

# An Anatomical Study for Selective Neurectomy of the Calf Muscles

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## Abstract

**Background:** Calf hypertrophy is an aesthetic concern for women. Many methods such as liposuction, botulinum toxin type A injection and muscle resection have been used to reduce the calf size with reasonable results. A technique of selective neurectomy of the medial gastrocnemius and soleus muscles is used to improve the result of calf muscle reduction. There are few reports of selective neurectomy for calf hypertrophy in clinical cases and of anatomical study of nerves to gastrocnemius and soleus muscle.

**Objective:** To demonstrate the anatomical variation of nerves to gastrocnemius and soleus muscles.

**Methods:** Thirty five cadaveric legs (22 males and 13 females) with an average age of 43.7 years were dissected to determine the location of nerves to the gastrocnemius and soleus muscles. Number, direction and location of these nerves were recorded.

**Results:** The nerve to the soleus muscle had 2 branches: medial and lateral. The nerve to medial gastrocnemius had 1 branch in 31 (89%) and 2 branches in 4 (11%) of the legs examined. The nerve to the lateral gastrocnemius had only 1 branch in all legs. Eighteen male legs (82%) had 1 branch of nerve to the medial gastrocnemius and 4 male legs (18%) had 2 branches. All female legs had 1 branch of nerve to the medial gastrocnemius.

**Conclusion:** The nerves to medial and lateral soleus muscles have a constant number of branches, but the nerve to the medial gastrocnemius has variable number of branches.

**Keywords:** Selective neurectomy, calf muscle reduction, anatomical study

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## INTRODUCTION

Calf hypertrophy is an aesthetic concern for women, especially in Asians. The causes of the enlarged calves are either an excess of subcutaneous fat or calf muscle hypertrophy, or both<sup>1</sup>. There are many methods for reducing the calf circumference, depending on

the cause, such as liposuction in patients with excessive subcutaneous fat, and muscle resection, botulinum toxin injection and radiofrequency treatment for muscle hypertrophy<sup>2-7</sup>. The effect of Botulinum toxin injection is only temporary, and needs to be repeated every four to six months<sup>7,8</sup>. The resection of

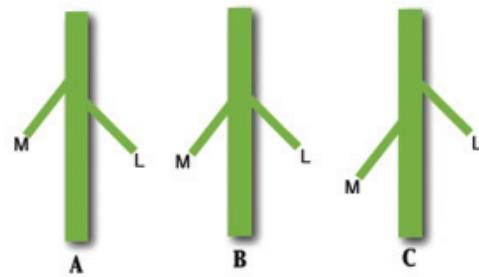
gastrocnemius muscle is time consuming and has risks such as hematoma formation and contour irregularity<sup>9</sup>. Also, the recovery period is long. Selective neurectomy of the nerve to gastrocnemius and soleus muscles can reduce the size of the muscles permanently, with a short recovery period. This procedure requires knowledge of the precise anatomy and variation of these nerves<sup>5-8</sup>. Few anatomical studies can be found in the literature<sup>5,6</sup>. The aim of the present study was to determine the number of muscular branches of the tibial nerve to the gastrocnemius and soleus muscles. The results should be helpful for selective neurectomy for calf reduction.

### MATERIAL AND METHODS

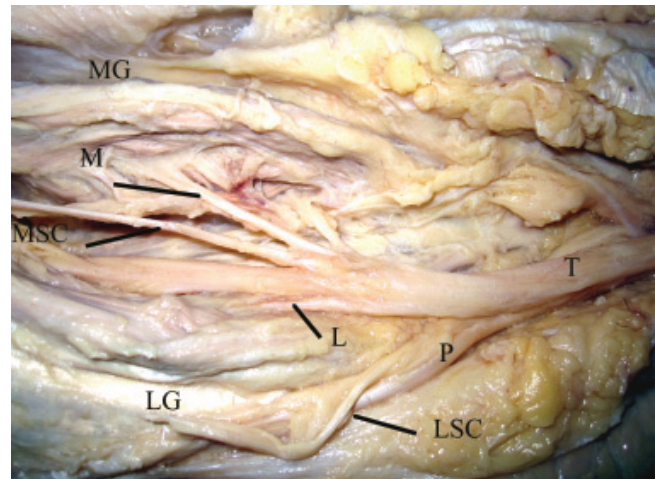
Thirty five cadaveric legs (22 males and 13 females) with an average age of 43.7 years were dissected to study the course of nerves to gastrocnemius and soleus muscles. This study was approved by the research ethics committee of the Faculty of Medicine, Siriraj Hospital, Mahidol University, Bangkok, Thailand. The cadavers were prepared by the usual methods. Each cadaver was placed prone with hip in neutral position and the knee extended. The popliteal region was exposed and the location of all branches of the popliteal nerve was recorded. Four bony landmarks were used as reference points: medial and lateral epicondyles of the femur and medial and lateral malleoli. Two heads of the gastrocnemius were retracted apart to trace the entrance of nerve branches into the muscles. Demographic data, number and position of the branches of the nerves to gastrocnemius and soleus muscles were recorded.

### RESULTS

The nerve to the gastrocnemius muscle arose from the tibial nerve in three different ways: 1) the nerve to the medial gastrocnemius muscle diverged superiorly to that of the lateral gastrocnemius muscle in 19 specimens (54%); 2) in 10 specimens (29%), the nerves to the medial and lateral gastrocnemius muscles diverged at the same level; 3) the nerve to the medial gastrocnemius muscle diverged inferiorly to that of the lateral gastrocnemius muscle in 6 specimens (17%) (Figure 1). Thirty one specimens were found to have one branch of nerve to the medial gastrocnemius



**Figure 1** The relation of nerves to gastrocnemius muscles. (A) Diverging point of the nerve to medial gastrocnemius is superior to that of the nerve to lateral gastrocnemius (54%). (B) Diverging points of nerves are the same (29%). (C) Diverging point of the nerve to medial gastrocnemius is inferior to that of the nerve to lateral gastrocnemius (17%)



**Figure 2** Demonstration of the medial (M) and lateral (L) branches of the nerve to gastrocnemius muscle. T, tibial nerve; P, peroneal nerve; MSC, medial sural cutaneous nerve; LSC, lateral sural cutaneous nerve

(89%) and 4 specimens had 2 branches (11%). Eighteen of 22 males had 1 branch of nerve to the medial gastrocnemius (82%) and 4 males had 2 branches (18%). All 13 females had 1 branch of nerve to the medial gastrocnemius. The nerve to the lateral gastrocnemius muscle originated from the tibial nerve with one branch in all specimens (Figure 2). The nerve to the soleus muscle originated from tibial nerve in all specimens. The diverging site was at the same level as the nerve to gastrocnemius in 6 of 35 specimens (17%) and lower in 29 specimens (83%). Each specimen had only one branch each of medial and lateral sural nerve.

## DISCUSSION

Bulky calf is considered to be aesthetically unpleasing especially in Asian women with short stature<sup>1</sup>. Liposuction is the treatment of choice when excessive subcutaneous fat is the cause. Prolonged edema, irregularity of skin, and fibrosis are the common complications<sup>4</sup>. Botulinum toxin type A injection can reduce the calf circumference by partial denervation of the gastrocnemius muscle by blocking the release of acetylcholine. In animal studies, muscle fibers injected with the toxin showed atrophy histologically within 10 to 14 days after injection. But the effect of the toxin lasts only four to six months. Repeated injections are required, and because the paralysis is often unpredictable, occasional asymmetries and unaesthetic outcomes occur<sup>7</sup>. Radio-frequency cauterization can reduce the volume of the gastrocnemius by releasing energy to the muscle causing focal coagulation necrosis<sup>10</sup>. There have been reports of extensive fibrosis of the calf muscle and plantar flexion contracture caused by this device<sup>11</sup>.

Surgical operations intended to reduce the muscle volume can be classified into direct (muscle resection) and indirect (selective neurectomy) methods. Combined resection of gastrocnemius and part of soleus muscle is the most effective procedure for reduction of the calf circumference, but it has many drawbacks such as technical difficulty, significant post-operative pain, prolonged recovery, significant scarring, and calf irregularity. Endoscopic-assisted muscle resection can be done with a small incision, under direct vision, and can minimize the risk of bleeding and neurovascular injury, but requires much experience and special instruments<sup>12</sup>. Selective neurectomy of gastrocnemius and soleus muscles is a simple procedure with minimal morbidity and a reliable outcome. The advantages include a short incision, short operative time and recovery time, but the improvement in calf circumference may be mild and a flat calf appearance may occur with this method.

Tsai et al. reported incomplete denervation of the gastrocnemius after neurectomy<sup>5</sup>. This finding emphasizes the importance of the anatomic study of the nerves to gastrocnemius and soleus muscles. In the present study, we found that the nerve to the medial gastrocnemius divides into 2 branches in 11% of the specimens. All nerves to the soleus muscle diverged from tibial nerve in the present study. But Hwang et al.

found that 70% of branches to the soleus muscle diverged from tibial nerve and 30% from the nerve to lateral gastrocnemius<sup>6</sup>. Thus, there are variations in the anatomy of the nerves to gastrocnemius and soleus muscles. Surgeons who wish to do selective neurectomy should be aware of these variations, and use a nerve stimulator during the procedure and perform meticulous dissection. This should improve the results of neurectomy.

## CONCLUSION

There were variations in the anatomy of the nerves to gastrocnemius and soleus muscles. The surgeon should be aware of these variations if he or she wishes to obtain good results from selective neurectomy for calf reduction.

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