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Ultrasound Clinical Case Study

High Resolution Ultrasound in Genicular Nerve Radiofrequency Ablation

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Dr Angus Watts is a fellowship-trained general, musculoskeletal, and interventional radiologist and founder of Panorama Radiology Specialists.

Panorama Radiology Specialists offers a variety of minimally-invasive imaging-guided pain management therapies for moderate to severe OA, including intra-articular cortisone, platelet rich plasma and hyaluronic acid injections, and genicular nerve radiofrequency (RF) neurotomy.

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Introduction

The genicular nerves are key sensory nerves that innervate the knee joint. Chronic knee pain caused by osteoarthritis (OA) originates from the transmission of pain signals through them.

OA is a chronic and progressive condition, with no known cure. Total knee replacement is currently the most commonly performed surgery in Australia. Current non-surgical management techniques include reducing body mass index (BMI), analgesics, oral nonsteroidal anti-inflammatory drugs (NSAIDs), physiotherapy and imaging guided therapies. Historically patients waiting for a TKR or who are not suitable for surgery were left to endure months or years of debilitating knee pain. In some cases, patients may not be able to tolerate analgesics for a variety of reasons.

Genicular nerve radiofrequency ablation has been demonstrated to be a safe and effective method of treating and managing chronic knee pain in patients with OA[1]. My team and I at Panorama Radiology Specialists perform this potentially life-changing procedure using an advanced Canon Medical Aplio i700 Prism Edition ultrasound system and a high-resolution i18LX5 matrix transducer.

The procedure – why ultrasound guidance?

Traditionally, genicular nerve ablation has often been performed using fluoroscopy (mobile XRay) in an operating theatre environment. Fluoroscopy is an imprecise imaging modality which does not provide any degree of soft tissue detail, hence traditional RF techniques rely on bony landmarks for needle placement.

Our experience with ultrasound and 3T MRI has shown considerable variability in the anatomical course of the genicular nerves, which in many cases may in fact lie several cm from the bony landmarks targeted with traditional fluoroscopic techniques. With a coagulation radius of 10-15mm, precision needle placement is critical to the success of genicular neurotomy.

For ultrasound guided RF ablation procedures of the genicular nerve, we use high-resolution ultrasound and CT to systematically identify and localise each genicular nerve, and inject them with local anaesthetic. The inferolateral genicular nerve is typically avoided due to its proximity to the common peroneal nerve.

An RF cannula tip is placed under real-time high definition sonographic vision adjacent to each genicular nerve with an extremely high degree of precision. Each nerve has a diameter of approximately 1-2mm, similar to the tip of the cannula itself. We utilise superb microvascular imaging (SMI) to aid identification of deeply located genicular neurovascular bundles.

An RF ablation cannula is passed through the probe and positioned abutting each genicular nerve, followed by application of a radiofrequency current, creating a neuronal lesion of 10-15mm. This causes denervation which can often result in immediate relief of the patient's pain.

RF ablation of the genicular nerve under ultrasound guidance is a relatively new technique, facilitated by advances in ultrasound technology which now allow accurate visualisation of the genicular nerves, and thus offers significantly greater precision of needle placement compared to traditional fluoroscopic RF techniques which rely on bony landmarks and do not account for the high degree of individual anatomical variability of the genicular nerves.

Dynamic real-time visualisation of the genicular nerves using high resolution ultrasound guidance in our experience offers an extremely high degree of precision needle placement. The Aplio i700 utilises leading edge ultrasound technology which we have found offers a significant improvement in image detail of fine anatomical structures including the genicular nerves, enabling accurately positioning of RF probes, which promises to improve the efficacy of the procedure.

Haematoma, pseudoaneurysm, or arteriovenous fistulas are rare potential complications of the procedure caused by injury to the genicular artery[2]. High-resolution ultrasound allows the genicular nerves and artery to be accurately isolated, minimising the potential risk of complications.

Ultrasound guidance also has the additional advantage of not utilising ionising radiation in the procedure.

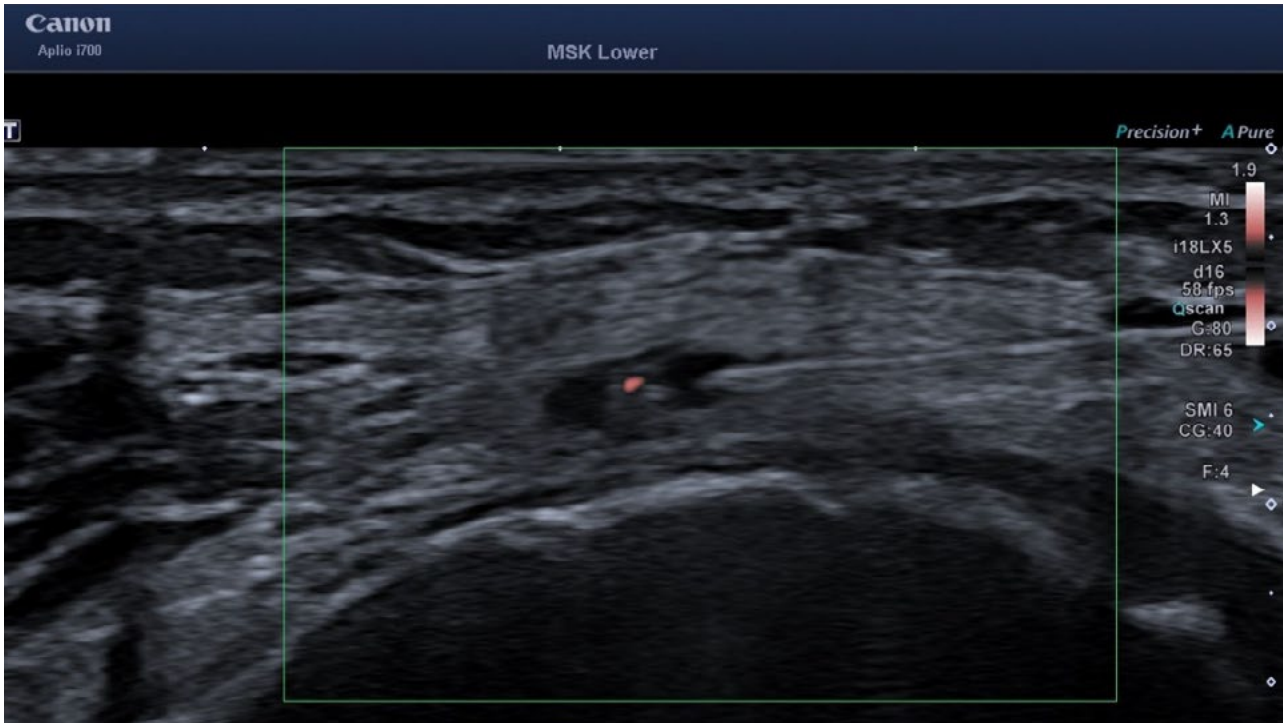

Figure 1: SMI demonstrates the accompanying artery of the superior medial genicular nerve.

Conclusion

The success of genicular nerve RF ablation relies on the accurate visualisation of the genicular nerve.

The Canon Aplio i700 Prism Edition and the i18LX5 matrix transducer deliver the spatial and temporal resolution needed to identify and track small nerves quickly and confidently. iBeam + and IDMS matrix technology produce an ultra-thin ultrasound beam providing high-frame rates, enhanced penetration, and high detail resolution.

Superb Micro-Vascular Imaging (SMI) allows the small accompanying artery of the nerve to be located, reducing the risk of complications by ensuring it is avoided during ablation. Compared to conventional Doppler methods, SMI has the advantages of high frame rates, high sensitivity (particularly in vessels with low velocities), high spatial resolution and low motion artefacts.

References

[1]Merrin, E., & Grimshaw, L.A. (2021). Technique for ultrasound-guided radiofrequency denervation of genicular nerves for chronic knee pain. AJUM, 24(4), 238-245. DOI: https://doi.org/10.1002/ajum.12280

[2]Kim SY, Le PU, Kosharskyy B, Kaye AD, Shaparin N, Downie S. Is genicular nerve radiofrequency ablation safe? A literature review and anatomical study. Pain Physician 2016; 19: E697–705.

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*compared to the previous versions of Aplio i-series

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CANZ-RR-001 09/2023