Effect of Genicular Nerve Radiofrequency Ablation for Knee Osteoarthritis: A Retrospective Chart Review

Brody Fitzpatrick; Matthew Cowling, DO; Michelle Poliak-Tunis, MD; Kathryn Miller, MD

ABSTRACT

Background: Genicular nerve block and radiofrequency ablation improve pain and function in patients with knee osteoarthritis. We aimed to evaluated the efficacy of these procedures and to identify factors predicting outcomes.

Methods: We conducted a chart review of 18 patients referred for these procedures from our clinic. Pain scores were collected before and after the procedure and at a follow-up visit. Functional measures were recorded before the procedure.

Results: Both procedures reduced pain in the post-procedure and follow-up settings, and the Western Ontario and McMaster Universities Osteoarthritis Index correlated with the paired differences of pre- and follow-up pain scores.

Discussion: These procedures provided significant pain relief, and the Western Ontario and McMaster Universities Osteoarthritis Index may help identify appropriate candidates for these procedures.

INTRODUCTION

Osteoarthritis (OA) is the most common form of arthritis and is a leading cause of disability in the United States.1 Thirty-five million people in the US are 65 and older, and over half of them have radiographic evidence of osteoarthritis in at least 1 joint.[1] In addition to an aging population, approximately two-thirds of US adults are overweight. Obesity is the largest modifiable risk factor of knee osteoarthritis (KOA) and can complicate its management.

To address the needs of people suffering from this condition, international management guidelines have been developed to recommend evidence-based care for osteoarthritis.[2] These guidelines are in agreement that first-line care for KOA should prioritize the appropriate exercise and weight loss prior to medications, injections, and joint replacement. Despite the existence of well-developed osteoarthritis management guidelines, the characteristic management of osteoarthritis is not concordant with these recommendations, suggesting that the majority of people don't receive appropriate care.[3] In an effort to address this evidence/practice gap, there is growing international interest in the development and dissemination of coordinated osteoarthritis management programs designed specifically to ensure that patients are supported in receiving quality KOA care.

As osteoarthritis progresses, a total knee arthroplasty has been shown to be an effective treatment.[4] However, patients with body mass index (BMI) ≥ 40 are often excluded from joint replacement due to higher surgical risk. In the last decade, the genicular nerve block (GNB) and radiofrequency ablation (RFA) have been shown to improve outcomes in KOA by reducing pain and improving function.[5] During these procedures, the patient initially receives injections with an anesthetic (usually lidocaine) under fluoroscopic guidance to block the superior medial, superior lateral, and inferior medial genicular nerves. If they report a satisfactory response to the GNB (≥50% pain reduction), they may go on to receive an RFA, wherein alternating current is used to deliver thermal energy to an area of nerve tissue. This causes cell death, thus decreasing pain signals from that area. Patients who undergo RFA may receive up to 12 months of pain relief.[6]

Studies evaluating the efficacy of GNB and RFA have shown

• • •

Author Affiliations: University of Wisconsin School of Medicine and Public Health (UWSMPH), Madison, Wisconsin (Fitzpatrick); Department of Orthopedics and Rehabilitation, UWSMPH, Madison, Wisconsin (Poliak-Tunis, Cowling); Department of Medicine, UWSMPH, Madison, Wisconsin (Miller).

Corresponding Author: Michelle Poliak-Tunis, MD, 1685 Highland Ave, Madison, WI 53705; phone 608.263.9550; email poliak@rehab.wisc.edu.

Published online May 26, 2021.

promise in pain management in KOA; however, it is not known if these procedures are beneficial to patients receiving high-quality care and little is known regarding patient factors (eg, BMI, functional status) that predict outcomes of these procedures. It is also unknown if patients who receive guideline-recommended care for KOA will receive additional benefit from GNB and RFA. Therefore, we aimed to evaluate the efficacy of these procedures in a population of patients meeting all KOA quality care indicators and to identify factors predicting outcomes.

Table 1. Patient Characteristics by Group[a]

	Genicular Nerve Block (n = 26)	Radiofrequency Ablation (n = 7)
Unique patients (n = 18)	18 (100%)	5 (27.8%)
Leg		
Bilateral	12 (46.2%)	1 (14.3%)
Left	6 (23.1%)	3 (42.9%)
Right	8 (30.8%)	3 (42.9%)
Age – year	61.7 (15.2)	61.6 (6.7)
Body mass index	38.8 (8.1)	41.6 (5.7)

[a]Reported as mean (SD) or N (%)

METHODS

We conducted a retrospective chart review on 21 patients with primary KOA who were referred for a GNB or RFA from an osteoarthritis management program between October 1, 2017 and May 31, 2019. Patients seen in this program have higher levels of pain and dysfunction compared to the general KOA population. In addition, unlike patients managed in typical care, patients in seen in this program receive guideline-based care. Ultimately, 18 patients completed a procedure; therefore, only the information these patients' charts was utilized for statistical analyses.

Information obtained from medical charts included demographics; BMI; tobacco smoking status; prior treatments; procedure type and date; numeric rating scale (NRS) scores; osteoarthritis indices, including Knee Injury and Osteoarthritis Outcome (KOOS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC); Veterans RAND (VR)-12 scores; and functional tests, including timed up-and-go, single-leg stance, and 30-second chair rise.

NRS scores were collected in the peri- and post-procedural settings within the hospital. Scores also were collected at a follow-up visit, with a median of 46 (range 1-279) days post-procedure. Of the VR-12, osteoarthritis indices, and functional measures collected from the patients' medical records, only those completed immediately prior to a GNB or RFA were included in statistical analyses.

Data was summarized by mean (SD) or N (%). Comparison of NRS scores over time between groups utilized mixed effects ANOVA with time (pre, post, and follow-up), procedure (GNB or RFA), and their interaction as fixed effects and subject identification as a random effect. The mixed effects ANOVA model controlled for surgery number and leg (right, left, bilateral) as fixed covariates. *T* tests were used for single time point comparisons between procedural groups; correlations (95% CI) were calculated based on Pearson's correlation coefficient. Analyses were conducted using R for statistical computing version 3.5; all tests were 2-sided tests with $\alpha = 0.05$.

RESULTS

Of the 18 patients who underwent a GNB, 5 (27.8%) proceeded to undergo an RFA following 1 or more GNBs. In summation, the patients completed 26 GNBs and 7 RFAs. There were no statistically significant differences between ages, BMIs, VR-12, osteoarthritis indices, or functional measures of the procedure groups (Table 1). There were also no statistically significant differences in the NRS scores between nonmorbidly obese (BMI < 40) and morbidly obese (BMI ≥ 40) patients at any of the measurement intervals, nor were there any differences in the average NRS reduction in the post-procedural and follow-up intervals between these groups. Lastly, there were no statistically significant correlations comparing the differences in the pre- and post-procedural NRS scores to BMI, VR-12, osteoarthritis indices, or functional measures.

When comparing the pre- and post-procedure NRS scores of patients who underwent a GNB, the average NRS score decreased from 6.6 to 1.6 ([difference] -5.0; 95% CI, -6.1 to -3.9; $P < 0.001$). In addition, the average pre-procedure and follow-up NRS scores decreased from 6.6 to 4.5 (-2.1; 95% CI, -3.3 to -0.9; $P = 0.001$). Similar results also were found for patients who underwent an RFA, with average pre- and post-procedure NRS scores decreasing from 8.1 to 5.4 (-2.7; 95% CI, -4.8 to -0.7; $P = 0.010$) and average pre-procedure and follow-up NRS scores decreasing from 8.1 to 5.1 (-3.1; 95% CI, -5.5 to -0.6; $P = 0.016$). While not statistically significant ($P = 0.052$), there was a trending interaction when comparing the differences in the average post-procedural change in NRS scores between procedure groups, demonstrating a 23% greater reduction in NRS scores for patients who underwent a GNB compared to those who underwent RFA. (See Table 2.)

Collection of functional measures was rather incomplete, with most variables having data for ~12 to 15 GNB and 1 to 2 RFA patients. Therefore, for correlation analyses of these variables with change in NRS, we grouped GNB and RFA patients together. The relationship between WOMAC total score and the paired differences of pre- and follow-up NRS scores for GNB and RFA demonstrated a significant correlation of -0.668 (95% CI; -0.932 to -0.008), signifying that patients who had higher (worse) WOMAC scores tended to receive more pain reduction from a GNB or RFA than patients with lower (better) WOMAC scores. (See Table 3.)

Published online May 26, 2021.

DISCUSSION

This study replicated previous studies by demonstrating that both GNB and RFA were successful in reducing pain in the post-procedural and follow-up settings.[5] Notably, patients who received a GNB reported lower post-procedural pain and a greater absolute pain reduction than patients who received an RFA. While peculiar, this result also has been reported in prior studies. The authors postulated that there may be an incongruence between the area anesthetized by lidocaine during a GNB and the area subsequently lesioned during an RFA that may account for the discrepancy.[7] Overall, although the efficacy of these procedures has been well documented, to our knowledge, this is the first time they have shown to provide pain relief for nonsurgical candidates with severe knee osteoarthritis after receiving care at a multidisciplinary clinic.

Table 2. Summary of Numeric Rating Scale Over Time Between Groups[a]

Procedure	Time	Mean (95% CI)	Difference (95% CI)	*P* value	Interaction	*P* value
GNB	Pre	6.6 (5.5 to 7.7)	–		Post change difference	
	Post	1.6 (0.5 to 2.7)	-5.0 (-6.1 to -3.9)	< 0.001	-2.3 (-4.6 to 0.02)	0.052
	Follow-up	4.5 (3.3 to 5.7)	-2.1 (-3.3 to -0.9)	0.001		
RFA	Pre	8.1 (6.1 to 10)	–		Follow-up change difference	
	Post	5.4 (3.4 to 7.4)	-2.7 (-4.8 to -0.7)	0.010	1.0 (-1.8 to 3.7)	0.484
	Follow-up	5.1 (2.6 to 7.5)	-3.1 (-5.5 to -0.6)	0.016		

Abbreviations: GNB, genicular nerve block; RFA, radiofrequency ablation.
[a]Reported as mean (95% CI) from mixed effects ANOVA controlling for surgery number and leg (left, right, or bilateral).

Table 3. Correlation (95% CI) of Functional Variable Prior to Surgery and Change in Numeric Rating Scale as Post and Follow-up Time Points

	Postoperative Correlation			Follow-up Correlation		
Variable	**N**	**Correlation**	**(95% CI)**	**N**	**Correlation**	**(95% CI)**
VR-12 - MCS	25	-0.162	(-0.523 to 0.249)	18	0.166	(-0.326 to 0.588)
VR-12 - PCS	25	0.248	(-0.164 to 0.585)	18	-0.120	(-0.555 to 0.368)
KOOS - pain	14	-0.264	(-0.697 to 0.310)	13	0.182	(-0.410 to 0.666)
KOOS - symptoms	18	-0.296	(-0.670 to 0.198)	13	0.157	(-0.431 to 0.652)
KOOS - ADL	10	-0.242	(-0.757 to 0.457)	10	0.620	(-0.016 to 0.899)
KOOS - sport	9	0.236	(-0.508 to 0.778)	6	-0.121	(-0.849 to 0.766)
KOOS - QOL	9	-0.213	(-0.769 to 0.525)	7	-0.462	(-0.902 to 0.446)
WOMAC - stiffness	17	0.190	(-0.320 to 0.614)	12	0.129	(-0.480 to 0.654)
WOMAC - function	9	0.067	(-0.625 to 0.700)	9	-0.617	(-0.909 to 0.080)
WOMAC - total	9	0.159	(-0.565 to 0.744)	9	-0.668	(-0.923 to -0.008)
TUG	14	-0.003	(-0.533 to 0.529)	12	0.298	(-0.333 to 0.744)
Single leg balance - right	7	0.443	(-0.465 to 0.897)	6	-0.758	(-0.972 to 0.140)
Single leg balance - left	8	0.505	(-0.310 to 0.892)	7	-0.510	(-0.912 to 0.395)
Chair rise	14	-0.019	(-0.544 to 0.517)	12	0.031	(-0.553 to 0.594)
Body mass index	33	0.186	(-0.168 to 0.498)	23	0.139	(-0.290 to 0.521)

Abbreviations: VR, Veterans RAND; MCS, mental component score; PCS, physical component score; KOOS, Knee Injury and Osteoarthritis Outcome; ADL, activities of daily living; QOL, quality of life; WOMAC, Western Ontario and McMaster Universities Osteoarthritis Index; TUG, timed up-and-go.

Statistical analysis did not demonstrate a relationship between BMI and the NRS scores at any point before or after receiving a GNB or RFA. This contradicts 2 prior studies demonstrating an association between increased BMI and increased likelihood of knee pain.[8,9] In our study, our ability to compare pain scores stratified by BMI classes may have been limited by group sample sizes, as most of our patients had BMI > 40.0. Despite this result, patients tended to receive similar pain relief regardless of BMI. Therefore, although we don't completely understand the relationship between BMI and osteoarthritic knee pain, GNBs and RFAs provide significant benefit for patients with severe KOA.

To date, there have not been any well-established guidelines for when to refer patients for a GNB or RFA, although some authors have recommended standardized protocols for patient selection.[5,10] Therefore, one goal of this study was to identify variables influencing treatment outcomes of these procedures. Patients who had higher (worse) WOMAC total scores tended to have a higher likelihood of receiving benefit from these procedures. Ultimately, we want to utilize patient-specific variables to develop an algorithm to help guide patient selection and referral processes for GNB and RFAs.

The primary limitation of this study is small sample size. In order to be included in the study, patients must have visited our clinic and have been referred for, and subsequently completed, a GNB or RFA between October 2017 and May 2019. Due to our clinic's time and resource restrictions, and because GNB and RFAs are second- or third-line therapies for osteoarthritic knee pain, only 18 patients met inclusion criteria. Therefore, this study is underpowered to detect many statistically significant results; of those that are significant, interpretations and generalizations are limited. Thus, larger studies will be needed in the future to identify significant differences and allow for stronger interpretations of significant results. Lastly, due to the inability to standardize data collection protocols with a retrospective chart review, many functional measures obtained could not be used for statistical analyses. Therefore, future studies should consider conducting a prospective trial with standardized protocols for data collection.

Published online May 26, 2021.

CONCLUSION

This retrospective chart review demonstrated clinically meaningful pain relief with GNB and RFA for nonsurgical candidates with severe primary knee osteoarthritis being referred from a multidisciplinary osteoarthritis clinic. Additionally, the WOMAC may be valuable in the evaluation of primary knee osteoarthritis and referral protocol for GNB and RFA in the future.

Funding/Support: None declared.

Financial Disclosures: None declared.

REFERENCES

1. Powell A, Teichtahl AJ, Wluka AE, Cicuttini FM. Obesity: a preventable risk factor for large joint osteoarthritis which may act through biomechanical factors. *BrJ Sports Med.* 2005;39(1):4-5. doi:10.1136/bjsm/2004.011841

2. Stoffer MA, Smolen JS, Woolf A, et al., Development of patient-centered standards of care for osteoarthritis in Europe: the eumusc.net-project. *Ann Rheum Dis*. 2015;74(6): p.1145-1149. doi:10.1136/annrheumdis-2014-206176

3. Østerås N, Jordan KP, Clausen B, et al., Self-reported quality care for knee osteoarthritis: comparisons across Denmark, Norway, Portugal and the UK. *RMD Open.* 2015;1(1):e000136. doi:10.1136/rmdopen-2015-000136

4. Lützner J, Lange T, Schmitt C, et al. The S2k guideline: Indications for knee endoprosthesis: Evidence and consent-based indications for total knee arthroplasty. *Orthopäde*, 2018;47(9):777-781. doi:10.1007/s00132-018-3612-x

5. Choi WJ, Hwang SJ, Song JG, et al. Radiofrequency treatment relieves chronic knee osteoarthritis pain: A double-blind randomized controlled trial. *Pain*. 2011;152(3):481–487. doi:10.1016/j.pain.2010.09.029

6. Jamison DE, Cohen SP. Radiofrequency techniques to treat chronic knee pain: A comprehensive review of anatomy, effectiveness, treatment parameters, and patient selection. *J Pain Res*. 2018;11,1879-1888. doi:10.2147/JPR.S144633

7. McCormick ZL, Reddy R, Korn M, et al. A prospective randomized trial of prognostic genicular nerve blocks to determine the predictive value for the outcome of cooled radiofrequency ablation for chronic knee pain due to ssteoarthritis. *Pain Med.* 2018;19(8),1628–1638. doi:10.1093/pm/pnx286

8. Rogers MW, Wilder FV. The association of BMI and knee pain among persons with radiographic knee osteoarthritis: A cross-sectional study. BMC Musculoskeletal Disorders. 2008;9:163. doi:10.1186/1471-2474-9-163

9. Marks R. Obesity profiles with knee osteoarthritis: correlation with pain, disability, disease progression. Obesity (Silver Spring). 2007;15(7):1867–1874. doi:10.1038/oby.2007.221

10. Reddy RD, McCormick ZL, Marshall B, Mattie R, Walega DR. Cooled radiofrequency ablation of genicular nerves for knee osteoarthritis pain: a protocol for patient selection and case series. Anesth Pain Med. 2016;6(6):e39696. doi:10.5812/aapm.39696

Published online May 26, 2021.