

Validation of a Novel Intraarticular Posteromedial Surgeon-Administered (IPSA) Injection for TKA Analgesia

William Mihalko,¹ Jess H. Lonner,²
Andrew I. Spitzer,³ Nicholas S. Piuze,⁴
Jason Russell,⁵ Stan Dysart,⁶ Jeffrey Gonzales,⁶
Michael A. Mont⁷

¹University of Tennessee Health Science Center, Campbell Clinic Orthopaedics, Memphis, TN; ²Thomas Jefferson University, Philadelphia, PA; ³Cedars-Sinai Medical Center, Los Angeles, CA; ⁴Cleveland Clinic, Cleveland, OH; ⁵Louisiana State University Health Sciences Center, New Orleans, LA; ⁶Pacira BioSciences, Inc., Tampa, FL; ⁷Sinai Hospital of Baltimore, Baltimore, MD

OBJECTIVE

This cadaver study aimed to investigate an intraarticular posteromedial surgeon-administered (IPSA) single injection in terms of volume, reproducibility, and nerves reached by injectate

CONCLUSIONS

- 1 The IPSA technique consistently reached the infrapatellar branch of the saphenous nerve (ISN), nerve to vastus medialis muscle (NVM), and posterior capsule, with minimal proximal dye spread
- 2 This novel single-injection IPSA approach may be an efficient alternative to multi-injection periarticular infiltration or ultrasound (US)-guided adductor canal block (ACB) when anesthesia resources are limited
- 3 These results support further investigation to confirm clinical outcomes

PRESENTING AUTHOR: William Mihalko; wmihalko@campbellclinic.com

DISCLOSURES: WM (2-3B-Aesculap/B. Braun, Pacira BioSciences; 4-Medtronic; 5-AAHKS, FDA, Medacta; 6-Saunders/Mosby-Elsevier; 7A-Aesculap/B. Braun; 7B-Saunders/Mosby-Elsevier; 8-Journal of Arthroplasty, Journal of Long Term Effects of Medical Implants, Journal of Orthopaedic Research, Orthopaedic Clinics of North America; 9-AAHKS, AAOS, ASTM International, Campbell Foundation, Hip Society, ISTA, Knee Society, ORS), JHL (2-Zimmer Biomet; 3B-Force Therapeutics, Pacira BioSciences, Smith & Nephew, Zimmer Biomet; 4-Force Therapeutics, Proteonova; 5-Force Therapeutics, Heron Therapeutics, Smith & Nephew, Zimmer Biomet; 6-Saunders/Mosby-Elsevier, Springer, Wolters Kluwer Health-Lippincott Williams & Wilkins; 7A-Smith & Nephew, Zimmer Biomet; 7B-Saunders/Mosby-Elsevier, Springer, Wolters Kluwer Health-Lippincott Williams & Wilkins; 9-AAHKS, Knee Society), AIS (2-DePuy, Pacira BioSciences; 3B-DePuy, Flexion Therapeutics, Pacira BioSciences, TraumaCad; 5-DePuy, Pacira BioSciences), NSP (3B-Stryker; 5-Osteal Therapeutics, Peptilogics, RegenLab, Signature Orthopaedics, Zimmer; 8-Journal of Hip Surgery, Journal of Knee Surgery; 9-AAHKS, ISCT, ORS), JM (3B-Pacira BioSciences), SD (3A-Pacira BioSciences; 4-Pacira BioSciences), JG (3A-Pacira BioSciences; 4-Pacira BioSciences), MAM (3B-Stryker, 3M, Ethicon, Exactech, Next Science, Pacira BioSciences, Smith & Nephew; 4-CERAS Health, Mirror AR, Peerwell, US Medical Innovations; 5-Kolon TissueGene, Microport, NIH, Organogenesis, Patient-Centered Outcomes Research Institute, Pacira BioSciences; 7A-Medicus Works, LLC, Stryker; 7B-UpToDate, Inc., Wolters Kluwer Health - Lippincott Williams & Wilkins; 8-Journal of Arthroplasty, Journal of Knee Surgery, Surgical Technology International, Orthopaedics; 9-American Association of Hip and Knee Surgeons, Knee Society, Hip Society).

FUNDING: This study was funded by Pacira BioSciences, Inc. Assistance with poster preparation was provided under the authors' direction by MedThink SciCom and funded by Pacira BioSciences, Inc.

REFERENCES: 1. Kim DH et al. *Anesthesiology*. 2014;120(3):540-550. 2. Wang D et al. *Sci Rep*. 2017;7:40721. 3. Greenky MR et al. *J Arthroplasty*. 2020;35(5):1228-1232.

Presented at the Orthopaedic Research Society Annual Meeting; February 2-6, 2024; Long Beach, CA

INTRODUCTION

- ACBs targeting the saphenous nerve (SN) and its infrapatellar branch (ISN) and the NVM are an alternative to traditional femoral nerve (FN) blocks for postsurgical analgesia after total knee arthroplasty (TKA)^{1,2}
 - ACBs are associated with greater preservation of quadriceps muscle strength compared with FN blocks, enabling earlier mobilization and faster recovery²
- ACBs are conventionally administered by trained anesthesiologists under US guidance, requiring appropriate resources and expertise; however, US-guided approaches may not be accessible to all orthopaedic practices
- Intraoperative surgeon-administered ACBs may block the same nerves as an anesthesiologist-administered US-guided ACB when US-guided approaches are not available³

METHODS

- There were 5 fresh-frozen lower limb cadaver specimens examined sequentially
- First, a board-certified regional anesthesiologist administered a US-guided ACB to the first lower limb cadaver specimen
 - The SN was targeted using an in-plane needle approach, and the NVM was targeted more proximally because it enters the adductor canal; 10 mL of indocyanine green dye diluted with sterile saline was injected at each location (20 mL total)
- Next, an orthopaedic surgeon performed a medial parapatellar arthrotomy and placed an 18-gauge bevel needle 1 to 2 cm proximal to the adductor tubercle angled posteromedially to the axis of the femur
 - Fluoroscopy was used to document the needle angle, position relative to the femur, and spread of a 10-mL bolus of methylene blue and radiopaque dye

- The needle was left in place, and a second 10-mL bolus was injected
- An anatomist dissected the knee to observe the dye spread to structures including the SN, ISN, NVM, FN, and vascular structures
- The injectate volume, needle position, needle size, and timing between surgeon-administered boluses were adjusted in subsequent specimens in an iterative manner based on the findings of the previous knees
 - Needle angles were measured from vertical with the needle tip directed proximally and posteriorly from the entry point and slightly medial to the axis of the femur toward the femoral head
 - The total volume injected was 20 mL for all knees, with timing that varied in the first 2 subsequent specimens to determine the volume spread
 - The US-guided ACB was repeated in specimen 3 to confirm consistency of anatomic coverage

RESULTS

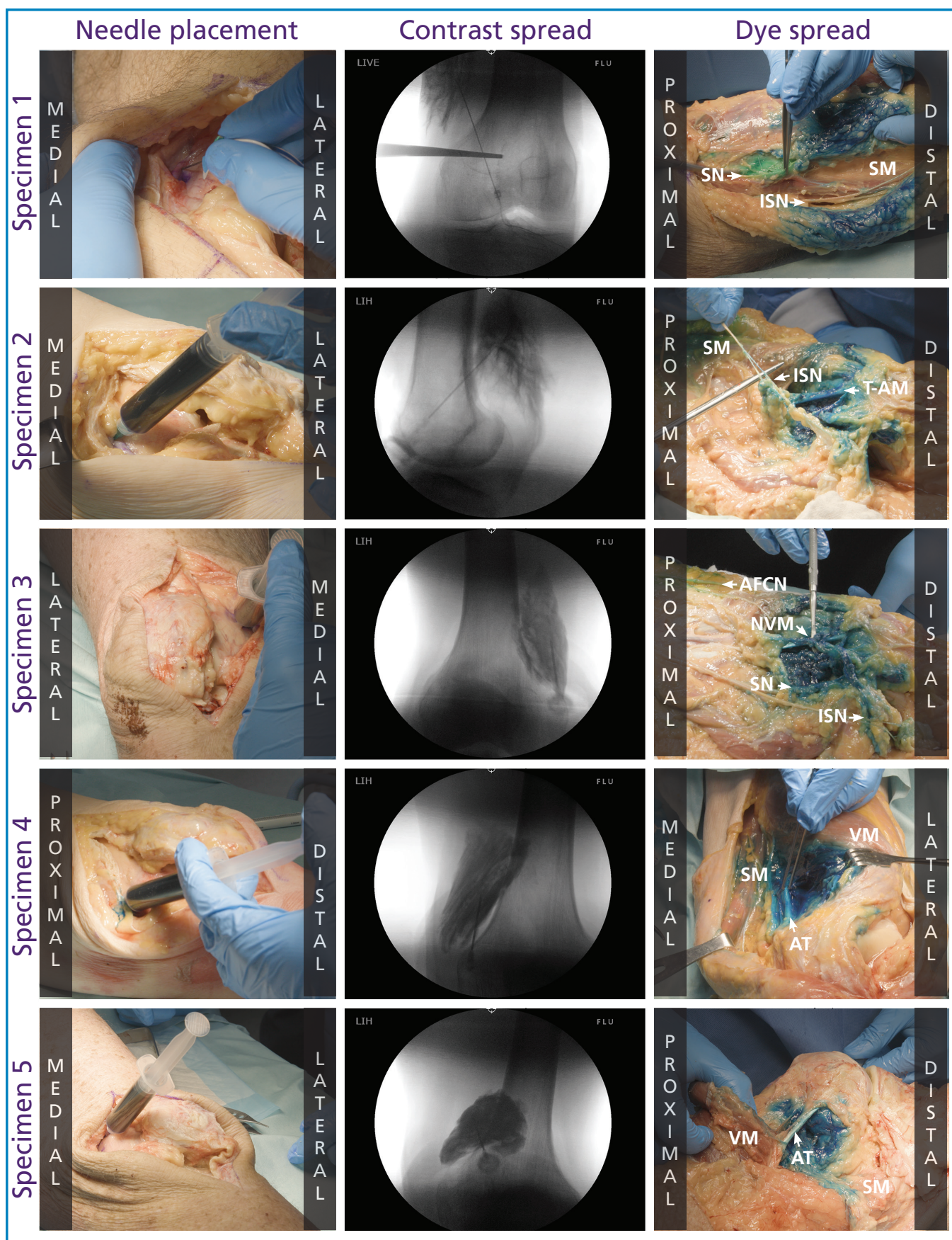
CADAVERIC LOWER LIMB SPECIMENS

- Characteristics of the lower limb cadaver specimens used in the study are shown in Table 1

Table 1. Lower Limb Cadaver Specimen Characteristics

	Lower limb cadaver specimen 1	Lower limb cadaver specimen 2	Lower limb cadaver specimen 3	Lower limb cadaver specimen 4	Lower limb cadaver specimen 5
Sex	Male	Female	Male	Male	Male
Age, y	80	81	73	83	73
Laterality	Left	Left	Right	Left	Left
Body mass index, kg/m ²	24.4	26.4	24.7	22.2	24.7
Mid-thigh circumference, cm	47.5	47.5	49.5	39.0	49.5
Method(s) evaluated	US-guided ACB, IPSA injection	IPSA injection	US-guided ACB, IPSA injection	IPSA injection	IPSA injection
ACB, adductor canal block; IPSA, intraarticular posteromedial surgeon-administered; US, ultrasound.					

Figure. Needle placement (left panels); needle angle, position, and dye spread under fluoroscopy (middle panels); and dye spread to structures of interest (right panels).



AFCN, anterior femoral cutaneous nerve; AT, adductor tendon; ISN, infrapatellar branch of the saphenous nerve; NVM, nerve to the vastus medialis muscle; SM, sartorius muscle; T-AM, tendon of adductor magnus.

ITERATIVE PROCEDURES AND ANATOMIC STRUCTURES DYED

- The needle angle and dye spread to dissected structures for each lower limb cadaver specimen are shown in the Figure
- Dye injection procedures and the structures dyed for each lower limb cadaver specimen are summarized in Table 2
- Upon dissection of lower limb cadaver specimen 1, the needle tip from the IPSA injection appeared to be in the subcutaneous space posterior to the VM
 - No blue staining from the IPSA injection was found within the adductor canal, but rather in the subcutaneous tissue
- Needle size was adjusted from 4 inches for lower limb cadaver specimen 1 to 1.5 inches for specimens 2 through 5
- Needle angles for lower limb cadaver specimens 1, 2, 3, 4, and 5 were 30°, 40°, 55°, 30°, and 70°, respectively
- Minimal proximal spread was observed after the IPSA injection in lower limb cadaver specimens 2 and 3; therefore, all 20 mL were injected at once in specimens 4 and 5
- In 3 of 5 lower limb cadaver specimens, the ISN was outside the adductor canal and was not stained by the US-guided ACB (green dye)
- Blue staining (associated with the IPSA injection) of the ISN, NVM, and posterior capsule, but not the adductor canal, was observed in lower limb cadaver specimens 2, 3, and 5
 - The results suggest the superomedial genicular nerve branches may be covered using this approach because blue staining was confined in the interval between the pes and the capsule

Table 2. Dye Injection Procedures and Structures Dyed for Each Cadaver

Lower limb cadaver specimen	Surgeon-administered characteristics				Structures dyed	
	Needle length, in*	Needle angle, ° posterior to femur	Time between injections, min	Location of the ISN (relative to sartorius muscle)	Green (US-guided ACB) [†]	Blue (surgeon-administered infiltration)
1	4	30	9	Superficial	SN NVM AC	None
2 [‡]	1.5	40	5	Superficial	NA	SN ISN NVM PC
3	1.5	55	5	Within the AC	SN NVM AC	SN ISN NVM PC
4 [‡]	1.5	30	0	Superficial	NA	None
5 [‡]	1.5	70	0	Within the AC	NA	SN ISN NVM
*All needles were 18-gauge sharp. [†] A US-guided ACB was performed in lower limb cadaver specimens 1 and 3. [‡] Only landmark approach/methylene blue was administered in specimens 2, 4, and 5. ACB, adductor canal block; ISN, infrapatellar branch of the saphenous nerve; NA, not applicable; NVM, nerve to the vastus medialis muscle; PC, posterior capsule; US, ultrasound.						

DISCUSSION

- In addition to reaching the ISN, NVM, and posterior capsule, dye staining patterns suggest this approach may cover the genicular nerves, although additional confirmation is needed because the genicular nerves were not dissected in this study
- Dye injected via the IPSA approach did not reach the adductor canal; however, multiple nerves that are typically blocked for TKA analgesia via multiple injections were stained after a single IPSA injection
- The anatomic variant where the ISN coursed outside of the adductor canal observed in 3 of 5 lower limb cadaver specimens may provide insight into the reported variable clinical effectiveness of ACBs
 - Notably, dye from the US-guided ACB did not contact the ISN in the variant in which the ACB was administered