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Localization of the Lateral Retinacular Nerve for diagnostic and therapeutic nerve block for Lateral Knee Pain: A Cadaveric Study

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Abstract

Objective—To describe the anatomical landmarks for localization of the lateral retinacular nerve (LRN) in order to facilitate diagnostic and therapeutic nerve block and treatment for anterolateral knee pain.

Design—Descriptive study.

Setting—Anatomy laboratory in academic institution.

Methods—Twenty lower extremities were dissected in 12 cadavers. The sciatic nerve was identified, and its branch to the posterior aspect of the knee, the superior lateral genicular nerve (SLGN), was dissected. The SLGN dissection was continued distally to identify its first branch, the LRN. Two measurements were taken from the branch point on the lateral knee deep to the distal biceps tendon in alignment with the fibular head. A validation study was performed as follows: 1 milliliter of colored dye was injected at the first and second measurements. The cadaveric knee was then dissected to assess the accuracy.

Main Outcome Measurements—Localization of the branch point of the LRN from the SLGN via dissection and then direct assessment of injected dye at the measurement points via dissection

Results—The branch point of the LRN from the SLGN was, on average, 5.5 cm $\pm$ 0.66 (with a range of 4.5 to 7.0 cm) proximal to the lateral tibiofemoral joint line and 2.6 cm $\pm$ 0.62 (2.0 to 4.5 cm) proximal to the tip of the lateral femoral epicondyle. On assessment of the two measurements, the measurement 5.5 cm proximal to the lateral joint line accurately targeted the branch point in 100% (4/4) of the knees, whereas the measurement 2.6 cm proximal the tip of the lateral femoral epicondyle accurately targeted the branch point in 75% (3/4) of the knees.

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Conclusion—The results of this study provide two dependable landmarks and a description of the path of the LRN making it possible to target the lateral retinacular nerve to diagnose and alleviate lateral knee pain.

INTRODUCTION

Knee pain is one of the most common reasons for referral to an outpatient musculoskeletal clinic ¹. Patellofemoral pain syndrome (PFPS) is a frequent source of anterior knee pain and is commonly seen in the young active population ^{2,3}. Knee pain is often poorly localized, but the anterior aspect of the knee around the patella is a commonly cited location for pain.

In PFPS, abnormal knee mechanics and overuse, including patellofemoral malalignment, lateral patellofemoral overloading and tight lateral patellofemoral retinaculum ^{2,4,5}, can lead to chronically stressed peripatellar soft tissues, particularly in the lateral patellofemoral retinaculum (lateral retinaculum). The lateral retinaculum is composed of multiple fascial layers from the iliotibial tract and quadriceps tendon that converge and interdigitate on the anterolateral aspect of the patella ⁶. This retinaculum is innervated by the lateral retinacular nerve (LRN), which is a branch of the superior lateral genicular nerve (SLGN). Tightness and shortening of the lateral retinaculum can lead to secondary nerve damage of the LRN resembling the histopathologic picture of interdigital neuritis (Morton's neuroma)⁷.

The literature includes a broad spectrum of successful techniques in conservative management of PFPS, including therapeutic exercises and patellar taping ^{8,9}, however some patients continue to experience peripatellar pain refractory to conservative measures. In these patients, studies have shown improvement of lateral knee pain after lateral retinacular release. Interestingly, it has been shown that lateral retinacular release does not reliably result in appreciable improvement in patellofemoral contact pressure despite the improvement of pain ^{10–13}. Therefore, resection of the lateral retinacular nerve is thought to be the underlying mechanism of improvement in knee pain following lateral retinacular release¹².

The infrapatellar branch of the saphenous nerve, a well-documented source of medial knee pain ¹⁴, is commonly and successfully treated with peripheral nerve blocks to alleviate medial knee pain ¹⁵. Yaser et al ¹⁷ recently investigated the anatomic landmarks for blocking the superior medial genicular nerve (SMGN) and inferior medial genicular nerve (IMGN) through cadaveric dissection. Neurectomy of the lateral retinacular nerve has been previously reported for intractable anterolateral knee pain ¹⁶, yet the contribution of the lateral retinacular nerve to anterolateral knee pain is not well documented and there is little published about nerve block targeting the lateral retinacular nerve.

The objective of our cadaveric study is to examine and document the anatomical landmarks for localization of the lateral retinacular nerve in order to facilitate targeting for nerve block to diagnose and treat anterolateral knee pain.

MATERIALS AND METHODS

A total of 20 lower extremities were dissected in 12 embalmed cadavers from a first-year medical anatomy course (eight female, four male, age 57–95 years at the time of death). Four limbs were excluded - one because of total knee arthroplasty, and three due to prior complete dissection of the patella. With the cadaver in the prone position, the lateral femoral epicondyle, lateral patella and fibular head were identified by palpation. The iliotibial tract, the long and short heads of the biceps femoris and the vastus lateralis muscles were cleaned and defined. The sciatic nerve was identified at the superior end of the popliteal fossa, and its branch to the posterior aspect of the knee, the superior lateral genicular nerve (SLGN), was identified. Dissection of the SLGN was continued distally to identify its first branch, the lateral retinacular nerve (LRN). Its relationship to the lateral retinaculum was verified. With the lower extremity in full extension, a line was drawn longitudinally through the fibular head extending superiorly along the femur to a level 4cm superior to the lateral epicondyle. Two measurements were taken along this line on the lateral knee. The first measurement was taken from the point at which the LRN branched from the SLGN to the lateral tibiofemoral knee joint line. The lateral tibiofemoral joint line correlates with the midpoint between the distal femur and the proximal tibia. The second measurement was taken from the LRN branch point off the SLGN to the tip of the lateral femoral epicondyle (Figure 1). The tip of the lateral femoral epicondyle was located by palpating the peak eminence on the femoral epicondyle as the fingers descend the lateral femur.

After calculating the mean measurement for the first and second data points, the accuracy of the measurements was tested. One milliliter of red dye was injected at the first measurement point in each knee and 1 milliliter of blue dye was injected at the second measurement point at each knee in a total of 4 undissected lower extremities. The injections were performed with the cadaver in the prone position and a lateral to medial approach was used to target the branch point of the SLGN and LRN. With the subject in full knee extension, a line was drawn parallel from the fibular head extending proximally to the femur. The needle was inserted at the mean measurements to the depth of the femoral periosteum. The knees of the cadavers were then dissected and the accuracy of each respective color to the branch point of the SLGN and LRN was visualized.

RESULTS

The SLGN most commonly branched from the sciatic nerve just proximal to its division into the tibial and common fibular nerves. In 20% of the cases (4/20) the sciatic nerve divided high in the proximal thigh and the SLGN branched from the common fibular nerve near the superior boundary of the popliteal fossa. The SLGN consistently traveled in the superolateral aspect of the popliteal fossa in a horizontal course off the sciatic nerve to reach the medial aspect of the biceps femoris tendon. It then continued distally in an oblique course to the lateral aspect of the knee, remaining deep to the biceps tendon and iliotibial tract where the SLGN branched. One branch traveled directly to the synovial surface of the lateral femoral condyle; the other branch, the LRN traveled with the superior lateral genicular artery and vein along the tendons of the biceps femoris and vastus lateralis giving branches to the lateral retinaculum.

The branch point of the LRN from the SLGN was, on average, 5.5 cm $\pm$ 0.66 (with a range 4.5 to 7.0 cm) proximal to the lateral tibiofemoral joint line and 2.6 cm $\pm$ 0.62 (with a range of 2.0 to 4.5 cm) proximal to the tip of the lateral femoral epicondyle (Figure 1).

The red dye injected at the measurement 5.5 cm proximal to the lateral joint line accurately targeted the branch point of the LRN from the SLGN in 100% (4/4) of the knees, whereas the measurement 2.6 cm proximal to the tip of the lateral femoral epicondyle accurately targeted the nerve in 75% (3/4) of the knees (Figure 2).

DISCUSSION

The results of this study indicate that the LRN is consistently present and can be found within a narrow range of distances related to prominent landmarks in the lateral knee compartment. Even when the sciatic nerve branched in the proximal thigh, the LRN was reliably found within the same range of distances from the lateral knee joint line and the tip of the lateral femoral epicondyle. Therefore, these anatomical structures are reliable landmarks for localization of the LRN. The physiatrist evaluating a patient for lateral knee pain can, on average, find the LRN at 5.5 cm proximal to the lateral joint line and 2.6 cm proximal to the tip of the lateral femoral epicondyle when measured with a line drawn longitudinally through the fibular head extending proximally along the femur with the knee in full extension. Male and female data was combined, as Q angle was not anticipated to have an effect on our measurements.

On injecting at these two measurements using exclusively anatomic landmarks in the undissected knees, the branch point of the LRN and SLGN is consistently targeted when injecting 5.5 cm proximal to the lateral joint line. In comparison, the same branch point is targeted 75% of the time when injecting 2.6 cm proximal to the tip of the lateral femoral epicondyle (Figure 2). This difference in reliability between the first and second measurement points could be secondary to the fact that palpation of the tip of the lateral femoral epicondyle is less common among medical professionals performing a knee examination compared to palpation of the lateral joint line. As a result, the true 'tip' of the lateral femoral epicondyle is more difficult to reliably localize.

It is likely that the pain relief patients experience in patellofemoral pain syndrome with lateral retinacular release is a result of resection of the LRN¹². Considering the proximity of SLGN and LRN to the iliotibial band (ITB) and the lateral femoral condyle as depicted in Figure 1, this nerve can also be a culprit for distal iliotibial friction syndrome. Improvement of pain after injection under the distal ITB can be explained by the LRN block effect. Improvement of lateral knee pain after stretching of the ITB can be partly explained by decreasing LRN irritation under the ITB in addition to the well-established biomechanical effect. While LRN block has not been widely documented, with reliable landmarks and documentation of a consistent neural pathway it can be proposed as a good choice for conservative management of lateral knee pain.

Researchers have evaluated and discussed the innervation of the lateral retinaculum previously, but none have provided precise and reliable surface landmarks for the course of

the LRN. Fulkerson localized the LRN by performing stains on lateral retinacular biopsies for visualization of the nerves⁴. Horner reported finding a branch of the SLGN innervating the lateral retinaculum without precisely identifying landmarks in fresh cadaveric knees¹². In operative management of knee pain, Nahabedian¹⁸ discussed that in order to excise the lateral retinacular nerve he incised the lateral retinaculum between the patella and the iliotibial tract. These researchers have laid the groundwork, and emphasized the significance of the LRN in chronic persistent lateral patellar pain. Yet, the literature currently contains inadequate information for clinical application such as diagnostic or therapeutic block. This study aims to provide reliable landmarks to precisely localize and block the LRN.

Choi et al¹⁹ investigated radiofrequency neurotomy as a therapeutic intervention for patients with chronic knee pain. With the patient in a supine position, they target the genicular nerve branches of the medial and lateral aspect of the knee under fluoroscope guidance. During the procedure, sensory stimulation is used to confirm the proximity of the needle to the target nerve. The detailed landmarks provided in this study of the location of the supralateral genicular nerve can be utilized to assist current localization of the nerve. Although these genicular nerve blocks are typically performed with the patient in the supine position, contrary to the injection to the cadaver in this study, a lateral to medial approach (along a line drawn parallel from the fibular head to the femur with the knee in full extension) can be used to block the nerve branches in the supine position as well (Figure 3 & 4). It is important to position the knee so that the femoral epicondyles are parallel with the image receptor for a true AP projection. An injection given at the branching point of SLGN and LRN can achieve an effective block of both nerves, while also maintaining distance from the sciatic nerve trunk. Further, ultrasound imaging can be utilized to avoid injecting neighboring arterioles, although the depth of the structures often challenges optimal visualization. The accuracy and the efficacy of the LRN nerve block using ultrasound guidance needs to be confirmed by a prospective study.

Potential limitations in this study should also be noted. The study included a small number of subjects, limited by the cadavers available in the anatomy laboratory therefore the results may not represent the general population. Further, the cadavers were dissected and injected in the prone position with knee in full extension, which can be challenging in patients with knee pain in clinical practice. Therefore, future clinical studies to evaluate the accuracy and efficacy of the nerve block are warranted.

CONCLUSION

The results of this study provide dependable landmarks and a description of the path of the LRN making it possible to target the lateral retinacular nerve to alleviate lateral knee pain. This information, in combination with experienced musculoskeletal diagnostic and treatment skills, can be useful in the management of patients with chronic refractory lateral knee pain.

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Figure 1.

Figure 1A. Illustration of the nerve supply to the lateral retinaculum: posterior and lateral views. The SLGN branches from the SN. The LRN branches from the SLGN 5.5 cm proximal to the lateral joint line and 2.6 cm proximal to the tip of the lateral femoral epicondyle. The LRN then passes anteroinferiorly deep to the biceps femoris tendon to supply the lateral retinaculum. Note that the relative diameters of the SLGN and LRN in this image are increased to aid visibility.

Figure 1B. Dissection showing the paths of the SLGN and LRN: lateral view. Abbreviations: LRN lateral retinacular nerve; SLGN superior lateral geniculate nerve; SN sciatic nerve.

Figure 2.

Dissection of a cadaveric knee in the prone position. The red dye injected at the measurement 5.5 cm proximal to the lateral joint line and the blue dye injected 2.6 cm proximal to the tip of the lateral femoral epicondyle. Abbreviations: LRN lateral retinacular nerve; SLGN superior lateral geniculate nerve

Figure 3.

Photograph of the right knee joint in full extension with the patient supine. With an imaginary line drawn parallel from the fibular head to the femur, a spinal needle is placed on the skin of the patient at 5.5 cm proximal to the lateral joint line at the branch point of the LRN from the SLGN. Abbreviations: LRN lateral retinacular nerve; SLGN superior lateral geniculate nerve

Figure 4.

Fluoroscopic image of a true anteroposterior view of the right knee joint in full extension. A spinal needle is placed on the skin of the patient at 5.5 cm proximal to the lateral joint line at the branch point of the LRN from the SLGN. Abbreviations: LRN lateral retinacular nerve; SLGN superior lateral geniculate nerve