Variant branching pattern and supply of the posterior division of femoral nerve: report of a rare case

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Abstract

Introduction
The knowledge of the variant nerves in the adductor canal and around the knee has gained importance with the increased popularity of knee surgeries, like knee replacement, anterior cruciate ligament repair and arthroscopy for diagnosis and treatment of knee disorders. The common postoperative complications of these surgeries are nerve injuries and persistent pain. This region has an equal importance to anaesthetists giving saphenous nerve block in the adductor canal, in which the nerve is anaesthetised with a minimal decrease in quadriceps motor power while providing analgesia after knee surgery. This article reports a rare case of variant branching pattern and supply of the posterior division of the femoral nerve.

Case report
During routine dissection of a 60-year-old male cadaver, we observed an unusual presentation of the nerves in the adductor canal on the right side. A mixed nerve was formed in the adductor canal by union of a branch arising from the nerve to vastus medialis and the saphenous nerve. Proximal to the knee, the mixed nerve subdivided into three branches—a muscular branch supplying the vastus medialis obliquus, an articular branch supplying the knee joint and a cutaneous branch supplying the infrapatellar region. This rare finding regarding the distribution of the nerves in the adductor canal, lower third of the front of the thigh and the medial side of the knee has not been reported in literature. Therefore, the innervations of the vastus medialis obliquus, knee joint and infrapatellar region by an unusual mixed nerve may be of clinical interest to the knee surgeons.

Conclusion
Surgeons performing total knee arthroplasty, anterior cruciate ligament repair and arthroscopy through medial approach should be aware of such rare variation. This finding has an equal importance to anaesthetists giving saphenous nerve block in the adductor canal to relieve pain following surgical interventions of the knee.

Introduction
The knowledge of the variant nerves in the adductor canal and around the knee has gained importance with the increased popularity of knee surgeries, like knee replacement, anterior cruciate ligament repair and arthroscopy for diagnosis and treatment of knee disorders. The common postoperative complications of these surgeries are nerve injuries and persistent pain. This region has an equal importance to anaesthetists giving saphenous nerve block in the adductor canal in which the nerve is anaesthetised with a minimal decrease in quadriceps motor power while providing analgesia after knee surgery.

The adductor canal is an aponeurotic tunnel in the middle third of the thigh that contains femoral vessels and its branches, the saphenous nerve and the nerve to vastus medialis. The saphenous nerve and the nerve to the vastus medialis arise from the posterior division of the femoral nerve just below the inguinal ligament in the femoral triangle and traverse lateral to the femoral artery. The nerve to the vastus medialis enters the muscle and sends a branch to the knee joint. The saphenous nerve crosses the femoral artery anteriorly, from the lateral to medial side, and becomes superficial by passing between the sartorius and gracilis. It gives rise to the infrapatellar branch that provides cutaneous sensation from the lower patella to the upper anterior portion of the leg. The saphenous nerve pierces the deep fascia to become subcutaneous, which run along the medial border of the tibia and medial side of the foot as far as the first metatarsophalangeal joint. Classically, the vastus medialis is attached to the medial border of the patella and helps in the extension of the knee joint. The lowest fibres of the vastus medialis are more horizontal and help in the stabilisation of the patella. The nerve supply to the vastus medialis is from the branch of the posterior division of the femoral nerve. Some authors have named vastus medialis as vastus medialis longus (VML) and lowest horizontal fibres as vastus medialis obliquus (VMO) and have suggested a dual nerve supply to both parts of the muscle.

As the recent reports have been explored, there are various studies on the innervations pattern of the vastus medialis and infrapatellar branch of the saphenous nerve individually. There are no reports regarding the formation of mixed nerve in the adductor canal. We are reporting an interesting case in which a mixed nerve was formed in the adductor canal by contribution from the nerve...
to the vastus medialis and saphenous nerve. This mixed nerve supplied the VMO, knee joint and skin around the patella. In addition, we also observed a unique pattern of innervations to the VML and VMO from the nerve to the vastus medialis and the mixed nerve respectively.

**Case report**

During routine cadaveric dissection of the lower limb in a 60-year-old male cadaver, we observed a variation in the course and distribution of the nerve to the vastus medialis and saphenous nerve on the right side. The left side was normal. The front of the thigh and infrapatellar region was dissected and neural structures were exposed. The muscles of the anterior compartment of the thigh were exposed, and arrangement of the neurovascular bundle was documented and the specimen was photographed.

The nerve to the vastus medialis and saphenous nerve originated from the posterior division of the femoral nerve below the inguinal ligament in the femoral triangle.

The nerve to the vastus medialis traversed lateral to the femoral artery, and near the apex of the femoral triangle it gave a branch (3 cm in length) that contributed to the mixed nerve. The nerve to the vastus medialis continued down in the adductor canal and supplied the VML.

The saphenous nerve was related lateral to the femoral artery in the adductor canal and followed its normal course in the leg and foot. Near the apex of the femoral triangle, the saphenous nerve gave a branch (3 cm in length) that contributed to the mixed nerve. It has no infrapatellar branch near the knee.

Thus, it was observed that the mixed nerve traversed lateral to the saphenous nerve and divided into three branches above the knee:

- Medial muscular branch that supplied the lower part of the VMO.
- Intermediate articular branch that supplied the knee joint.
- Lateral cutaneous branch that was related lateral to the sartorius and supplied the infrapatellar region (Figure 2 and 3).

**Discussion**

The adductor canal is an aponeurotic tunnel in the middle third of the thigh that contains femoral vessels with its branches, the saphenous nerve and the nerve to the vastus medialis. The saphenous nerve crosses the artery anteriorly from the lateral to the medialis and becomes superficial by passing between the sartorius and gracilis. It gives rise to the infrapatellar branch that provides cutaneous sensation from the lower patella to the upper anterior portion of the leg. The nerve to the vastus medialis enters the muscle and sends a branch to the knee joint.

The damage to the infrapatellar branch of the saphenous nerve may lead to an insignificant numbness but also to painful neuroma and reflex sympathetic dystrophy, decreasing the quality of life of the patients. Recently, ultrasound-guided saphenous nerve block within and distal to the adductor canal have shown success. However, a potential side effect is an unintentional block of branches of the nerve to the vastus medialis, resulting in undesired motor weakness. Second, Leib and
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Perry described the vastus medialis to consist of two portions—the VML and VMO. The VML is reported to directly contribute to knee extension, while the VMO provides medial stabilisation of the patella during knee extension. A medial approach for total knee arthroplasty and arthroscopy splits the vastus medialis muscles and may damage the muscle or the nerves situated in this region, leading to extensor mechanism failure and subsequently patellar maltracking.

The saphenous nerve after leaving the adductor canal did not give an infrapatellar branch, but the whole sensory nerves of the infrapatellar region were originating from the medial femoral cutaneous nerve. The infrapatellar region was innervated by the medial cutaneous femoral nerve proximally and saphenous nerve distally and stated that these two nerves have a complicated distribution in the infrapatellar region. The inferior patellar branch of the saphenous nerve was present in all limbs in a study of 230 cadavers and classified the nerve into four types according to its relationship to the sartorius muscle: posterior, penetrating, parallel and anterior. Classically, the nerve supply to the vastus medialis is thought to arise solely from the nerve to the vastus medialis running in the adductor canal. The authors further speculate that the vastus medialis has dual nerve supply. There was dual nerve supply from the VMO to the vastus medialis that usually had four to five terminal branches and another from the saphenous nerve just before the origin of the infrapatellar branch. On electromyographic study, the contraction of muscle by stimulation of the saphenous nerve shows that the saphenous nerve is not purely sensory. The nerve supply to the vastus medialis has a consistent bipartite pattern from the posterior division of the femoral nerve. A short and slender nerve termed the lateral branch supplied the upper lateral portion of the muscle. The other part, a medial branch, supplied the middle and lower portion of the muscle. There is an increase in the number of nerve fibres supplying the muscle towards the distal end, with the lowermost muscle fibres receiving the richest nerve supply. In another study dual pattern study of the nerve distribution to vastus medialis was observed. In the first pattern, the main trunk ran in the mid portion of the vastus medialis and then divided into multiple branches that entered the distal oblique fibres of the muscle. In the second pattern, the main trunk ran in the posterior portion of the muscle and branched to the distal oblique fibres.

In our study, we noticed the mixed nerve formation in the adductor canal by contribution from the nerve to the vastus medialis and the saphenous nerve. The nerve to the vastus medialis supplied the VML and a muscular branch from the mixed nerve supplied the VMO. The mixed nerve gave an infrapatellar branch that was related lateral to the sartorius and to the infrapatellar region. The saphenous nerve was related medial to the sartorius and without giving an infrapatellar branch it followed its normal course in the leg. There was an additional branch from the mixed nerve that supplied the knee joint.

Conclusion

Apart from academic interest, the knowledge about the presence of unusual mixed nerves and its branches in the adductor canal and around the knee along with the dual nerve supply to the vastus medialis should help the surgeons and anaesthetists performing different procedures in these regions. Surgeons should be aware of such rare variation of nerves and performing different procedures around the knee through awareness of such rare variation of nerves and its branch should also have an idea of this kind of variation while giving saphenous nerve block to avoid unintentional involvement of nerves supplying the vastus medialis, which may result in undesired motor weakness.

Acknowledgements

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Abbreviations list
VML, vastus medialis longus; VMO, vastus medialis obliquus.

References

Figure 3: F, femoral nerve; A, nerve to vastus medialis; B, saphenous nerve; a, communicating branch from nerve to vastus medialis; b, communicating branch from saphenous nerve; C, mixed nerve; d, muscular branch to VMO from mixed nerve; e, articular branch to knee joint from mixed nerve; f, infrapatellar branch from mixed nerve.

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