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A Cadaveric Study to Assess Accuracy of Ultrasound Guided Genicular Nerve Block Department of PMR, SMS Medical College, Jaipur

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Abstract

Background: Osteoarthritis is musculoskeletal degenerative disease causes severe pain and limited activity of daily living of normal human being. Many pharmacological and non-pharmacological agents available but they produce limited benefit with serious side effect. Genicular nerve is sensory efferent to knee joint by keeping this in context we can alleviate pain by block genicular nerve under ultrasound guidance.

Objective: To determine the accuracy of an anatomic landmark with ultrasound-guidance to locate genicular nerve in a cadaveric model.

Material & Methods: Cadaveric type study at tertiary level medical teaching institute include lightly embalmed twenty-four cadaveric knee specimens without any surgical intervention around the knee joint were used in the study. Bony landmark is used as surface markings, and to guidance for real-time ultrasound imaging, 1 ml methylene blue dye is injected with the help of a spinal needle. Knee specimens were subsequently dissected to assess accuracy whether the nerve is dyed with ink or not. If the nerve is stained with ink, it is considered as an accurate placement.

Result: Dissection of cadavers after injection shows that in 20 out of 24 cadavers Superior Medial Genicular Nerve (SMGN) and Inferior Medial Genicular Nerve (IMGN) was dyed with methylene blue dye and in 4 out of 24 cadaver SMGN, IMGN and the surrounding structure was dyed with methylene blue dye.

Conclusion: Study result shows that by using anatomical landmark SMGN and IMGN nerve block can be performed accurately.

Keywords: Genicular nerve, osteoarthritis, superior medial genicular nerve, inferior medial genicular nerve, ultrasound-guided block, knee injection, knee pain, cadaveric study.

Introduction

Chronic knee pain secondary to osteoarthritis is one of the most common forms of musculoskeletal disease worldwide. It is estimated that 3.8% of the world's population suffer from symptomatic knee osteoarthritis which equals to approximately, 277 million people living with knee osteoarthritis worldwide, the prevalence of osteoarthritis is similar across the globe. The prevalence of osteoarthritis knee in the Indian population is estimated to be 28.7%[(1)].

Osteoarthritis progresses as longevity increases, and degenerative changes lead to loss of articular cartilage and periarticular bone. It often causes joint pain resulting in high morbidity, low quality of life, polypill increasing the financial burden and loss of working days.

Pain in osteoarthritis is generally classified as nociceptive, due to cartilage damage, releasing of inflammatory mediators including C-reactive protein, cytokines, leukotrienes and prostaglandins. Besides cartilage which is mostly avascular and aneural, surrounding tissues like synovium, bone, soft tissue can also contribute to the pain experience through a complex pathway. Subchondral bone erosion can give rise to neuropathic pain due to destruction of the chondral structure; it is densely innervated, thus exposing free nerve endings.

Many rat models of osteoarthritis knee with subchondral bone erosion and exposed free nerve endings present with neuropathic pain characteristic like burning sensation, prickling sensation, electric shock, feeling pins & needles[(2)].

Osteoarthritis can be managed non pharmacologically utilizing physical modalities and exercises. Pharmacological management of osteoarthritis knee may include NSAIDS and synthetic opioids which can be used for a short period only due to their possible adverse effects[(3)]. Visco-supplementation with hyaluronic acid[(4)] has been in vogue in recent past, but slowly the emerging evidence has failed to show the meaningful benefit even if multiple doses have been instilled, but it may also lead to joint swelling and arthralgia in the long term[(17)]. Many oral supplementations like chondroitin sulphate, glucosamine have also been promoted with questionable results. Many patients have responded to neuropathic pain medication like Gabapentin, Pregabalin, Amitriptyline showing that there might be some neuropathic component in degenerative osteoarthritis.

There is an also upcoming trend of regenerative interventions like platelet-rich plasma (PRP) and mesenchymal stem cell transplant. PRP, when injected into joint cavity, activates the release of TGF-β and IGF-1 growth factor stored in their α-granules[(18)] and these growth factor act on chondrocyte to enhance and support cartilaginous matrix but despite managing pain still, remain challenging in these cases.

Genicular nerve is one of the sensory efferents for knee pain arising from the tibial nerve in the posterior part of the leg in the popliteal fossa. Genicular nerve further divides into superomedial, inferomedial and superolateral to supply the medial and superolateral area of knee joint respectively. This efferent flow can be blocked by targeted drug delivery and radiofrequency ablation with good relief shown by chronic studies. This study is planned to explore the accuracy of the genicular nerve block by using USG guidance and anatomical surface landmarks.

Material & Methods

Study Design - Observational, cross-sectional type study was conducted at SMS Medical College, Jaipur after ethical approval from the designated college ethical committee. The sample size was calculated at 95% confidence level assuming 50% accuracy of genicular nerve block taking maximum variance approach. At the precision of 10% inaccuracy of genicular nerve block, minimum 96 attempts on cadaver planned with a sample size of 24 cadavers.

Method - A 13-5 MHz linear ultrasound probe (sonosite) was used by the investigator for this study. While positioning the cadaver in a supine position, the limb was placed in external rotation with 15-20-degree flexion at the knee joint, and the ultrasound probe is placed medially in the sagittal plane. Anatomical landmark is identified, and the transducer is oriented to see toward the femoral epicondyle. The transducer is moved proximally to see adductor tubercle and insertion of adductor magnus tendon. The bony cortex one centimeter anterior to the insertion of adductor magnus is targeted for the Superior Medial Genicular Nerve injection. The medial collateral ligament is then visualized in sagittal orientation, and the probe is then moved distally to see the tibial insertion of the medial collateral ligament on the tibial medial epicondyle. The point between the crest of the medial epicondyle and insertional end of medial collateral fibers is identified to inject Inferior Medial Genicular Nerve.

A 22-gauge spinal needle attached with 5cc Luer lock syringe filled with methylene blue dye is inserted with an in-plane approach directed forward to bony cortex under ultrasound guidance as described earlier to infiltrate the nerve.

The cadaver is then placed in lateral decubitus position for dissection, and a skin incision is marked on the medial side of the knee joint from femoral epicondyle to the tibial epicondyle. The skin flap is reflected, leaving the superficial fascia intact. Now strip the superficial fascia from deep fascia starting proximally to expose the vastus medialis muscle. The upper part tendon of vastus medialis is reflected, and the relationship of superior medial genicular nerve (SMGN) with adductor magnus muscle, adductor tubercle and femoral epicondyle examined. SMGN arise from the tibial nerve in the superior popliteal region and curve around the shaft of the femur passing anteriorly between the adductor magnus and femoral epicondyle and lying 1 cm anterior to adductor tubercle. Inferior Medial Genicular Nerve (IMGN) arises from the tibial nerve in the lower popliteal region. In the lower medial side of knee joint relationship of IMGN between the medial collateral ligament and tibial medial epicondyle identified. Medial Collateral ligament (MCL) inserted in the lower medial side of knee joint below the tibial medial epicondyle. IMGN lies deep to the medial collateral ligament. Horizontal incision given on MCL and IMGN is identified along with corresponding arteries.

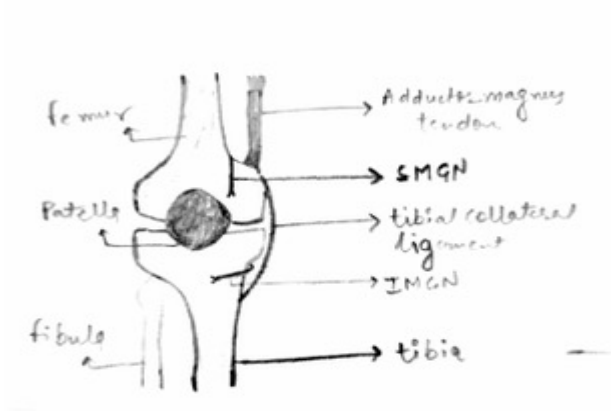

Figure 1: anatomical innervation around knee joint.

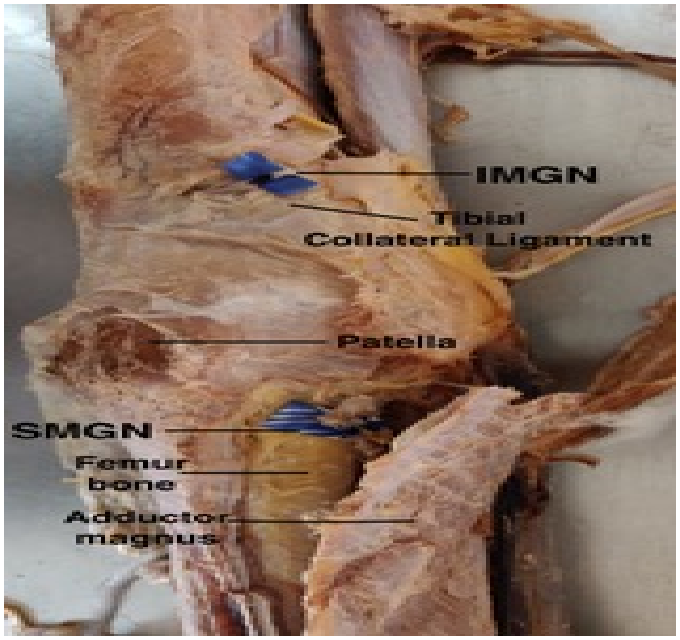

Figure 2: cadaveric dissection showing SMGN and IMGN nerve.(SMGN=superior medial genicular nerve) (IMGN=inferior medial genicular nerve)

Observation

Post injection dissection of cadaver shows that in 20 out of 24 cadaver SMGN and IMGN was dyed with methylene blue dye and in 4 out of 24 cadaver SMGN, IMGN and the surrounding structure was dyed with methylene blue dye.

Result And Discussion

Pain is a major clinical presentation in osteoarthritis (OA), it presents not only with nociception but neuropathic patterns also. The neuropathic pain shows evidence of central as well as peripheral sensitization. Abnormal signals arise not only from injured free nerve ending but also from the intact nociceptors that share the common innervation territory.

Subchondral bone is highly innervated with free nerve ending, so in cases where there is subchondral erosion, there is a possibility of neuropathic pain component as the free nerve ending get exposed, and c-fiber get stimulated.

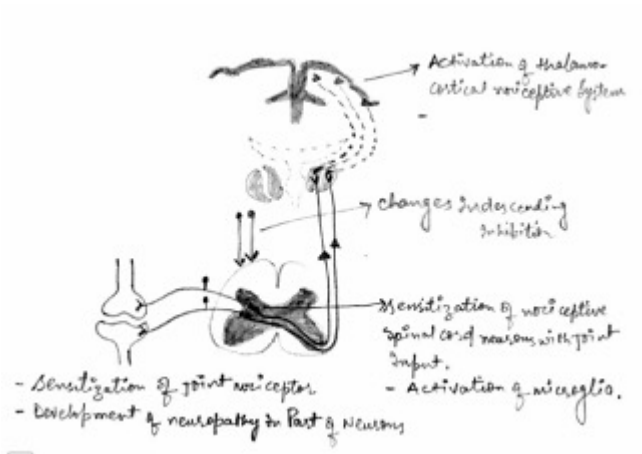

Figure 3: Mechanism of neuropathic pain production

The nerve supply of knee joint as described by Kennedy et al.[14] has two groups of articular branches: anterior and posterior groups. The nerves in the anterior group are the articular branches of the femoral, the common peroneal, and the saphenous nerve. The posterior group consists of articular branches of the tibial, the obturator and the sciatic nerves[7,14]. The tibial nerve projects articular branches at the popliteal fossa and is mainly responsible for innervation of the medial and posterior aspect of the knee joint[6]. Tibial nerve divides into superomedial and inferomedial genicular nerve and innervates the anterior portion of the knee joint. The articular branches of the common peroneal nerve innervate the inferolateral and anterolateral aspect of the articular capsule[7]. The saphenous nerve gives sensation to the anteroinferior side of the capsule[6].

Superior medial genicular nerve lies near adductor tubercle just beneath the insertion of vastus medialis tendon, and inferior medial genicular nerve lies deep to the medial collateral ligament along with their corresponding arteries. By real-time scanning, we can locate these nerves and inject the therapeutic solution.

Nowadays, genicular nerve ablation with the help of real-time scanning using USG and fluoroscope has emerged as an excellent modality to reduce pain and increase mobility and function. Choi et al.[3], conducted a study and targeted superomedial, inferomedial, and superolateral articular branches for radio-frequency ablation and showed improvement in pain as well as function in chronic knee osteoarthritis. Here we investigated and confirmed the utility of anatomical landmarks to facilitate faster and accurate ultrasound scanning.

The advantages of ultrasound are portability, non-ionic radiation, excellent real-time soft tissue and vascular imaging which enables landmark confirmation and prevent inherent injection of neurovascular bundles. Fluoroscopy-guided intervention exposes the physician and patients to radiation, shows only osseous structures and its availability is limited to tertiary care only. Protzman et al.[12] in a single case study employed ultrasonography to identify the genicular arteries and nerves; subsequently placed the needle with bony landmarks using fluoroscopic imaging. Ultrasound allowed them to locate the nerves more accurately in this single case. However, it could be suggested that ultrasound imaging of that kind of small nerve may not be achieved every time due to possible technical issues regarding the low performance of the ultrasound system and thick subcutaneous fat tissue in obese patients which might decrease the quality of echoic images. In cadaveric specimens, the genicular nerves and vessels could not be identified with ultrasonography. In the current study, the aim was to identify anatomic landmarks for genicular nerves for better ultrasound guidance. These landmarks show where the genicular nerves might be targeted, and they can also be better visualized in this technique, thereby reducing the procedure time. Future studies may investigate if ultrasonography is feasible to directly visualize the genicular nerves in a larger sample group and using higher frequency probe with dedicated software which also using doppler.

Our study has shown a similar result as with previously done studies. But some limitations are worthy of consideration, a small number of cadavers was used in the investigation, so some anatomic variations of genicular nerves may have been overlooked. Only two of the three genicular nerves were investigated in this study as it has been suggested that only these two genicular nerves are involved in clinically evident medial knee pain. The medial articular branches were targeted mostly as most patients suffer from medial compartment pain and disease.

Conclusion

Study result shows that by using anatomical landmark SMGN and IMGN nerve block can be performed accurately.

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