

## Observational Study

# Prospective Within Subject Comparison of Fluoroscopically Guided Lumbosacral Facet Joint Radiofrequency Ablation Using a Multi-Tined (Trident) Versus Conventional Monopolar Cannula

George Deng, MD<sup>1,2</sup>, Ashley Smith, PhD<sup>1,2</sup>, and Robert Burnham, MD<sup>1,3</sup>

From: <sup>1</sup>Vivo Cura Health, Calgary, Alberta, Canada; <sup>2</sup>Department of Clinical Neurosciences, Cumming School of Medicine, University of Calgary, Alberta, Canada; <sup>3</sup>Division of Physical Medicine and Rehabilitation, Faculty of Medicine, University of Alberta, Alberta, Canada

Address Correspondence:  
George Deng, MD  
Vivo Cura Health  
#100 - 325 Manning Rd NE  
Calgary, Alberta, Canada T2E 2P5  
E-mail:  
george.deng@vivocura.ca

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**Background:** Radiofrequency ablation (RFA) for the lumbar facet joints has demonstrated efficacy in the management of chronic low back pain. The traditional technique uses a conventional monopolar (CM) cannula placed parallel to the putative nerve to produce a thermal lesion resulting in pain relief of the facet joints. A new multi-tined (MT) cannula has come onto the market that allows targeting the putative nerve using a perpendicular to the nerve approach.

**Objectives:** This study describes the technique using the MT cannula and compares its efficacy and procedural characteristics to the CM cannula.

**Study Design:** This is a pre-post crossover observational study.

**Methods:** Fifty-one patients were recruited between June 2015 and March 2020. Each patient underwent 2 fluoroscopic guided lumbosacral RFA procedures on 2 separate occasions at the same facet joints, using the CM and MT cannula consecutively. The primary outcome measure was change in pain on the 11-point numeric rating scale (NRS). Secondary outcome measures included change in Pain Disability Quality of Life Questionnaire (PDQQ) score, duration and magnitude of pain relief, local anesthetic use, adverse events, procedural and fluoroscopy exposure time, and radiation dose.

**Results:** There were no statistically significant difference between CM versus MT cannula in terms of absolute (4.0 versus 4.3) and relative (52% versus 57%) change in NRS ( $P = 0.99$ ) and PDQQ (22 versus 22,  $P = 0.61$ ) at 3 months, or overall pain magnitude (71% versus 72%,  $P = 0.96$ ) and duration of relief (8.7 months versus 8.4 months,  $P = 0.68$ ). The procedures using the MT cannula were completed faster (37.6 minutes versus 31.1 minutes,  $P < 0.001$ ) and required less local anesthetic (15.8 mL versus 11.0 mL,  $P < 0.001$ ) and radiation dose (41.5 mGy versus 30.2 mGy,  $P = 0.05$ ). No adverse events were observed with either cannula.

**Limitations:** This was an observational study at a single center with the proceduralist not blinded to the intervention.

**Conclusion:** This study demonstrated that the outcomes in terms of pain, disability, quality of life, adverse events, and fluoroscopy exposure time were equivalent between the 2 cannulae. However, RFA using the MT cannula was faster to perform and involved less local anesthetic and radiation.

**Key words:** Pain, radiofrequency ablation, facet joint, intervention, lumbar spine, fluoroscopy

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**R**adiofrequency ablation (RFA) is a percutaneous outpatient procedure that uses thermal energy to denervate the zygapophyseal (facet)

joints. It has grown in popularity as an option in the management of facetogenic chronic low back pain (1). RFA of the lumbar facet joints provides significant

improvements in pain (2-4), function (3,4), and patient satisfaction (3). It also reduces analgesic use (3-5) and healthcare utilization (6).

RFA of the lumbar facet joints is traditionally performed with a conventional monopolar (CM) cannula. Two different techniques have been described, based on the angle of the cannula to the nerve, either parallel or perpendicular (7). A CM cannula produces a 3-dimensional thermal lesion with a tapered end resulting in a 2-dimensional thermal footprint that varies in size depending on the angle of the cannula to the nerve (8). Anatomical and clinical comparisons of these 2 approaches using a CM cannula demonstrate that the parallel to the nerve approach increases the likelihood of ablating the target nerve (9,10) and improves clinical pain, disability, and function outcomes (10,11). However, the parallel approach requires the cannula to pass through more tissue, which may be more technically challenging, uncomfortable, and time-consuming especially in cases with anatomical variations or presence of spinal instrumentation.

Recently, a multi-tined Trident (MT) radiofrequency cannula has been developed. This cannula produces a pear-shaped lesion with a large bulbous base (8). Unlike the tapered end of the thermal lesion from a CM cannula, an MT cannula produces a 3-dimensional thermal lesion with a bulbous end resulting in a 2-dimensional thermal footprint onto the target nerve that is stable through a wide range of angles between the cannula and the nerve (8). An 18-gauge MT cannula with a 5 mm active tip heated to 80°C for 2 minutes will produce a thermal lesion at the cannula tip measuring approximately 8 mm in width and depth (8). Based on the anatomy of the cervical facets, a perpendicular to the nerve approach has been proposed to ablate the medial branches of the dorsal rami using an MT cannula (8). We hypothesize that this proposal can be further extended to the medial branches of the dorsal rami (and the L5 dorsal rami) of the lumbosacral facets.

To the authors' knowledge, there has been no previous comparison of outcomes between a CM cannula using the validated parallel to the nerve approach and an MT cannula using a perpendicular to the nerve approach. The aim of this study was to compare the effectiveness of these 2 techniques in terms of patient-reported outcomes of pain, disability, and quality of life as well as procedural efficiencies, including fluoroscopy time, radiation absorption dose, and total procedure duration.

## METHODS

The research protocol was approved by the Conjoint Health Research Ethics Board of the University of Calgary (REB20-0355).

A pre-post observational study was conducted between June 2015 and March 2020 at a single center to evaluate the procedural characteristics of consecutively performed lumbar facet RFA using a CM cannula and MT cannula (Fig. 1). The paired study design investigated differences in outcomes prior to and 3 months following lumbar spine RFA performed with these 2 different cannulae on the same patients.

### Participants

The inclusion and exclusion criteria are described in Table 1.

Prior to June of 2015, patients undergoing lumbar spine RFA at our institution received their RFA with the CM cannula. In June of 2015, the MT cannula was available to use for lumbar spine RFA. During the study period, 51 patients returned for repeat procedure upon resumption of their familiar pain, defined as pain with the same characteristics as the pre-RF pain in terms of severity, location, quality, radiation, aggravating and relieving features occurring within the expected timeframe of facet joint reinnervation. At that point, each underwent lumbar spine RFA with the alternate cannula at the same facet joint levels. During the study period, 20% of the patients previously had successful RFA with the CM cannula, and upon return with their familiar pain, RFA was performed with the alternate cannula. The other 80% of the patients requested RFA of their lumbar facet for the first time and had received the procedure with the MT cannula. Upon return with their familiar pain, the alternate cannula was used. Sixty-seven percent and 88% had undergone prior successful RFA at the same facet level for the MT and CM RFAs, respectively. All procedures were performed by the same physician with 25 years of experience performing fluoroscopically guided neuraxial procedures.

### Procedure Techniques

Facet joints to be initially targeted for intervention were determined by history and physical examination. Dual diagnostic local anesthetic facet interventions were performed, including either 2 consecutive medial branch blocks (MBB), or a facet joint injection (containing local anesthetic and corticosteroid) and an MBB (containing only local anesthetic). A positive response during the first 6 hours during the local anesthetic phase

following a facet joint steroid injection was counted as a block for practicality. MBBs were performed using 0.5 mL of 2% lidocaine mixed with 0.5% bupivacaine per nerve and facet joint injections were performed using 1 mL of 20 mg triamcinolone mixed with 0.5 mL of 0.5% bupivacaine or 2% lidocaine per joint. A positive response was defined as  $\geq 50\%$  concordant pain relief on an 11-point NRS in the first 6 hours after a block when compared to baseline. Two consecutive positive blocks were required before RFA. Techniques for facet joint injections and MBBs were performed as per Spine Intervention Society Practice Guidelines (12).

### CM RFA Technique

With the patient lying prone, the target vertebrae were identified, and the declined and oblique view was identified based off the superior end-plate of that vertebrae. The overlying skin, soft tissue, and medial branch nerve were anesthetized with 1-2 mL of 1% preservative-free lidocaine without epinephrine using a 25-gauge, 3.5-inch-long needle. Additional local anesthetic was injected as required for patient comfort. A 16-gauge CM cannula with a 10 mm curved active tip (Diros Technology Inc, Markham, Ontario, Canada) was directed towards the junction of the superior articular process and transverse process of the L1-L5 or the S1 sacral ala through the anesthetized tissue. Once the cannula contacted the periosteum, the final position of the cannula was adjusted and confirmed on the ipsilateral oblique, AP, and lateral views. Figure 2 demonstrates the final fluoroscopic images with the superior end-plate squared off. Thereafter, an additional 1.0 mL of 1% lidocaine was injected. The RF cannula was connected to the Diros OWL® URF-3AP radiofrequency generator (Diros Technology Inc, Markham, Ontario, Canada) with a grounding pad placed on the patient's leg, and then the thermal lesion was delivered. No motor or sensory

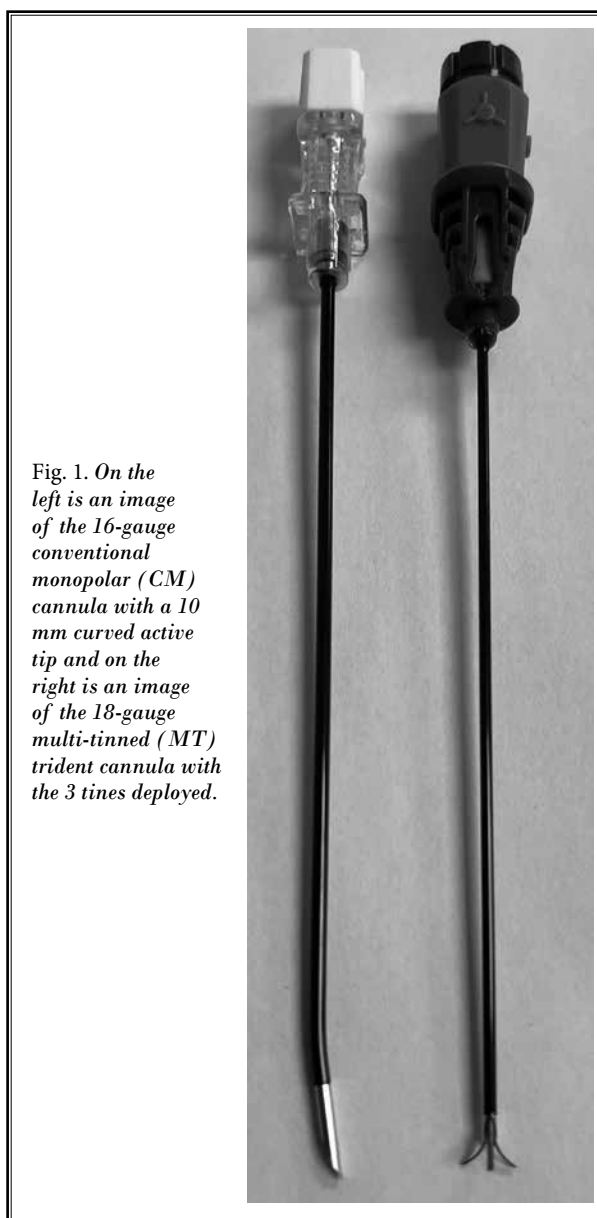


Fig. 1. On the left is an image of the 16-gauge conventional monopolar (CM) cannula with a 10 mm curved active tip and on the right is an image of the 18-gauge multi-tined (MT) trident cannula with the 3 tines deployed.

Table 1. Inclusion and exclusion criteria

<b>Inclusion Criteria</b>	<ol style="list-style-type: none"> <li>1. &gt; 18 years of age</li> <li>2. chronic (&gt; 6 months duration)</li> <li>3. mechanical, non-radiculopathic, or non-inflammatory low back pain</li> <li>4. refractory to conventional conservative treatments</li> <li>5. low back pain of facet joint origin as determined by <math>\geq 50\%</math> pain relief during the local anesthetic phase of 2 diagnostic facet joint blocks (either 2 MBBs or 1 intra-articular and 1 MBB)</li> </ol>
<b>Exclusion Criteria</b>	<ol style="list-style-type: none"> <li>1. local or systemic infection</li> <li>2. coagulopathy</li> <li>3. local anesthetic allergy</li> <li>4. pregnancy</li> <li>5. pacemaker</li> <li>6. neurostimulator</li> <li>7. concurrent interventional therapy for sacroiliac joint or discogenic pain</li> </ol>

stimulation was performed. The lesion temperature was 80°C, and the lesion duration was 145 seconds, which included 15 second ramp-up time. No corticosteroids were injected after completion of nerve ablation.

If the RFA procedure was extensive and bilateral, it was sometimes performed over 2 days. These were treated as one procedure, and the procedure duration, fluoroscopy exposure time, radiation dose, and local anesthetic dose of the 2 days were summed, and the outcome measures were reported for the combined procedure. Following the RFA procedure, patients were given an emergency clinic phone number to call if they developed an adverse event or complication.

#### **MT RFA Technique**

With the patient lying prone, the target vertebra was identified, the superior endplate was squared off and the oblique view was identified with an unobstructed view of the junction of the superior articular process and the transverse process or sacral ala. The skin, soft tissue, and medial branch nerve were anesthetized with 1-2 mL of 1% preservative-free lidocaine without epinephrine using a 25-gauge, 3.5-inch-long needle. Additional local anesthetic was injected as required for patient comfort. An 18-gauge MT cannula with a 5mm active tip (Diros Technology Inc, Markham, Ontario, Canada) was placed 1-2 mm inferior to the junction of the superior articular process and transverse process of the L1-L5 or the S1 sacral ala through the anesthetized tissue. Once the cannula contacted the periosteum, the tines were deployed, and the final position of the cannula was confirmed on the oblique, AP, and lateral views. Figure 3 demonstrates the final fluoroscopic images with the superior end-plate squared off. Thereafter, an additional 1.0 mL of local 1% lidocaine was injected, and the thermal lesion was delivered in an identical manner as the CM technique described above.

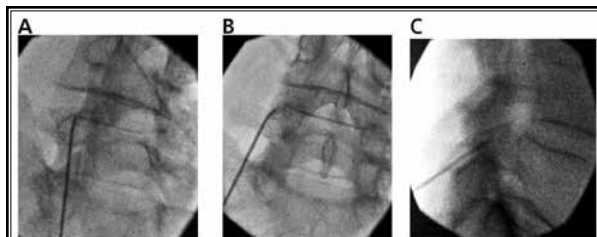


Fig. 2. Fluoroscopic images of radiofrequency ablation of the left L4 medial branch at the L5 vertebral level using a conventional monopolar cannula. The oblique view a), anteroposterior view b), and lateral view c) are shown.

#### **Outcome Measures**

The primary outcome for this study was the change in pain 3 months post-RFA. Secondary outcomes included change in PDQQ score, overall magnitude, and duration of pain relief, adverse events, procedure duration, fluoroscopy exposure time, absorbed radiation dose, and local anesthetic used.

#### **Numeric Pain Rating Scale**

Pre-and post-RFA pain was measured using the 0-10 NRS. It is the first of the 6 questions on the PDQQ.

#### **Pain Disability Quality-of-Life Questionnaire (PDQQ)**

This 6-item questionnaire uses 6 zero to 10-point NRS (total scores range from 0 to 60) to investigate the average response for the prior week for 3 domains: pain, disability, and quality of life. Suitable responsiveness, reliability, and validity have been demonstrated for interventional spine procedures (13). The PDQQ was completed in person on the day of the RFA and via email or telephone contact 3 months post-RFA. Two to 3 months post RFA has been documented to be the time of maximal pain relief (3).

#### **Magnitude and Duration of Pain Relief**

When patients returned for repeat RFA procedure(s), they were asked to retrospectively estimate the overall average magnitude (percentage) and duration of pain relief (months) they experienced.

#### **Complications**

Patients were provided a telephone number and prompted to contact the clinic to report any complications. They were also asked at the 3-month telephone/email follow-up contact.

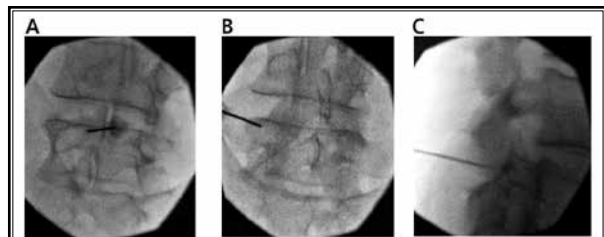


Fig. 3. Fluoroscopic images of radiofrequency ablation of the left L4 medial branch at the L5 vertebral level using a multi-tined cannula. The oblique view a), anteroposterior view b), and lateral view c) are shown.

**Procedural Characteristics**

Fluoroscopic exposure time and radiation dose were automatically calculated and stored by the C-arm. Procedural duration was calculated as the time from the first fluoroscopic image to the time when the last cannula was removed from the patient. Local anesthetic dose was tallied by the x-ray technician post-procedure.

**Analyses**

Patient age, gender, and level of facet joints treated were summarized using descriptive statistics (Tables 2 and 3). Data were firstly analyzed for normality via observation of box plots and Shapiro-Wilks test. Procedural characteristics (procedural time, fluoroscopy time, local anesthetic, and absorbed radiation dose) were analyzed using paired t-tests (Table 4). Percentage of patients experiencing  $\geq 50\%$  pain relief and  $\geq 50\%$  improvement in PDQQ scores ('responders') at 2 to 3 months post-RFA were also calculated, with  $\chi^2$  analysis used to evaluate whether there was a difference in the proportions of responders with each cannula post-RFA.

Multilevel modeling, using the linear mixed models (LMM) function in SPSS Version 24.0 (SPSS Inc., Chicago, IL), was used to account for the repeated responses given by each patient for analyses of pain (NRS), PDQQ score, and overall estimate of the magnitude and duration of pain relief (Table 5). The models controlled for the repeated measures by including random effects for patients as a random slope, as determined during model building. A variance components covariance structure and restricted maximum likelihood estimation (REML) were used. In addition, using forward selection, age, gender, order of procedure (CM or MT), and whether this was a repeat procedure, regardless of the technique (No/Yes), were included in all initial

multivariable models and were retained in the final model if  $P < .05$ .

Differences in pain and disability were investigated using LMM with a random slope accounting for repeated measures over time (Pre- or Post-RFA). The models evaluated the effect of Cannula (CM or MT) on NRS (0-10) and

Table 2. Characteristics of patients undergoing lumbar spine radiofrequency ablation.

Age (mean, standard deviation, range)	60.7; (11.0 years; 28-83)
Gender: n; %; Age (mean $\pm$ standard deviation)	Male: 24; 47%; (57.4 $\pm$ 12.0) Female: 27; 53%; (63.4 $\pm$ 9.1)

Table 3. Summary of characteristics for lumbar radiofrequency ablation. Respective number of patients with number of procedures performed at each vertebral level; unilaterality of procedure, and whether single or multiple levels of procedures were performed.

Unilateral versus bilateral	Bilateral: 37
	Unilateral: 14 Left: 4 Right: 10
Total number of each facet joints ablated - n (%)	L3/4: 17 (10)
	L4/5: 73 (43)
	L5/S1: 79 (47)
Number of patients per number of facet joint levels ablated: n	1 level: 11
	2 levels: 32
	3 levels: 8
Number of patients per number of facet joints ablated on each patient: n	1 facet joint: 0
	2 facet joints: 22
	3 facet joints: 4
	4 facet joints: 20
	5 facet joints: 0
	6 facet joints: 5

Table 4. Procedure and fluoroscopy exposure time, absorbed radiation, and local anesthetic used for both RFA cannulae.

	Cannula CM	Cannula MT	Mean Difference (95% CI)	Test Statistic	P value	Effect Size Cohen's d Co-efficient
Procedure Duration Mean (95%CI), mins	37.6 (35.1, 40.1)	31.3 (29.0, 33.7)	6.2 (3.2, 9.2)	t49 = 4.20	< 0.001	0.7
Fluoroscopy Exposure Time Mean (95%CI), mins	97.0 (87.7, 106.2)	99.9 (90.0, 109.8)	-2.4 (-11.7, 6.9)	t48 = 0.52	0.61	0.07
Air Kerma (95%CI), mGy	41.5 (33.1, 50.0)	30.2 (22.9, 37.5)	11.5 (4.2, 18.8)	t42 = 3.18	0.003	0.5
Local Anesthetic of 1% lidocaine (95%CI), mL	15.8 (14.6, 17.0)	11.0 (10.0, 12.0)	4.9 (4.0, 5.8)	t49 = 11.1	< 0.001	1.2

CM, conventional monopolar; MT, multi-tined; CI, confidence interval; mins, minutes; mGy, milligray; mL, milliliters.

Table 5. Pre- and post-RFA pain and PDQQ scores (95% confidence intervals) for study patients.

		Cannula CM	Cannula MT
Pain Severity NRS	NRS mean NRS (95% CI)	Pre-RFA: 7.3 (6.8, 7.9) Post-RFA: 3.4 (2.7, 4.0)	Pre-RFA: 7.5 (6.9, 8.0) Post-RFA: 3.1 (2.4, 3.8)
	Pre-Post Treatment Difference Mean (95%CI)	4.0 (3.2, 4.8)	4.3 (3.5, 5.1)
	Effect Size Cohen's d coefficient	1.8	1.9
	% change in NRS (95% CI)	52 (42, 61)	57 (49, 66)
	% with ≥ 50% NRS reduction (95% CI)	63 (49, 76)	71 (57, 84)
PDQQ	PDQQ score mean (95% CI)	Pre-RFA: 46 (44, 49) Post-RFA: 24 (20, 28)	Pre-RFA: 46 (43, 48) Post-RFA: 24 (19, 28)
	Pre-Post Treatment Difference Mean (95%CI)	22 (18, 26)	22 (18, 26)
	Effect Size Cohen's d coefficient	1.9	1.8
	% Change in PDQQ (95% CI)	47 (39, 56)	49 (41, 57)
	% with ≥ 50% PDQQ improvement (95% CI)	45 (31, 59)	42 (27, 56)
Overall Magnitude & Duration of Pain Relief	%Magnitude pain relief (95% CI)	71 (62, 80)	72 (62, 82)
	Duration of relief months (95% CI)	8.7 (7.0, 10.4)	8.4 (7.1, 9.7)

CM, conventional monopolar; MT, multi-tined; NRS, numeric rating scale; PDDQ, Pain Disability Quality of Life Questionnaire.

PDQQ (0-60). Linear mixed models with random intercepts were also used to evaluate the effect of Cannula (CM or MT) on both the subjective percentage of pain relief and duration of pain relief post-RFA.

Cohen's d coefficient was calculated for paired samples to estimate effect size for procedural characteristics and pain relief (change in NRS) or PDQQ scores 3 months post-RFA.

## RESULTS

### Demographic Data

A total of 51 patients underwent lumbar spine RFA with each cannula between June 2015 and March 2020. Demographic data are summarized in Table 2.

### RFA Characteristics

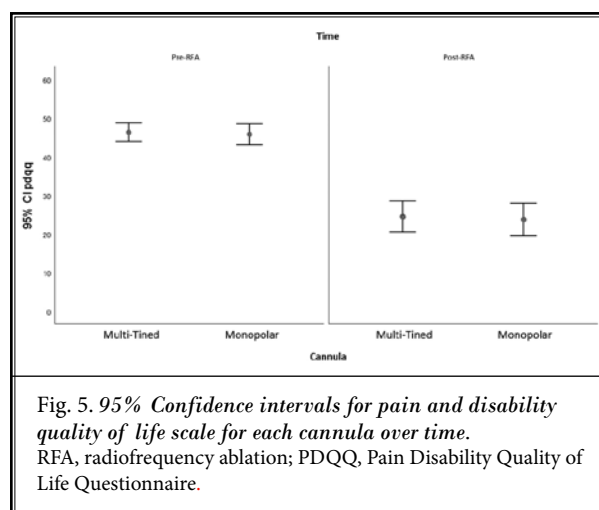
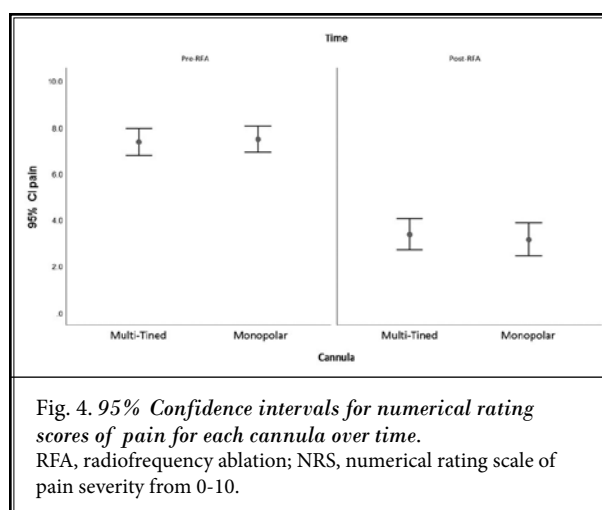
The RFA characteristics are summarized in Table 3. Seventy-seven percent of patients had multiple levels ablated, with 74% undergoing bilateral procedures. Of the 14 patients who had unilateral procedures, 10

of them had it performed on the right side. The most targeted level was L5-S1, followed by L4-L5 and then L3-4.

### Effectiveness of Lumbar Spine RFA

Effectiveness of NRS and PDQQ scores for patients in the study are demonstrated in Table 5. Multilevel models controlling for the effect of age and gender did not demonstrate any significant difference, for either pain ( $F_{1, 95.5} = 0.00$ ,  $P = 0.99$ ; Fig. 4) or PDQQ scores ( $F_{1, 95.3} = 0.32$ ,  $P = 0.57$ ; Fig. 5) over time. There was no significant difference in mean percentage improvement in pain (52% vs 57%;  $F_{1, 46.7} = 1.47$ ,  $P = 0.23$ ) or PDQQ scores (47-49%;  $F_{1, 46.2} = 0.26$ ,  $P = 0.61$ ) following RFA with either cannula. There was no significant difference in the proportion of patients reporting ≥ 50% reduction of pain with either cannula ( $\chi^2 = 3.57$ ,  $df = 1$ ,  $P = 0.059$ ). Overall, 3 months post-procedure, approximately 60-70% of patients undergoing RFA with either cannula reported ≥ 50% reduction of pain, whilst 40-45% of samples reported





$\geq 50\%$  improvement in PDQQ scores. The order of procedure performed ( $F_{1, 48.6} = 0.02, P = 0.89$ ;  $F_{1, 45.4} = 0.01, P = 0.94$ ) or whether the patient was repeating the procedure ( $F_{1, 48.4} = 2.25, P = 0.14$ ;  $F_{1, 45.3} = 1.29, P = 0.26$ ) did not moderate pain relief or PDQQ scores respectively.

### Magnitude and Duration of Pain Relief With RFA – CM vs MT

There was no significant difference in the overall estimate of pain relief magnitude ( $F_{1, 27.4} = 0.003, P = 0.96$ ) or duration ( $F_{1, 23.0} = 0.17, P = 0.68$ ) for either cannula (Table 5). Patients reported approximately 70% pain relief for 8-9 months following thermal RFA for either cannula (Table 5).

### Safety and Procedural Characteristics

No patient reported any adverse event or complication through the period of this data collection.

Table 4 summarizes the RFA procedural characteristics for patients undergoing the procedure with the different cannula. RFA using MT was significantly shorter ( $t_{47} = 4.98, P < .001$ ) and required less absorbed radiation dose (Air Kerma) ( $t_{42} = 3.18, P = .003$ ) and local anesthetic ( $t_{49} = 11.1, P < .001$ ). There was no statistically significant difference in fluoroscopy exposure time ( $t_{46} = .39, P = .70$ ).

### DISCUSSION

This is the first prospective study designed to compare outcomes and procedural characteristics of lumbar facet RFA performed using a CM cannula with a parallel to nerve approach or an MT cannula with a perpendicular to the nerve approach. This study dem-

onstrated that there were no significant differences in the change in pain or PDQQ scores at 3 months post-RFA or the overall retrospective estimate of pain relief magnitude and duration with either cannula. When evaluating procedural characteristics, the MT cannula RFA had a significantly shorter procedure duration and required significantly less absorbed radiation and local anesthetic.

Our study sample presented with moderate-to-severe pain, disability, and reduced quality of life and is consistent with other study samples treated with lumbar facet RFA in a clinical tertiary care primary practice (10,14-16). The age and gender profile of our participants are also similar to other reported studies (10,14-16). Our study also demonstrated a comparable rate (73%) of bilateral RFAs performed in this practice environment, as reported in one previous study (66%) (5).

Our study demonstrated a 4-point reduction (approximately 50-60%) in pain 3 months post-RFA, which is similar to that reported by a systematic review (17) and other cohort studies performing lumbar facet RFA(10,14,16). The average duration of pain relief in our study for the CM (8.7 months) or MT cannulae (8.4 months) was comparable to that reported in other studies ranging from 4 to 9.9 months (10). Thus, our sample and outcomes are consistent with those previously reported for lumbar facet RFA.

Previous studies in the lumbar spine found that the perpendicular to the nerve approach demonstrated poorer outcomes compared to the parallel to the nerve approach using a CM cannula (10,11). The poorer outcomes with that approach are presumed to be due to the small cross-sectional footprint associated

with an ellipsoid lesion produced by the tip of the CM cannula (18), which limits the likelihood of capturing the putative nerve (7). Thus, our current study results provide novel clinical evidence that a perpendicular to the nerve approach can provide similar pain outcomes, but only when an MT cannula is used. This is supported anatomically by the pear-shaped burn shape produced by the MT cannula (8), which produces a large enough cross-sectional footprint to ablate the MBBs in the cervical spine (8). Given that the medial branches of the lumbar spine also travel along a predictable region of the periosteum, we speculate that the lesion shape produced by the MT produces the same effect in the lumbar spine as it does in the cervical spine.

Our study demonstrated procedural efficiencies, with the MT cannula requiring significantly shorter procedural duration (31.3 vs 37.6 mins), less local anesthetic, and less absorbed radiation doses. Procedural duration may reflect procedural complexity and are comparable to a benchmark study using a CM cannula, which reported a procedure duration of 38.2 minutes (15). Placement of the MT cannula is similar to performing an MBB. It is therefore a familiar procedure for most spine interventionalists and an easily acquired skill for learners. Because MT RFA accommodates a perpendicular approach, less soft tissue is penetrated with the cannula. Additionally, the MT cannula size was smaller than the CM cannula used in this study. These factors may make the MT RFA a more comfortable procedure. This is inferred by significantly less local anesthetic being required for MT RFA compared to the CM RFA. Although fluoroscopy exposure time was not significantly different between the 2 cannulae, absorbed radiation dose was higher with the CM cannula. The air kerma measurement is a more accurate description of the radiation used during a procedure than fluoroscopic exposure time (19). The increased radiation, as measured by the air kerma, is likely due to increased tissue penetration, particularly with the decline view as well as more frequent spot images being required to advance the cannula through more tissue and a more technically demanding cannula placement.

There were no differences between the rate of adverse events between these 2 techniques. This is a limitation of registry outcome studies whereby rates of adverse events may be underestimated. However, overall, lumbar facet RFA has an excellent safety profile (20). Even in complex anatomy, risks for RFA are nominal (21). Theoretically, the MT cannula may have added safety, as the cannula will ultimately rest per-

pendicularly on top of the periosteum, whereas the CM cannula is advanced parallel against the medial branch with no bony endpoint to prevent advancement to the spinal nerve roots. Although a cost analysis was not formally performed in this study, an MT cannula is approximately 5 times more expensive than a CM cannula which may preclude its routine use. However improved procedural efficiency may compensate for the cost difference in routine cases. The authors have found that the flexibility of the direction of approach to the target nerve afforded by the MT cannula makes it the preferred and sometimes sole choice in circumstances of challenging anatomy, such as the presence of surgical instrumentation.

### Strengths and Limitations

There are a few limitations to consider. Firstly, an experimental design was not used to power the differences between cannulae for pain or PDQQ outcomes. However, conjunction of consistent overlapping confidence intervals for both continuous and categorical data make this possibility unlikely. Selection bias is possible, as patients not responding to treatment will not likely return for follow-up procedures. There was also no control population, which raises an alternative conclusion; that neither cannulae worked. However, the large effect sizes and comparison to other literature preclude this as a suitable conclusion. The cannula gauges were not controlled due to the MT cannula only being available in the 18-gauge size. Studies on lesion sizes indicate that the 2 cannulas are similar with the 16-gauge CM cannula with a parallel approach producing a lesion with a width of 9.4 mm by a length of 13.3 mm lesion (22) and the 18-gauge MT cannula with a perpendicular approach producing a lesion with a width of 7.51 mm by a length of 8.72 mm (8). Blinding was also not formally included in the study design. Due to the nature of the procedure, the interventionalist could not be blinded. The outcome assessors were also not formally blinded but were unlikely to have understood the significance of the different cannulas. Also, the patient, while lying prone, could not see the procedure being performed and the vast majority, if not all, of the patients were unaware of the type of cannula that was being used. Lastly, this study used an inclusion criterion of 50% improvement with MBB instead of 80% improvement. Although an 80% improvement with MBBs has a higher success to RFA and is proposed as the gold-standard (23), many studies and clinical settings use a 50% cut off (24).



Strengths of this study included the use of consistent internal controls, such as the same experienced interventionalist performing all procedures. Additionally, each patient was able to act as their own control.

## CONCLUSION

Lumbar spine RFA using either the MT-cannula or

CM-cannula results in significant and comparable improvements in pain, disability, and quality-of-life, and require similar fluoroscopy exposure time to perform. The MT-cannula lumbar spine RFA procedure is quicker to perform, requires less local anesthetic, and delivers lower absorbed radiation dosage to the patient.

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