, E: LR5, △: Muscles, a: tibialis ant. m. tend., b: ext. hallucis longus m. tend., c: ext. digit. longus m. tend., d: calcaneal (Achilles) tend., e: gastrocnemius m., f: dorsalis pedis fascia, g: dorsal interosseous m. tend., h: ext. hallucis longus m. tend., i: ext. hallucis brevis m. tend., j: crural fascia, ▲: other surface markings, k: tibia).

Jungdo corresponds to the space between the flex. digit. longus m., and the soleus m.; the posterior tibialis muscle is situated in the deep layer. The relevant nerve is very alike to Yeogu in this respect (Fig. 2).

7. Seulgwan (LR7)

This point is located below the medial tibia condyle, 1 chon posterior to Eumneungchon (SP9). Sartorius m. and saphenous n. are situated in the superficial layer, and the inner layer corresponds to the anterior space to tendons of gracilis m., semitendinosus m., and semimembranosus m. (or gastrocnemius with aforementioned muscles in case of inclined acupuncture); tibialis n. are situated in the deep layer (Fig. 2).

Fig. 2. Photograph shows the foot gworeum meridian points (LR6-LR9) at the level of deep fascia and inner layer of leg (●: Meridian points, A: LR6, B: LR7, C: LR8, D: LR9, △: Muscles, a: flex. digit. longus m., b: soleus m., c: gastrocnemius m., d: sartorius m., e: semitendinosus m., f: semimembranosus m., g: rectus femoris m., f: crural fascia, ▲: gracilis m. tend, and semitendinosus m. tend., k: add. magnus m. tend., l: vastus medialis m., ▲: other surface markings, h: tibia).

8. Gokcheon (LR8)

This point is located at the extremity of the crease formed by the knee flexure. The relevant muscle is most alike to Seulgwan in this respect but at the inner layer there is the tip of the adductor magnus m. tend. The relevant nerve is the infrapatellar br. of saphenous n. in the superficial layer and the articular br. of tibial n. in the deep layer (Fig. 2).

9. Eumpo (LR9)

This point is located at 4 chon above the medial condyle of the femur. According to the direction of the acupuncture needle (upright or inclined position) the relevant muscles or nerves differ. Muscle in the superficial layer corresponds to sartorius m. The deep layer corresponds to the space between the adductor magnus m. and the medial margin of the
vastus medialis m. The relevant nerves are the saphenous n. in the middle layer and the cutaneous (cut.) br. of the obturator n. in the superficial layer (Fig. 2).

10. Jogori (LR10)

This point is located at 3 chon at a right angle to Gichung (ST36) situated at 2 chon lateral to Gokgol (CV2) on the median line of the abdomen. The relevant muscles are adductor longus m. in the superficial layer and the adductor brevis m. and adductor magnus m. in the deep layer. The relevant nerves are the femoral br. of genitofemoral n. and the anterior (ant.) cut. br. of the femoral n. at the outer layer, ant. division of the obturator n. in the middle layer, and lastly post. division of the obturator n. (Fig. 3, 4).

11. Eumnyeom (LR11)

This point is located at 2 chon at a right angle
downward to Gichung (ST30). There are the adductor longus m. in the superficial layer and the adductor brevis m. and adductor magnus m. in the deep layer. Relevant nerves are the obturator n. in the middle layer, the femoral br. of the genitofemoral n., the ant. cut. br. of the femoral n., and the ant. cut. br. of iliohypogastric n. in the superficial layer (Fig. 3, 4).

12. Geummaek (LR12)

This point is located at 2.5 chon lateral to Gokgol (CV2) and 0.5 chon lateral to Gichung (ST30). In the superficial layer there is the aponeurotic part of the external abdominal oblique m., and the internal oblique m. inside this muscle. The relevant nerves are the obturator n. at the middle layer, the femoral br. of the genitofemoral n., the ant. cut. br. of the femoral n., the ant. cut. br. of the iliohypogastric n. in the superficial layer (Fig. 3, 4).

13. Jangmun (LR13)

This point is located at the lower edge of the inner extremity of the 11th rib. In the superficial layer there is the external abdominal oblique m., and the internal oblique m. inside this muscle. The relevant nerves are the lateral cut. br. of the intercostal n. (T11) in the superficial and the ant. cut. br. of the intercostal n. (T11) at the deeper layer (Fig. 3).

14. Gimun (LR14)

This point is located at a position crossing with the mammillary line on the 6th intercostal space. There are the external abdominal oblique m. in the superficial layer and the intercostal muscles in the deep layer. The relevant nerves are the lateral cut. br. of the intercostal n. (T6) in the superficial layer and the ant. cut. br. of the intercostal n. (T6) at a deeper layer (Fig. 3).

Discussion

Foot gworeum MM originates at Daedon (LR1) in the lateral posterior to the angle of the hallux toenail, goes upward to the medial part of the lower limb passing by the dorsum of the foot, and reaches Gimun (LR14) in the lower chest via the pubis. So muscles or nerves relevant to this meridian muscle are chiefly situated at the medial parts of the lower limb and lower chest.

As mentioned above, anatomical knowledge of the meridian muscle is essentially required for the clinical application of MM. At the same time such knowledge must be exact for effective application of MM to clinics. But it is criticizable on muscles correspondent to the meridian muscle. We investigated muscles or components correspondent to the meridian muscle according to a common view that basically MM is closely connected with the meridian vessel as a part of the meridian, though we admit the necessity of the strict interpretation of Ling Shu of HUANDI NEIJING. Study carried out from this viewpoint shows some differences from already established data on MM (refer to Table 1 and 2); that is, anatomical constituents of MM such as muscle, fascia, ligament, nerve, and furthermore, different analytical methods from established procedure. But it is necessary to study further whether nerves are included among meridian muscle, considering flow pathways of MM, disease symptoms in relation with MM, the interpretation of Ling Shu of HUANDI NEIJING, etc. Above all the components of each meridian point investigated in this study were divided into three layers according to their depth from the body surface but on the other hand we came across that it might be wide differences in opinion according to the disparity of actual meridian points or the application angle of acupuncture. The present study was performed with upright acupuncture position for a basis. As we have already brought out several times, the direction of
Table 1. Differences from Established Studies from a Viewpoint of the Muscular Components of the Foot Gworeum Meridian Muscle in Human.

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<tr>
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<tbody>
<tr>
<td>LR₁</td>
<td>dorsal digital aponeurosis</td>
<td>-</td>
<td>dorsal pedis fascia</td>
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<tr>
<td>LR₂</td>
<td>dorsal interosseous muscle (m.) tend.</td>
<td>-</td>
<td>dorsal pedis fascia, dorsal interosseous m. tend.</td>
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<tr>
<td>LR₃</td>
<td>Extensor (ext.) hallucis brevis m. tend., dorsal interosseous m.</td>
<td>ext. hallucis longus m. tend.</td>
<td>dorsal pedis fascia, ext. hallucis brevis m. tend., ext. hallucis longus m. tend.</td>
</tr>
<tr>
<td>LR₄</td>
<td>tibialis anterior m. tend.</td>
<td>tibialis anterior m. tend.</td>
<td>dorsal pedis fascia, tibialis anterior m. tend.</td>
</tr>
<tr>
<td>LR₅</td>
<td>soleus m.</td>
<td>-</td>
<td>crural fascia, flexor (flex.) digitorum (digit.) longus m., posterior tibialis m.</td>
</tr>
<tr>
<td>LR₆</td>
<td>soleus m.</td>
<td>-</td>
<td>flex. digit. longus m., soleus m., posterior tibialis m.</td>
</tr>
<tr>
<td>LR₇</td>
<td>semimembranosus m. tend.</td>
<td>-</td>
<td>sartorius m., gracilis m. tend., semitendinosus m. tend., semimembranosus m. tend. (gastrocnemius m.)</td>
</tr>
<tr>
<td>LR₈</td>
<td>sartorius m., gracilis m. tend.</td>
<td>sartorius m., semitendinosus m. tend. semimembranosus m. tend.</td>
<td>sartorius m., adductor magnus m. tend.</td>
</tr>
<tr>
<td>LR₉</td>
<td>semimembranosus m. tend., gastrocnemius m.</td>
<td>sartorius m., vastus medialis m., adductor magnus m.</td>
<td>sartorius m., adductor magnus m., vastus medialis m.</td>
</tr>
<tr>
<td>LR₁₀</td>
<td>adductor longus m., adductor brevis m., pectineus m.</td>
<td>-</td>
<td>adductor longus m., adductor brevis m., adductor magnus m.</td>
</tr>
<tr>
<td>LR₁₁</td>
<td>same as for the above</td>
<td>-</td>
<td>same as for the above</td>
</tr>
<tr>
<td>LR₁₂</td>
<td>pectineus m., iliacus m.</td>
<td>-</td>
<td>external abdominal oblique m. aponeurosis, internal abdominal oblique m.</td>
</tr>
<tr>
<td>LR₁₃</td>
<td>external abdominal oblique m., internal abdominal oblique m., transverse abdominis m.</td>
<td>same as for the left</td>
<td>external abdominal oblique m., internal abdominal oblique m.</td>
</tr>
<tr>
<td>LR₁₄</td>
<td>external abdominal oblique m., internal abdominal oblique m., transverse abdominis m.</td>
<td>same as for the left</td>
<td>external abdominal oblique m., intercostal m.</td>
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</table>

the acupuncture needle in oriental medicine is generally composed of 3 types, the upright position inserted vertical to the skin, the down or transverse position, and the inclined position inserted at the angle of 45 degrees to the skin. The upright position is required for the application of the needle to LR₁,₅,₇,₁₃ (according to Ahan, Ref. 7), or LR₁₋₁₄ (according to Ref. 1), inclined or transverse position for LR₂₋₆,₁₃,₁₄ (according to Ahan, Ref. 7) or LR₁₋₁₄ (according to Ref. 1). Speaking for the last time, the
standardization of the acupuncture point locations was most recently arranged through an international conference between 3 countries, Korea, Japan, and China, and the present study was dependant on this standardization. The conception of “blood vessel” was excluded from a constituent of meridian muscle at this paper.

### Conclusion

This study was carried out to observe the anatomical components of the foot gworeum MM in human, classified into superficial, middle, and deep layers.

The cadaver was opened widely to expose internal structures such as muscles, nerves and others of foot gworeum MM in the lower limb and the lower chest. We obtained the conclusions as follows:

1. MM seemed to be closely matched to the meridian vessel system as a part of the meridian system.
2. This study somewhat differs from established studies from the viewpoint of the anatomical components of foot gworeum MM, and also in the aspect of methodical analytical procedure.
3. As shown in the result, foot gworeum MM in human is composed of the proper muscles, and may also include the relevant nerves, but this is as questionable as ever.
4. There is some conceptual difference between nerves which control the muscle of MM and nerves which pass near by MM in the

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<tr>
<td>LR1</td>
<td>dorsal digital branch (br.) of deep peroneal nerve (n.).</td>
<td>-</td>
<td>dorsal digital br. of deep peroneal n., dorsal br. of proper plantar digital n.</td>
</tr>
<tr>
<td>LR2</td>
<td>dorsal digital br. of peroneal n.</td>
<td>dorsal digital br. of deep peroneal n.</td>
<td>dorsal digital br. of deep peroneal n.</td>
</tr>
<tr>
<td>LR3</td>
<td>deep peroneal n.</td>
<td>deep peroneal n.</td>
<td>med. br. of deep peroneal n.</td>
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<tr>
<td>LR4</td>
<td>med. crural cutaneous (cut.) br. of saphenous n.</td>
<td>med. crural cut. br. of saphenous n.</td>
<td>saphenous n.</td>
</tr>
<tr>
<td>LR5</td>
<td>same as for the above</td>
<td>ant. br. of saphenous n.</td>
<td>saphenous n., tibial n.</td>
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<tr>
<td>LR6</td>
<td>same as for the above</td>
<td>-</td>
<td>same as for the above</td>
</tr>
<tr>
<td>LR7</td>
<td>saphenous n., tibial n.</td>
<td>-</td>
<td>same as for the above</td>
</tr>
<tr>
<td>LR8</td>
<td>saphenous n.</td>
<td>saphenous n.</td>
<td>infrapatellar br. of saphenous n., articular br. of tibial n.</td>
</tr>
<tr>
<td>LR9</td>
<td>ant. cut. br. of femoral n., saphenous n.</td>
<td>-</td>
<td>cut. br. of obturator n., saphenous n.</td>
</tr>
<tr>
<td>LR10</td>
<td>obturator n.</td>
<td>obturator n.,</td>
<td>femoral br. of genitofemoral n., ant. cut. br. of femoral n., ant. division of obturator n., post. division of obturator n.</td>
</tr>
<tr>
<td>LR11</td>
<td>obturator n.,</td>
<td>-</td>
<td>femoral br. of genitofemoral n., ant. cut. br. of femoral n., ant. cut. br. of iliohypogastric n., obturator n.</td>
</tr>
<tr>
<td>LR12</td>
<td>obturator n., femoral br. of ilioinguinal n.</td>
<td>-</td>
<td>femoral br. of genitofemoral n., ant. cut. br. of iliohypogastric n., obturator n.</td>
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dissection of cadaver.

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**References**