Techniques in Regional Anesthesia and Pain Management 17 (2013) 131–139

Available online at www.sciencedirect.com

ScienceDirect

www.elsevier.com/locate/trap

Ultrasound-guided pain interventions in the knee region

Domingo Manzano, MD[a,], Fernando Jimenez, MD[b], Marc Blasi, MSc[c]*

[a]*Department of Anesthesia, Chronic Pain Unit, Hospital ASEPEYO, Joaquin de Cárdenas 2, 28823 Coslada, Madrid, Spain*
[b]*Sports Science, Hospital SOLIMAT, Toledo, Spain*
[c]*Department of Fundamental Care and Medical-Surgical Nursing, University School of Nursing, Hospital Bellvitge, Barcelona, Spain*

ARTICLE INFO

Keywords:
Ultrasound-guided blocks
Musculoskeletal ultrasound
Knee injection
Saphenous nerve block

ABSTRACT

Most routine intra-articular and extra-articular knee infiltrations performed in pain management are carried out by means of blind techniques or fluoroscopy-guided techniques. Alternatively, ultrasound-guided techniques are a safer and more precise way to perform these procedures. An extensive knowledge of knee anatomy will help us to obtain high-quality real-time ultrasound images before performing any infiltrations. In the current article, we present how to systematically examine the knee sonoanatomy and also describe the ultrasound-guided interventional basis for knee joint pain management.

Introduction

Knee pain is one of the most frequent causes of medical consultation. It has a multifactorial etiology: myofascial, neuropathic, or articular. When it is not alleviated with etiologic treatment, we can infiltrate the periarticular tissue of the knee or perform blocks of the primary nerves that innervate the target pain-generating region or structure. To do so, blind-technique knee injections are relatively accurate in skilled hands. However, when a definitive diagnosis is needed, ultrasound-guided injections should be seriously considered. Ultrasound can help us to define the cause of knee pain and, above all, enables us to monitor interventional pain procedures, thus improving the accuracy of the infiltrations.[1,2]

Intra-articular and extra-articular structures of the knee relevant to pain management

Knee sonoanatomy

The knee may be anatomically divided into 4 compartments: anterior, posterior, lateral, and medial. High-frequency transducers (10-12 MHz) are used to evaluate all compartments except for the posterior compartment where lower frequencies are needed (8 MHz). It is important to mention that as far as intra-articular soft tissue structures (menisci, anterior cruciate ligament, and posterior cruciate ligament) are surrounded by bone, it is quite difficult to fully visualize them by means of ultrasound imaging.

Anterior compartment of the knee

To proceed to the examination of this compartment, the patient is placed in a supine position with the knee to be explored semiflexed (between 10° and 20°). A pillow should be placed below the knees for patient comfort.

First, the 4 muscle bellies of the quadriceps muscle that merge into the quadricipital tendon have to be identified and examined. Then, by placing the transducer longitudinal over the femoral long axis, with its distal edge in contact with the proximal border of the patella, the quadricipital tendon longitudinally can be visualized. The ultrasound image of the quadricipital tendon is hyperechoic and it presents a typical tendinous fibrillar pattern. It is very well defined on its anterior surface because of the contrast obtained with the

* *Corresponding author.*
E-mail address: domangas@gmail.com (D. Manzano).

1084-208X/$ - see front matter
http://dx.doi.org/10.1053/j.trap.2014.01.015

adjacent subcutaneous fat echotexture. Below the aforementioned tendon, the suprapatellar recess can be observed as a longitudinal hypoechoic structure.

To visualize the *patellar tendon*, the transducer is moved distally, following the femoral longitudinal axis until the infrapatellar region is reached. Moreover, the transducer has to be adjusted to end at the midsagittal plane of the anterior aspect of the knee, between the patella and the tibial tuberosity (Figure 1). The patellar tendon fibers have 2 different proximal attachments; deep fibers come from the distal border of the patella, whereas superficial fibers are a contribution from the quadricipital tendon, specifically, a prolongation of the rectus femoris' contribution to the quadricipital tendon. The patellar tendon is observed as a hyperechoic, fibrillar, uniform structure. Deep to the patellar tendon, the Hoffa fat pad can be observed as a slightly hyperechoic or isoechoic structure. The entire patellar tendon must be explored from its proximal patellar attachment to the distal attachment on the tibial tuberosity. At any point, the transducer can be rotated 90° to examine the tendon transversally on the short axis.

The examination of the medial and lateral patellar *retinacula* is performed with the transducer placed longitudinal to the femoral long axis. Proximal and medial to the patella, we can visualize the medial patellar retinaculum as a hyperechoic, fibrillar, thin structure (between 1 and 2 mm). It runs obliquely and transversely as an aponeurotic expansion from the sartorius and vastus medialis muscles to the medial patellar border. Conversely, the lateral patellar retinaculum appears as a hyperechoic band that runs obliquely and transversely as an aponeurotic expansion from the iliotibial band and the vastus lateralis muscle to its attachment on the lateral patellar border and the adjacent patellar tendon (Figure 2).

Posterior compartment of the knee

The patient is placed in a prone position with the knees extended and both feet hanging over the examination table. In this position, we can explore the muscles that define the popliteal fossa as well as the structures found within: the posterior horns of both menisci, the posterior cruciate ligament, and the popliteal blood vessels. In addition, to perform interventionist treatments of the posterior knee, we must learn to locate the semimembranous gastrocnemius bursa.

By placing the transducer longitudinally on the superior-medial border of the popliteal fossa, the medial head of the *gastrocnemius muscle* can be observed. By moving the transducer medially, a highly hyperechoic structure that corresponds to the semimembranosus tendon is visualized. The hypoechoic semimembranosus gastrocnemius *bursa* can be observed in this same region as it separates the medial border of the medial head of the gastrocnemius muscle and the semimembranosus tendon, just superficial to the medial femoral condyle (Figure 3). A Baker cyst is encountered if this bursa is filled with liquid.

Lateral compartment of the knee

To explore the lateral structures of the knee, the patient is asked to either internally rotate his or her leg or to lie in a lateral decubitus position on the opposite side of the knee that needs to be scanned. A pillow should be placed between the knees to stabilize them and for patient comfort.

The transducer is placed longitudinally on the external region of the knee. In the deepest plane, an important bone landmark that corresponds to the femoral condyle appears as a curved and reflective line. Superficial to the femoral condyle, there is a fibrillar hyperechoic structure that corresponds to the *iliotibial band*. This structure is the distal aponeurosis of the tensor muscle of fascia lata and the gluteus maximus muscle, and it attaches distally on the lateral tibial tubercle or the Gerdy tubercle (Figure 4).

The next step is to identify the collateral lateral *ligament*, which is a narrow band that runs oblique, caudal, and posterior, bridging between the lateral aspect of the femoral condyle and the head of the fibula. The *femoral biceps distal*

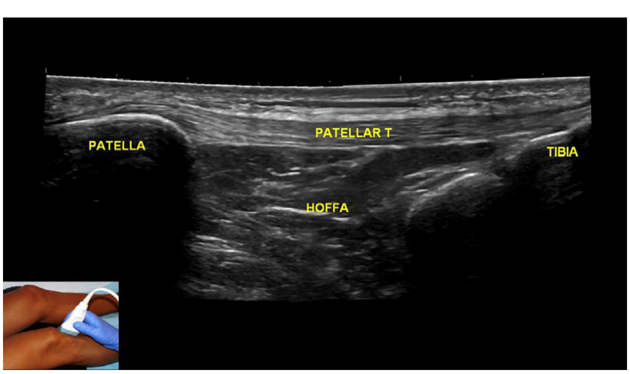

Fig. 1 – Sonoanatomy of the anterior compartment of the knee. The panoramic longitudinal study of the patellar tendon offers a well-defined cordlike image. It possesses a hyperechoic fibrillar pattern, different from the echotexture of the underlying Hoffa fat. (Color version of figure is available online.)

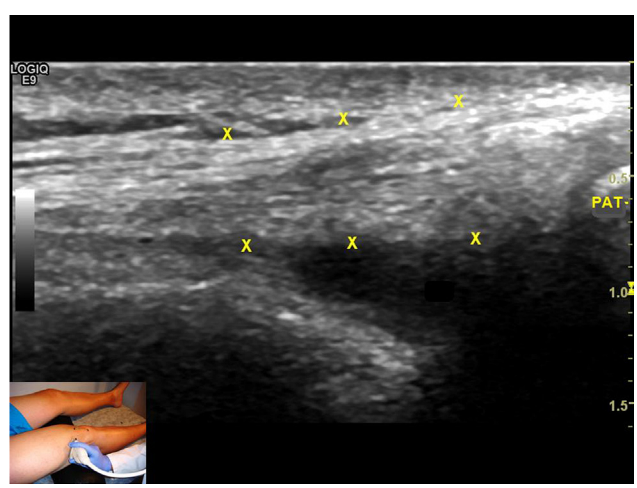

Fig. 2 – Sonoanatomy of the anterior compartment of the knee. The US longitudinal view of the external patellar retinaculum shows a hyperechoic fibrillar structure (X) as an expansion from the vastus lateralis muscle to the patellar lateral border. The area with hypoechogenic signal that appears deep to the lateral patellar retinaculum corresponds to the prolongation of the suprapatellar recess. (Color version of figure is available online.)

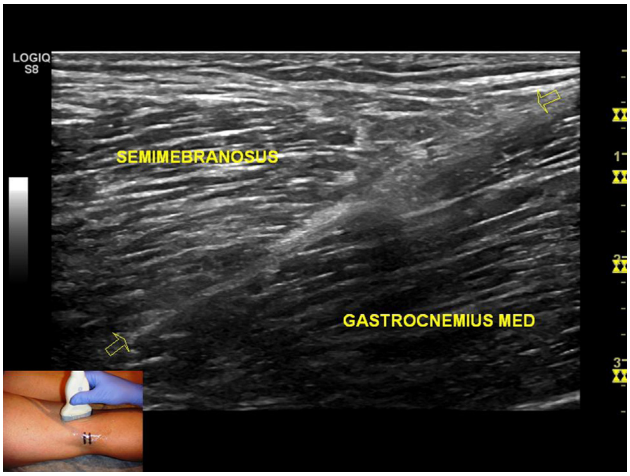

Fig. 3 – Sonoanatomy of posterior compartment of the knee. The 2 hyperechoic lines (arrows) correspond to the limits of the gastrocnemius semimembranosus bursa, which is empty in the present patient. This bursa separates the medial head of the gastrocnemius muscle from the semimembranosus tendon. (Color version of figure is available online.)

tendon also attaches on the head of the fibula and shows an oblique path disposed in a posterior and caudal direction that appears as a hyperechoic fibrillar band. This tendon extends proximally to constitute the biceps femoris distal myotendinous junction.

Medial compartment of the knee

The patient is placed in a supine position, partially tilted toward the affected side. The lower extremity to be scanned should be held in external rotation until the lateral border of the foot touches the examination table. In that position, the transducer is placed longitudinal to the femoral long axis, on the medial aspect of the knee, with a slightly angled orientation. The proximal attachment of the *collateral medial ligament* is observed as a band that runs distal from the medial femoral condyle until it reaches the proximal tibial epiphysis, deep to the pes anserine. The ultrasound image of the collateral medial ligament enables us to distinguish between the superficial and the deep components because of the different echotextures of these 2 layers (Figure 5).

If the transducer is moved distally toward the tibia, maintaining the collateral medial ligament as a landmark, the *pes anserine attachment* becomes visible. This structure is constituted by the merging of the distal sartorius, gracilis, and semitendinosus tendons, and it attaches on the anterior-medial aspect of the proximal tibial shaft. The ultrasound image of the pes anserine is presented as a fibrillar hyperechoic structure, superficial to the tibial cortical surface. The presence of a bursa is occasionally observed, and it appears as an anechoic space at the tendinous insertion.

Most frequent ultrasound-guided knee interventions

Ultrasound monitoring helps us to evaluate periarticular fluid collections (such as hematomas, abscess, and seromas), and it allows us to access accurately the knee joint and surrounding tissues to perform injections just adjacent to the structure that may be the cause of pain. The use of high-frequency transducers (12-15 MHz) enables us to obtain high-quality images of the analyzed anatomical structures and to precisely identify the safest location to perform the injection; this includes patients presenting restricted joint motion or with edematous tendon sheaths.

It is important to mention that extra-articular infiltrations of the knee soft tissues is controversial, especially regarding safety and efficacy, when compared with the generalized and accepted practice of the intra-articular injections to treat knee pathology.[3]

Iliotibial band infiltrations

Iliotibial band syndrome is the most common cause of lateral knee pain. Repetitive flexion-extension movements of the knee joint may produce microinjuries of the distal iliotibial band, an inflammation, and posterior implication of the serous bursa found between the iliotibial band and the lateral femoral condyle. Usually, it affects athletes who are involved in sports that require continuous running or repetitive knee flexion and extension, and it is caused by a combination of overuse and other biomechanical factors, specifically excessive friction of the distal band as it slides over the lateral femoral epicondyle. Therefore, it is very important to examine the space between this aponeurotic band and the lateral femoral condyle, because it is where most of frictional injuries are developed, causing the iliotibial band syndrome.[4,5]

The transducer is placed longitudinal to the femoral long axis, on the external aspect of the iliotibial band. The injection can be performed using an in-plane or out-of-plane approach. By focusing on the needle bevel, we must monitor the correct spread of the anti-inflammatory substance into the space adjacent the iliotibial band (Figure 6).

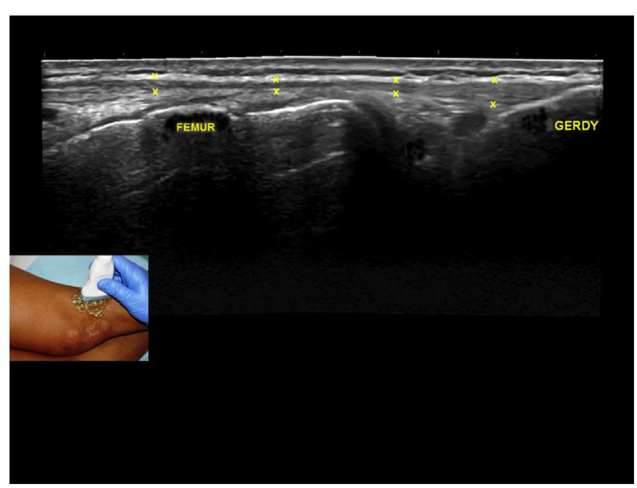

Fig. 4 – Sonoanatomy of the lateral compartment of the knee. Panoramic longitudinal view of the external femoral condyle showing the iliotibial band (X), which is observed as a fibrillar structure adjacent to the subcutaneous adipose tissue. (Color version of figure is available online.)

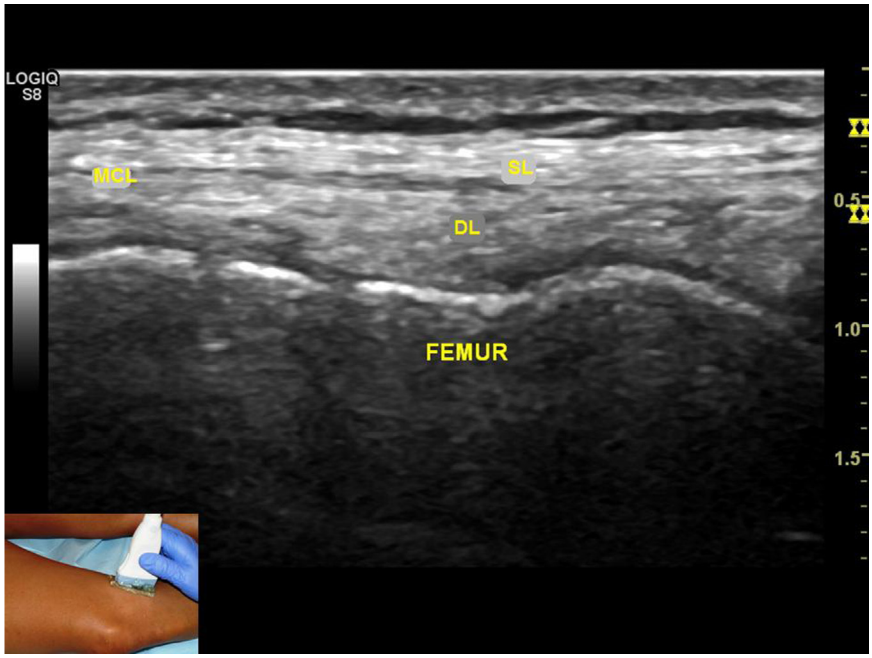

Fig. 5 – Sonoanatomy of the medial compartment of the knee. The superficial layer (SL) and deep layer (DL) of the medial collateral ligament (MCL) are observed, separated by a thin anechoic space corresponding to areolar connective tissue. (Color version of figure is available online.)

Peritendinous vascular sclerosis

Tendinosis is usually caused either by a long-term underuse or overuse of a tendon. As a consequence of repetitive microtraumatisms, an active process of destruction and repair is triggered at a microscopic level. This is macroscopically manifested by the overall thickening of the tendon and the loss of homogeneity of its fibrillar pattern. In some cases, this process resolves in a total repair but, unfortunately, sometimes it does not, establishing a degenerative process known as tendinosis. Histopathology studies have evidenced that in tendon samples affected by chronic overuse or underuse injuries, there exist only a small number of inflammatory cells (macrophages, lymphocytes, and neutrophils). Moreover, the main degenerative affectation was observed as an alteration of collagen fibers, fibrocytes, and ground substance. In addition, increase of vascularization owing to vascular hyperplasia rather than to angiogenesis was noted. Furthermore, blood vessels were abnormal and tended to be perpendicular to the tendon axis, disposed in a right angle.[6,7] Performing an ultrasound-guided infiltration of a sclerosing substance into the intratendinous blood vessels can correct the degenerative process and thus relieve the pain.[8]

Ultrasound-guided infiltration of blood vessels found in the peritendinous region, just before they run into the tendon, avoids direct introduction of the sclerosing substance into the tendon. To perform this technique, first the injured region of the tendon should be correctly visualized. Then, the puncture site is sterilized and a 21-gauge needle is prepared with the sclerosing substance—polidocanol. High concentrations of this drug are necessary to obtain effective sclerosis (0.5% for vessels in thin tendons and up to 2% for vessels in thick tendons). It is possible to monitor the needle bevel position in the peritendinous space and thus avoid infiltration of the tendon by using in-plane and out-of-plane approaches alternatively. During advancement of the needle, a visual relation between the needle bevel and the target vessel has to be maintained (Figure 7). Once the needle is positioned, injection of the sclerosing substance has to be performed in plane on the deep surface of the tendon. It is mandatory to monitor substance spread and the correct positioning of the bevel in relation to the target vessel during this process. In addition, it is important to remember that when using out-of-plane approaches, the needle is not entirely visualized and, therefore, special care has to be given to the location of the bevel.

Sclerotherapy can be combined with a little curettage of the deep surface of the tendon (Figure 8). This procedure offers

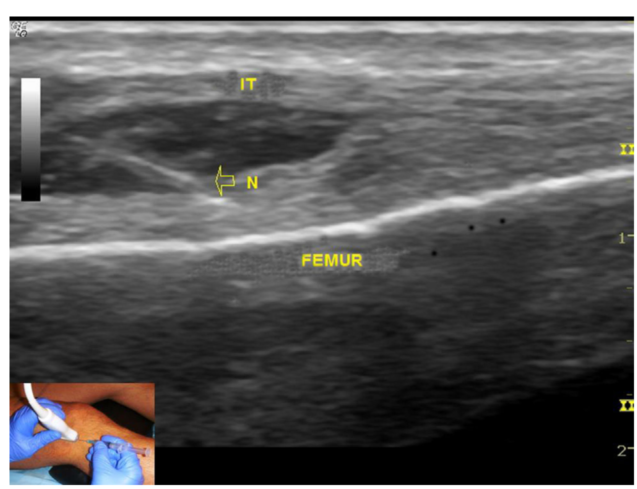

Fig. 6 – Iliotibial band infiltration. An in-plane approach where we can see the needle bevel (arrow). The substance infiltrated is administered just deep to the iliotibial band. (Color version of figure is available online.)

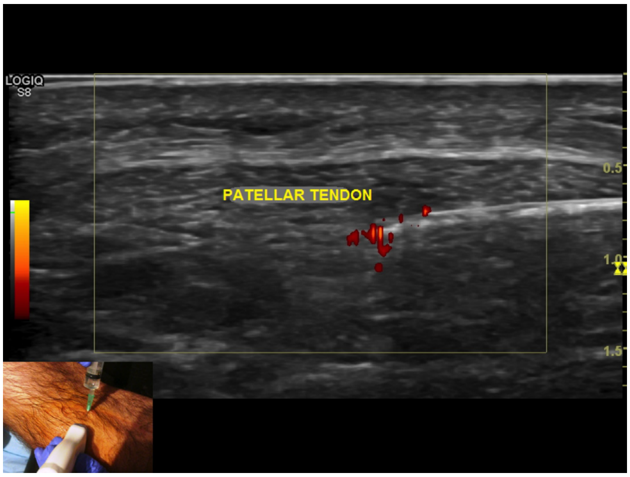

Fig. 7 – Sclerosis of the patellar tendon with polidocanol. Transverse view (short axis) of the patellar tendon using an in-plane approach. Power Doppler shows hyperplasic vessels, indicating the target point for this procedure. (Color version of figure is available online.)

good clinical results; however, it is a more radical method when compared with the isolated sclerosing injection. The main advantage is a shorter rehabilitation period; thus, the patient can return to physical activities in 3-6 weeks. Clinical trials with 2-3 years follow-up after intervention have demonstrated that patients stay free from tendon pain even during weight-bearing activities.[9,10]

Synovial plica invasive treatment

Sinovial plicae are intra-articular fibrous embryonic remnants. Although they are found in approximately 30% of patients, symptomatology is present only in a small number of cases. The medial plica frequently causes pain in the upper and medial edges of the patella, which increases with knee flexion and extension. It also causes hyperesthesia of this region, up to the articular line.[11] Plica syndrome treatment is usually conservative and is based on rest, using ice, and using nonsteroidal anti-inflammatory medication. Moreover, it is often used in conjunction with therapeutic exercise. If conservative treatment fails, either corticosteroid infiltrations or surgical removal of the plica of the affected knee may be performed.[12,13]

The ultrasound-guided technique is performed with the patient in a lateral decubitus position, using the medial retinaculum as a landmark. After examining the medial compartment, the medial retinaculum has to be located in a longitudinal plane. Then the transducer has to be rotated 90° to the transverse plane, on the proximal and medial border of the patella. Infiltration is performed using an in-plane approach under the medial retinaculum with a 21-gauge caliber needle, using a mixture of local anesthetics and corticosteroids (Figure 9).

Knee arthrocentesis and intra-articular infiltrations

Intra-articular injections are preferentially indicated in degenerative joint disease or osteoarthritis of the knee. They are also indicated to treat other joint diseases such as rheumatoid arthritis, arthropathies due to crystal deposits like gout, and other inflammatory arthritis. However, it is important to point out that arthrocentesis is primarily used for diagnostic purposes for all of the aforementioned.[7] Several approaches have been described for knee intra-articular injections; lateral or medial suprapatellar and infrapatellar. The lateral suprapatellar approach is preferred by most of the authors.[14,15]

The ultrasound-guided technique is performed with the patient in a supine position with the knee that has to be explored semiflexed (between 10° and 20° of flexion). A pillow is placed below the knee, causing a slight tension in the quadricipital tendon, which will help to avoid anisotropic ultrasound artifacts. First, the suprapatellar recess has to be located. The sonoanatomical landmarks to be considered are the quadricipital tendon, the superior border of the patella,

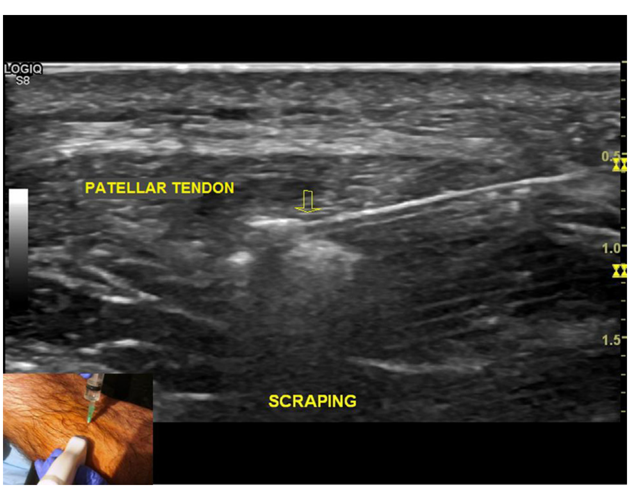

Fig. 8 – Curettage of the tendon vessels. The needle bevel (arrow), intending to dissect the vessels found on the deep surface of the patellar tendon. (Color version of figure is available online.)

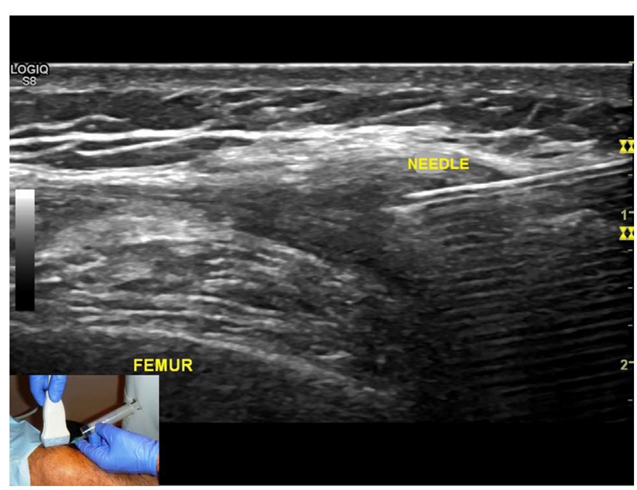

Fig. 9 – Synovial plica infiltration deep into the medial patellar retinaculum. Lateral approach with the needle in plane and a transverse view of the retinaculum. The deep aspect of the medial retinaculum is the infiltration target. (Color version of figure is available online.)

the distal femoral epiphysis, and the suprapatellar joint recess, the latter will also be our target. Depending on the degree of occupation of this recess, we will be able to obtain a more or less clear ultrasound image. We must apply minimal pressure possible on the skin to avoid the suprapatellar space collapse. To perform the infiltration using the in-plane approach, the transducer has to be rotated 90° to place it transversal to the femoral long axis, proximal to the patella. All sonoanatomical landmarks aforementioned must be identified again in the transverse plane. After performing all aseptic procedures indicated for ultrasound-guided procedures, we perform the puncture using a 22-gauge needle. The needle bevel advance must be carefully monitored until it is positioned in the hypoechoic part of the suprapatellar recess.

The ultrasound-guided evacuation procedure is similar to the ones used to treat other liquid collections. By using the lateral in-plane approach, it is possible to visualize the needle within the recess, to monitor the evacuation of the content, and to observe how the suprapatellar pouch slowly collapses (Figure 10). If we administer a therapeutic substance instead of performing an arthrocentesis, we will see it spreading within the suprapatellar recess. In obese patients or if there is poor visualization e bevel occurs, we can use color Doppler to ensure correct liquid flow during injection.

Nerves

The knee joint is innervated by sensory branches of the tibial, common peroneal, femoral, and obturator nerves. Articular sensory branches found around the knee joint are known as the genicular nerves.[16]

The tibial nerve is a terminal branch of the sciatic nerve results of the division of the latter at the level of the superior part of the popliteal fossa. It runs medially through the adipose tissue, deep into the deep fascia, and then toward the midpoint between both heads of the gastrocnemius muscle. The tibial nerve gives off 3 articular branches to the knee that join the superior, middle, and inferior medial genicular arteries. These branches innervate the posterior and perimeniscal portion of the capsule and the synovial lining; the latter also surrounds the cruciate ligaments (which, however, are extrasinovial).

The common peroneal nerve is the other terminal branch of the sciatic nerve. It divides lateral to the tibial nerve and runs between the tendon of the biceps femoris muscle and the lateral head of the gastrocnemius muscle. It has 2 articular branches, the upper lateral genicular nerve and the recurrent peroneal nerve, which innervate the collateral lateral ligament and the lateral and anterior-inferior region of the capsule.[17]

The anteromedial and anterolateral aspects of the capsule and the ligaments are basically innervated by the articular branches of the femoral nerve that constitutes the patellar plexus. The most important contribution to this plexus comes from a branch of the nerve to the vastus medialis muscle. In addition, a branch of the nerve to the vastus lateralis muscle innervates the superior-lateral region of the capsule. The saphenous nerve traverses the deep fascia on the medial aspect of the knee, between the sartorius muscle and the gracilis tendon. Then it gives off an infrapatellar branch that innervates the knee anteromedial cutaneous region.

The terminal branch of the posterior division of the obturator nerve joins the femoral artery in the popliteal fossa to further be part of the popliteal plexus, and thus it contributes to the innervation of the capsule and the menisci.

Because of the complex innervation pattern of the knee joint, the selective block of the saphenous nerve at the midthigh level together with the infiltration of the terminal articular branches (genicular nerves) is a good option to decrease pain and reduce analgesics consumption, without causing a motor block of the quadriceps muscle, in patients with acute or chronic knee pain.

Saphenous nerve

Anatomy and sonoanatomy

The saphenous nerve is the longest terminal branch of the femoral nerve.[18] It is a sensory nerve that provides cutaneous innervation to the knee anterior-medial and posterior-medial regions and to the medial, anterior-medial, and posterior-medial region of the leg, till the lateral malleolus. Once it divides off the femoral nerve, the saphenous nerve runs deep to the sartorius muscle within a triangular space constituted by an anterior border (sartorius muscle), a posterior-medial border (adductor longus muscle proximally and adductor magnus muscle distally), and a posterior-lateral border (vastus medialis). In this subsartorial space or adductor canal, the saphenous nerve is found together with the nerve branch to the vastus medialis muscle and the femoral vessels.[19] This canal extends from the apex of the femoral triangle to the opening of the adductor magnus muscle. In this canal, there exists an aponeurosis that runs from the vastus medialis to the adductor longus and adductor magnus muscles, across the femoral vessels and saphenous nerve, called the vastoadductor membrane in its distal portion.[20]

The position of the saphenous nerve regarding the femoral artery varies in its subsartorial trajectory. In the proximal

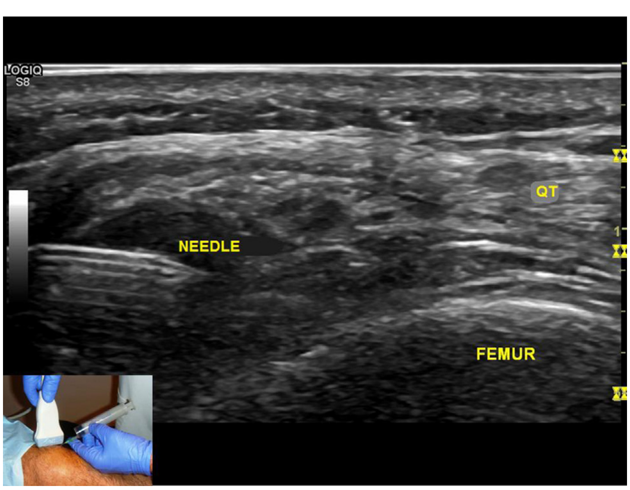

Fig. 10 – Short axis in-plane approach to the suprapatellar recess from lateral to medial. QT, quadricipital tendon. (Color version of figure is available online.)

one-third of the adductor canal, the saphenous nerve is located lateral and slightly superficial to the femoral artery. It then shifts medially to be found anterior or even medial to the femoral artery. In the distal region of the adductor canal it remains superficial, whereas the femoral artery and vein move on to a deeper plane toward the popliteal fossa. At this point, the descending genicular artery branches off the femoral artery, to further give off the saphenous branch that together with the saphenous nerve perforates the vastoadductor membrane at about 10 cm above the medial femoral epicondyle.[21-23] Once the saphenous nerve separates from the femoral vessels, it runs distal and the infrapatellar nerve branches off. After this division, the saphenous nerve perforates the deep fascia between the sartorius and gracilis muscles and moves on to the subcutaneous level. Finally, it descends along the medial aspect of the tibia joined by the great saphenous vein, and provides innervation to the medial aspect of the leg and the ankle.[24]

The sonoanatomical landmarks to perform the saphenous nerve block at the level of the thigh are the femoral vessels, as well as the muscular structures that constitute the adductor canal, primarily the sartorius muscle.

The ultrasound examination begins by locating the femoral artery at the inguinal level with a high-frequency linear transducer placed transversal to the femoral long axis. Then, the trajectory of the artery into the adductor canal, deep in the sartorius muscle, has to be followed. It is important to remember that the position of the saphenous nerve in the canal would vary as we move on distally (lateral, anterior, or medial to the artery). The saphenous nerve can be visualized, when possible, as a round hyperechoic structure adjacent to the femoral artery, the latter seen as a pulsatile anechoic structure. The femoral vein can be located deeper to the femoral artery. In some cases, it is also possible to identify the nerve to the vastus medialis muscle, medial to the artery (Figure 11).

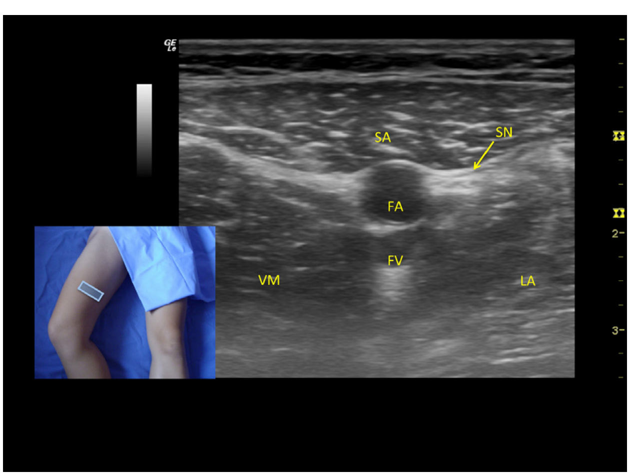

Fig. 11 – Sonoanatomy of the saphenous nerve in the subsartorial space or adductor canal (Hunter canal). The femoral artery (FA), femoral vein (FV), saphenous nerve (SN); medial and superficial, sartorius muscle (SA), vastus medialis muscle (VM), and adductor longus (LA) are observed (blue bar—probe placement). (Color version of figure is available online.)

Nerve block

The saphenous nerve can be blocked at the level of the adductor canal or distally. The patient is placed in a decubitus supine position with the affected leg externally rotated (30°-45°) and the knee flexed. A high-frequency linear transducer has to be placed transversally on the inguinal region to locate the femoral neurovascular bundle. Using the femoral artery as a landmark, the transducer has to be moved distal. After the deep femoral artery divides off, the trajectory of the femoral artery continues deep into the sartorius muscle.[23] At this point, the saphenous nerve can be observed as a round hyperechoic structure adjacent to the artery in a lateral, anterior, or medial position, slightly superficial to the femoral artery. Because of the high interindividual anatomical variability, it is mandatory to follow the nerve from the proximal aspect of the thigh to the furthermost distal region at the level of the adductor canal. Above all, the puncture point has to be selected carefully, where the best ultrasound image of the nerve can be obtained.[20] As it was mentioned before, the nerve to the vastus medialis muscle, branch of the saphenous nerve, is also found in the adductor canal; therefore, the injection of local anesthetics at this point can block both nerves.

The puncture has to be performed via an in-plane approach at either side of the transducer (Figure 12). We must ensure the correct spread of local anesthetic around the saphenous nerve or, if we do not see the nerve, around the femoral artery in the adductor canal. Various studies have shown that treatment with radiofrequency on the saphenous nerve has provided pain relief and improvement of the knee range of motion for more than 5 months.[25,26]

Genicular nerves

Anatomy and sonoanatomy

The genicular nerves are sensory branches of the tibial, common peroneal, and obturator nerves. They provide innervation to the capsule of the knee joint, as well as to the intra-articular and extra-articular ligaments.

The superior and inferior medial genicular nerves and the middle genicular nerve are branches of the tibial nerve. They

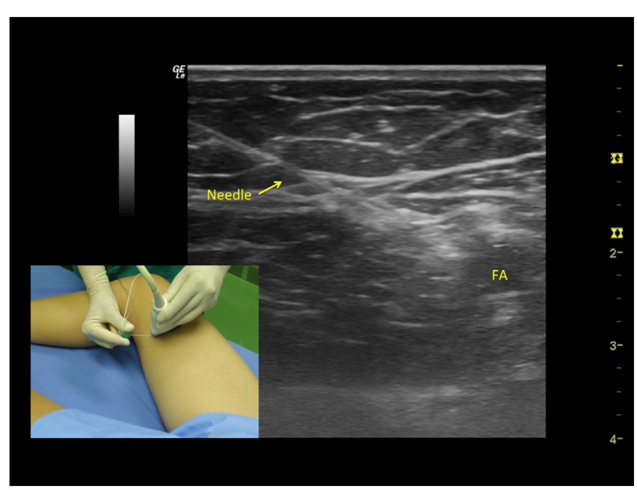

Fig. 12 – Saphenous nerve block. Needle in plane. FA, femoral artery. (Color version of figure is available online.)

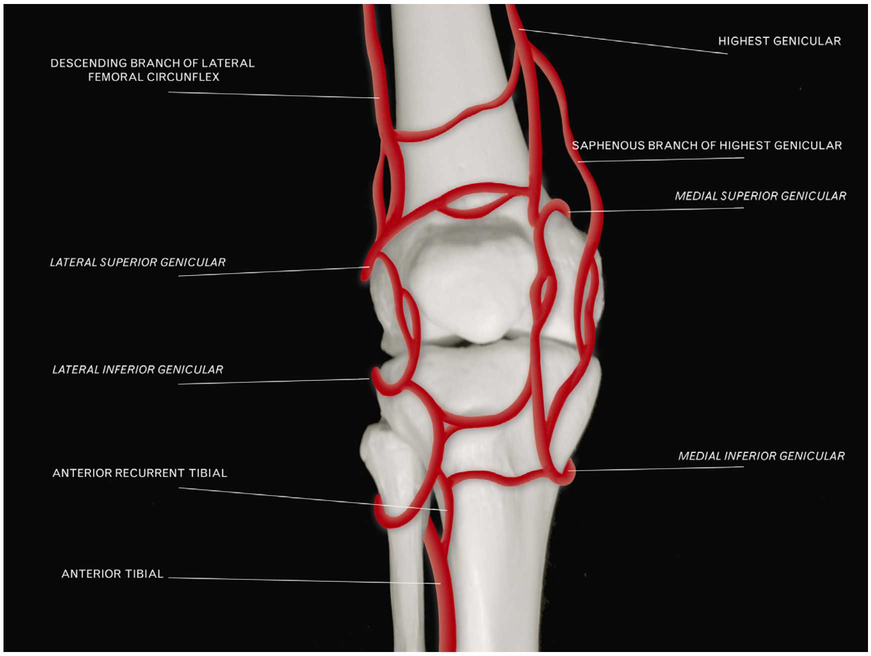

Fig. 13 – Knee arteries. (Color version of figure is available online.)

arise within the popliteal fossa and accompany the correspondingly named arteries (Figure 13). From the posterior popliteal region, they run along edge of the medial femoral epicondyles (the superior medial genicular nerve) and the tibial medial condyle (inferior medial genicular nerve) to reach the anterior aspect of the knee (Figure 14). The superior lateral genicular nerve and the inferior lateral genicular nerve are branches of the common peroneal nerve and they run along the correspondent arteries. They are correspondingly related to the lateral femoral epicondyle and the lateral tibial condyle.[27]

The genicular nerves are difficult to be visualized by ultrasound because they are very small in size. To find their exact location, the genicular arteries are used as landmarks because they share the same trajectories as the genicular nerves. Other important landmarks are the femoral and tibial cortical surfaces because of their close topographic relation to the genicular neurovascular bundles.

The patient is placed in a decubitus supine position. A high-frequency linear transducer is placed longitudinal to the femoral long axis, on the lateral aspect of the knee to locate the superior lateral genicular nerve and in the medial aspect of the knee to locate the inferior and superior medial genicular nerves. The transducer is moved to localize the transition point between the shaft of the femur and the femoral epicondyles. Then, using the Doppler mode, the genicular arteries have to be located as round pulsatile anechoic structures (Figure 14).

Nerve block

Blocks of the genicular nerves to treat knee pain have been previously described, performed under fluoroscopic guidance.[28] The targeted genicular nerves were those that had a close topographic relationship with the bone cortical surfaces, such as the femoral epicondyles (superior medial and superior lateral genicular nerves) and the medial tibial epicondyle (inferior medial genicular nerve). Although this study presented promising results, large clinical trials with longer follow-up periods are necessary to strengthen this evidence. Ultrasound guidance is a valid alternative to fluoroscopic guidance to perform the technique described by previous authors. The same bone landmarks can be used when the technique is performed under ultrasound guidance, and, moreover, it is also possible to visualize the genicular arteries that accompany the genicular nerves (Figure 15).

The patient is placed in a lateral decubitus position with the affected lower extremity resting on the examination table and exposing the medial aspect of the knee. A high-frequency linear transducer is placed accordingly to the femoral long axis. Then the transducer has to be moved to find the transition point between the shaft of the femur and the medial femoral epicondyle. Afterward, Doppler mode has to

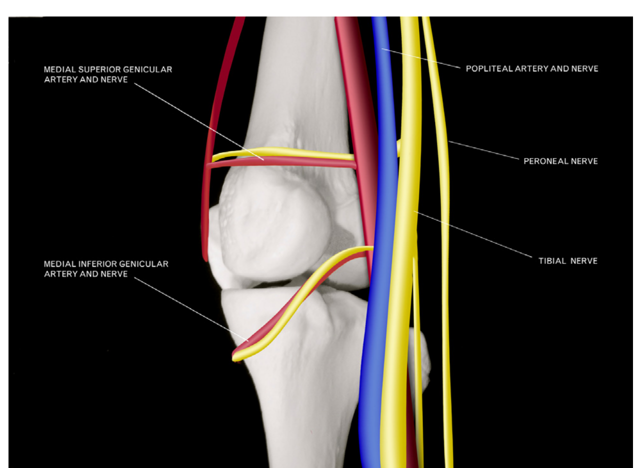

Fig. 14 – Medial genicular arteries and nerves. (Color version of figure is available online.)

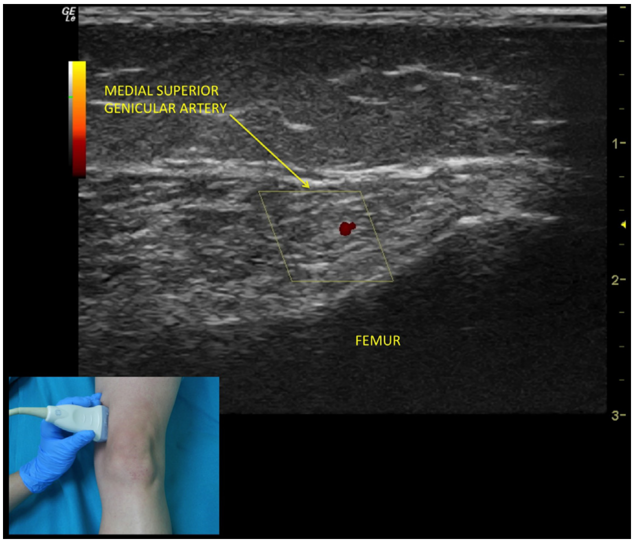

Fig. 15 – Superior medial genicular artery. The superior medial genicular nerve close to the superior medial genicular artery. Femoral cortical surface at the transition point between the shaft and the medial condyle. (Color version of figure is available online.)

be activated to better look for the pulsatile anechoic structure that corresponds to the superior medial genicular artery. This artery will be our target. To proceed to block the inferior medial genicular nerve, the transducer has to be maintained longitudinal to the femoral long axis and moved to the transition point between the shaft of the tibia and the medial tibial condyle. Then, using the Doppler mode, the inferior medial genicular artery has to be located as it accompanies the inferior medial genicular nerve and therefore will be our target.

To block the superior lateral genicular nerve, we have to change the position of the patient to expose the lateral aspect of the knee. The same indications previously mentioned to block the superior medial genicular nerve can be used on the contralateral side. All blocks have to be performed using an in-plane approach and the anesthetic spread must remain around each one of the genicular arteries.

REFERENCES

1. Berkoff DJ, Miller LE, Block JE. Clinical utility of ultrasound guidance for intra-articular knee injections: a review. *Clin Interv Aging*. 2012;7:89–95.
2. Bruyn GA, Schmidt WA. How to perform ultrasound-guided injections. *Best Pract Res Clin Rheumatol*. 2009;23(2):269–279.
3. Chalmers PN, Ellman MB, Chahal J, et al. Injection therapy in the management of musculoskeletal injuries of the knee. *Oper Tech Sports Med*. 2012;20(2):172–184.
4. Fredericson M, Cookingham CL, Chaudhari AM, et al. Hip abductor weakness in distance runners with iliotibial band syndrome. *Clin J Sport Med*. 2000;10(3):169–175.
5. Gunter P, Schwellnus MP. Local corticosteroid injection in iliotibial band friction syndrome in runners: a randomised controlled trial. *Br J Sports Med*. 2004;38(3):269–272.
6. Alfredson H, Ohberg L. Neovascularisation in chronic painful patellar tendinosis—promising results after sclerosing neovessels outside the tendon challenge the need for surgery. *Knee Surg Sports Traumatol Arthrosc*. 2005;13(2):74–80.
7. Hoksrud A, Ohberg L, Alfredson H, et al. Ultrasound-guided sclerosis of neovessels in painful chronic patellar tendinopathy: a randomized controlled trial. *Am J Sports Med*. 2006;34(11):1738–1746.
8. Willberg L, Sunding K, Forssblad M, Fahlström M, Alfredson H. Sclerosing polidocanol injections or arthroscopic shaving to treat patellar tendinopathy/jumper's knee? A randomised controlled study. *Br J Sports Med*. 2011;45(5):411–415.
9. Hoksrud A, Torgalsen T, Harstad H, et al. Ultrasound-guided sclerosis of neovessels in patellar tendinopathy: a prospective study of 101 patients. *Am J Sports Med*. 2012;40(3):542–547.
10. Larsson ME, Käll I, Nilsson-Helander K. Treatment of patellar tendinopathy—a systematic review of randomized controlled trials. *Knee Surg Sports Traumatol Arthrosc*. 2012;20(8):1632–1646.
11. Dupont JY. Synovial plicae of the knee. Controversies and review. *Clin Sports Med*. 1997;16(1):87–122.
12. Rovere GD, Adair DM. Medial synovial shelf plica syndrome. Treatment by intraplical steroid injection. *Am J Sports Med*. 1985;13(6):382–386.
13. Kim SJ, Choe WS. Arthroscopic findings of the synovial plicae of the knee. *Arthroscopy*. 1997;13(1):32–41.
14. Jackson DW, Evans NA, Thomas BM. Accuracy of needle placement into the intra-articular space of the knee. *J Bone Joint Surg Am*. 2002;84(9):1522–1527.
15. Dabke HV, Orth MS. Accuracy of needle placement into the intra-articular space of the knee. *J Bone Joint Surg Am*. 2004;86(2):433–434.
16. Clarke HD, Scott WN, Insall JN, et al. AnatomíaIn: Insall, Scott, et al., eds. *Rodilla*. Madrid: Marbán; 200413–76.
17. Damarey B, Demondion X, Wavreille G, et al. Imaging of the nerve of the knee region. *Eur J Radiol*. 2013;82(1):27–37.
18. Kent ML, Hackworth RJ, Riffenburgh RH. A comparison of ultrasound-guided and landmark-based approaches to saphenous nerve blockade: a prospective, controlled, blinded, crossover trial. *Anesth Analg*. 2013;117(1):265–270.
19. Kapoor R, Adhikary SD, Siefring C, McQuillan PM. The saphenous nerve and its relationship to the nerve to the vastus medialis in and around the adductor canal: an anatomical study. *Acta Anaesthesiol Scand*. 2012;56(3):365–367.
20. Horn JL, Pitsch T, Salinas F, et al. Anatomic basis to the ultrasound-guided approach for saphenous nerve blockade. *Reg Anesth Pain Med*. 2009;34(5):486–489.
21. Saranteas T, Anagnostis G, Paraskeuopoulos T, et al. Anatomy and clinical implications of the ultrasound-guided subsartorial saphenous nerve block. *Reg Anesth Pain Med*. 2011;36(4):399–402.
22. Trescot AM, Brown MN, Karl HW. Infrapatellar saphenous neuralgia—diagnosis and treatment. *Pain Physician*. 2013;16(3):315–324.
23. Manickam B, Perlas A, Duggan E, et al. Feasibility and efficacy of ultrasound-guided block of the saphenous nerve in the adductor canal. *Reg Anesth Pain Med*. 2009;34(6):578–580.
24. Lundblad M, Kapral S, Marhofer P, et al. Ultrasound-guided infrapatellar nerve block in human volunteers: description of a novel technique. *Br J Anaesth*. 2006;97(5):710–714.
25. Bogduk N. Pulsed radiofrequency. *Pain Med*. 2006;7(5):396–407.
26. Akbas M, Luleci N, Dere K, et al. Efficacy of pulsed radiofrequency treatment on the saphenous nerve in patients with chronic knee pain. *J Back Musculoskelet Rehabil*. 2011;24(2):77–82.
27. Hirasawa Y, Okajima S, Ohta M, et al. Nerve distribution to the human knee joint: anatomical and immunohistochemical study. *Int Orthop*. 2000;24(1):1–4.
28. Choi WJ, Hwang SJ, Song JG. Radiofrequency treatment relieves chronic knee osteoarthritis pain: a double-blind randomized controlled trial. *Pain*. 2011;152(3):481–487.