Distribution Mapping of an Investigational Nerve-selective Therapy for Chronic Knee Pain: A 3D Cadaveric Study.

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INTRODUCTION

Genicular radiofrequency (RF) ablation is used to manage knee joint pain although clinical outcomes are variable.[1] As RF lesion size are limited, and knee innervation is extensive and variable, adequate electrode placement to capture a substantial portion of knee innervation can be difficult to achieve.[2,3] The aim of this cadaveric study was to document the spread of an investigational nerve-selective biomaterial after ultrasound-guided injection, and evaluate spread relative to models of cadaveric knee innervation.

METHOD

- A novel, neural-selective, cooled, injectable biomaterial has been developed that overcomes the limitations of RF lesion size and neuroanatomical variability. As this compound is injectable and spreads extensively, precise needle placement is unnecessary to achieve adequate nerve capture In 6 cadaveric knee specimens, contrast enhanced nerve-selective cooled biomaterial was injected under ultrasound guidance using superolateral, superomedial and inferomedial target sites for genicular nerve blocks (20 ml at each site).
- Following injection, each specimen was CT-scanned and reconstructed to create high-fidelity 3D models of the injected biomaterial relative to bone (Fig. 1).
- Each 3D reconstruction was used to generate probability distribution (PD) maps of the nerve-selective cooled biomaterial (Fig. 2).
- PD maps were combined with knee innervation frequency maps[3] to assess capture.
- This study was approved by the University of Toronto Health Research Ethics Board (Protocol #27210).

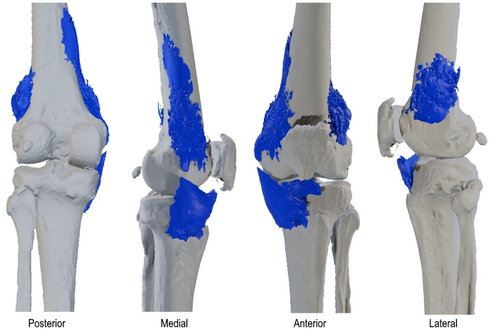


Figure 1. 3D Model of one knee specimen with 3D reconstruction of nerve-selective biomaterial

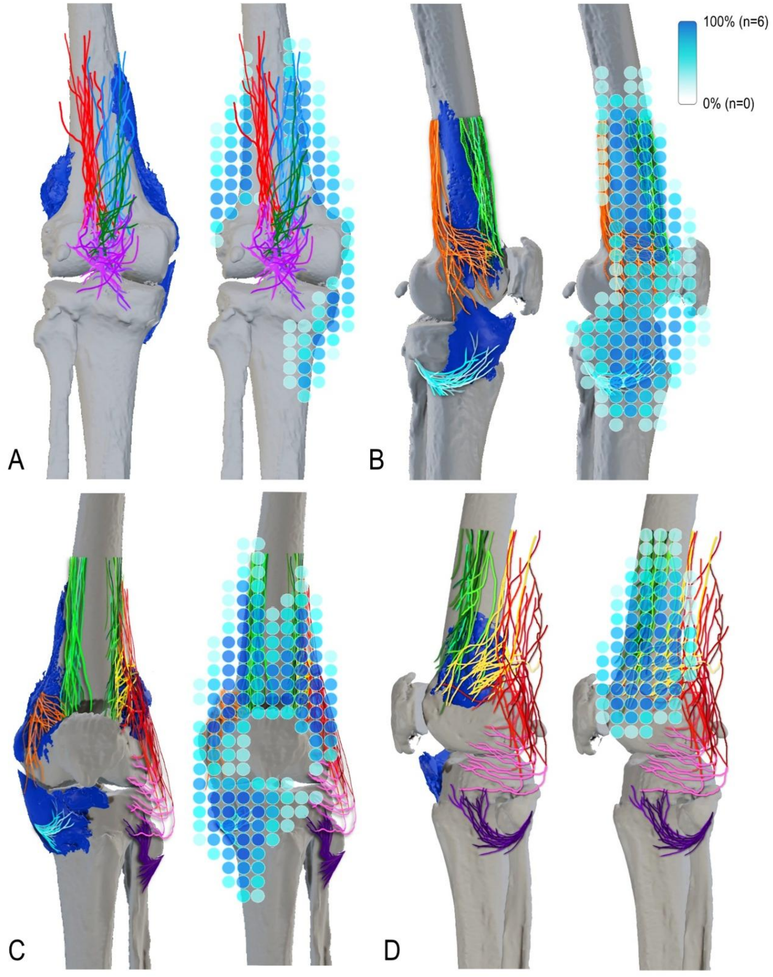


Figure 2. 3D Reconstruction of knee specimen following injection of nerve-selective biomaterial correlated with nerve frequency[3] and probability density map based on 6 specimens. Probability density maps were generated using uniformly sized circles positioned across the widest region of the bone in each view, arranged in a 10 × 30 grid. A. Posterior view. B. Medial view. C. Anterior view. D. Lateral view.

RESULTS

Six injected specimens were reconstructed from CT imaging data. For each specimen, anterior, posterior, medial and lateral PD maps of the knee joint were generated.

- The anterior PD map showed localization of superomedial/superolateral injectate along the junction of the femoral shaft and medial/lateral femoral condyles with spread to the surface of the femur above the patella. Inferomedial injectate was found at the junction of the tibial shaft and medial tibial condyle, with spread to the anteromedial area below the patella.
- The posterior PD map showed superior injectate localization along the junctions of the femoral/tibial shaft and respective condyles with minimal posterior spread.
- The medial PD map showed concentration of superomedial injectate along the femoral shaft with some distal spread to the femoral condyle. Inferomedial injectate was located along the medial tibia condyle.
- The lateral PD map showed superolateral injectate along the width of the femoral shaft with partial distal spread to the lateral condyle.

PD maps overlaid onto knee innervation frequency maps demonstrated overlap between injectate spread and nerve distribution at the level of the periosteum.

DISCUSSION

PD maps in this study provide anatomical evidence that locally injected nerve-selective biomaterial covers large areas around the knee, encompassing knee innervation extensively. Based on the overlay of knee innervation frequency and PD maps, technical optimization of the current injection protocol may require targeting superomedial and superolateral injections more distally at the condyles.

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ACKNOWLEDGEMENTS

The authors wish to thank the individuals who donated their bodies and tissue for the advancement of education and research.

