The Katz Journal *of* Medicine

ORIGINAL RESEARCH

The Success of Treatment for Osteoarthritis with a Genicular Nerve Block is Associated with Patients' Body Mass Index

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ABSTRACT

BACKGROUND

While the mainstay of treatment for severe osteoarthritis of the knee has been total knee arthroplasty, a prognostic genicular nerve block (GNB) followed by cooled radiofrequency ablation (CRFA) has been shown to provide long term relief of osteoarthritic knee pain and its disability. The goal of this study is to determine if there is a difference in the demographic makeup of those who had a successful prognostic genicular nerve block compared to those who did not.

METHODS

A retrospective chart review of 224 genicular nerve blocks was completed. The nerve block was considered successful if the patient reported a 50% or greater pain reduction for a week or more at follow up. Demographic cohorts that were compared include sex, age, race, and BMI.

RESULTS

Those who were categorized as non-obese, 36 out of 69 (52.2%) had unsuccessful blocks while 33 out of 69 (47.8%) in this BMI category had successful blocks. Of those who were categorized as obese, 25 out of 75 (33.3%) had unsuccessful blocks while 50 out of 75 (66.7%) in this BMI category had successful blocks. Of those who were deemed morbidly obese, 22 out of 75 (29.3%) had unsuccessful blocks while 53 out of 75 (70.7%) in this BMI category had successful blocks. These results were found to be statistically significant with a p-value of .011. Furthermore, GNB success was not found to be significantly impacted by patient age, race, or gender.

CONCLUSIONS

These findings demonstrate the utility of prognostic genicular nerve blocks in all patients with osteoarthritis of the knee, but, in particular, the obese patient, who experiences a greater chance of pain relief on average.

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Published Online: September 1, 2024. DOI: 10.1667/kjm.v1i1.677

Disclosures: The authors have no conflicts of interest or funding sources to disclose.

Acknowledgments: We thank Dr. Ellen Hauck (Temple University) for her guidance in designing this study, and for revising the final manuscript.

Osteoarthritis (OA), a degenerative joint disease in which cartilage breaks down over time, of the knee is one of the most common causes of disability in adults, with an overall lifetime risk of 13.83%.[1-2] There are multiple demographic risk factors which may increase the likelihood of developing osteoarthritis, including age, gender, obesity, diet, traumatic injury, and abnormal loading of the joint.[3] Beginning at age 45, there is an increase in the prevalence

of radiographic knee osteoarthritis. After age 50, the incidence of knee osteoarthritis increases with age at greater rates in females than in males.[4-5] The Framingham Osteoarthritis Study shows an increased relative risk of radiographic, progressive, and symptomatic knee osteoarthritis in females compared to males.[6] Body mass index (BMI) is a measure of weight adjusted for height, and according to the CDC it is an indicator of body fat used as a tracking tool rather than a diagnostic tool.[7] This makes BMI an ideal indicator of weight tracking, as there are already clear guidelines set as to how BMI correlates to the categories of weight used in this study.[7] BMI impacts the progression of osteoarthritis of the knee, with a higher incidence of osteoarthritis in obese patients compared to non-obese patients.[2] Further, the degree of radiographic osteoarthritis has been shown to vary among different races. African Americans are more likely to have severe osteoarthritis of the knee compared to Caucasians.[8]

Management of knee pain from osteoarthritis ranges from conservative non-operative methods to surgical joint replacement. Conservative management is utilized as the first line treatment approach to delay or prevent joint replacement.[9] Traditional conservative management for knee osteoarthritis includes weight loss, physical therapy, intra-articular knee steroid injections, viscosupplementation, and oral analgesia, including non-steroid anti-inflammatory medications.[10] Several of these treatment options may provide short-term temporary pain relief. If these options become ineffective, then surgical treatment may be pursued. Osteoarthritis of the knee is the most common pathologic indication for total knee arthroplasty (TKA), a surgical procedure in which the knee joint is replaced with synthetic material.[11] The incidence and prevalence of knee osteoarthritis and subsequently the number of TKA procedures performed has increased in recent years.[12] However, TKA may not be an ideal option for patients deemed poor surgical candidates due to comorbid medical conditions or for those who do not wish to undergo a major surgical procedure. One alternative treatment option for individuals with osteoarthritic knee pain is a genicular nerve block (GNB) followed by a cooled radiofrequency (CRFA) ablation of the genicular nerves.

A genicular nerve block is a minimally invasive prognostic procedure that provides short-term pain relief and is used to qualify a patient for a radio frequency ablation (RFA), meaning that if the GNB works for an individual patient, then RFA becomes an option. RFA of genicular nerves is an effective, safe, and minimally invasive procedure that provides long-term pain relief for patients with osteoarthritic knee pain.[13] Genicular nerve radiofrequency ablation has been shown to provide pain relief for about 3 to 6 months in some patients and sometimes longer in others.[10] It has also been shown that the repeated use of this minimally invasive procedure is safe for patients. In a previous study Weinstein et al showed that patients who have undergone RFA of the genicular nerves following a successful prognostic block have improved pain and functionality. The immediate pain relief was significant, with greater than 50% pain reduction in nearly all patients at rest, with movement, and with ambulation.[14] Improvements in pain and functionality have been shown to extend up to six months following a successful genicular nerve RFA.[15] Current data suggests that subjects who do not attain pain relief from the genicular nerve block were significantly more likely to have psychological comorbidities, smoking history, and diabetes[3]. There is limited data showing whether additional

patient demographics influence, or are predictive of, the success of the genicular block procedures.

The primary objective of this study is to examine patient demographics, specifically BMI, and compare demographics of those who had successful genicular nerve blocks and those who did not. The demographics collected were BMI, sex, age, race, and days until follow up. These demographics were considered to determine if other confounding factors were contributing to the differences in the success rate of genicular nerve blocks. The authors hypothesize that one or more patient demographics will be predictive of genicular nerve block success and provide insight into the patient population more likely to benefit from the procedure. This study could give insight into patient populations that would benefit most from genicular nerve blocks and therefore CRFAs.

METHODS

PATIENT SELECTION

This was a retrospective chart review at an urban academic multi-center health system. Institutional Review Board approval was obtained (IRB number 25801) to collect retrospective, deidentified data from patient charts who had undergone unilateral or bilateral genicular nerve block for osteoarthritic knee pain. Charts of patients who had genicular nerve blocks with or without CRFA ablation from January 2014 to May 2022 were identified.

Inclusion criteria for the study were patients who 1) were age 30-89; 2) had chronic knee pain with a diagnosis of osteoarthritis; 3) underwent a genicular nerve block; 4) either returned for a follow up visit or had a phone encounter where their percent pain reduction was documented. Exclusion criteria for this study were patients 1) with chronic knee pain not due to osteoarthritis that have undergone a genicular nerve block; 2) those who did not return for follow up; 3) those with a prior Total Knee Arthroplasty (TKA).

GENICULAR NERVE BLOCK PROCEDURE

Consent for the procedure was obtained prior to the patient entering the procedure room. The patient was positioned on the procedure table supinely with the correct leg positioned at a propped-up, bent angle with a towel-roll. The knee was prepped and draped under sterile technique. Under fluoroscopic guidance, an anterior-posterior view of the knee joint was obtained. The superior medial and lateral epicondyle of the femur and the distal aspect of the medial tibial epicondyle were identified as the target zones for the injections. The planned injection site was cleaned with chlorhexidine solution and sterile technique was maintained. A topical anesthetic (3 mL 1% lidocaine) was injected at 3 standardized sites for each patient. A 22-gauge 3.5" sharp cutting bevel spinal needle was then advanced using fluoroscopic guidance towards each of the target sites. Aspiration was confirmed to be negative for blood. 2 mL of a solution containing 0.25% bupivacaine and 5 mg of triamcinolone was instilled into each of the sites. The needles were then removed, and the injection sites appropriately cleaned and bandaged. The genicular nerve blocks at the health system were performed by a group of four board-certified chronic pain physicians following the same procedure guidelines.

DATA COLLECTION

The electronic medical records were retrospectively reviewed for patient demographics, pain score, percent pain reduction, and duration of reduction. If a patient underwent multiple nerve blocks on the

same knee or bilateral nerve blocks it was recorded as separate encounters. Genicular nerve blocks were considered successful if the patient experienced 50 percent pain reduction for a minimum of one week based on preprocedural and postprocedural pain score ratings. Of note, fifteen patients within the study used qualitative descriptive phrases during their follow up appointment and therefore did not have a numerical pain report. Six patients reported sustained pain relief or resolution of pain and were assigned to the successful block group. Four patients reported no pain relief and were assigned to the unsuccessful block group. Five patient responses were noted to be ambiguous or missing data and were excluded from the study. Furthermore, there were 170 unique patients in the study, with no patients lost to follow up, as any patient who may not have returned to the office was not provided to the researchers as part of the data inquiry.

Patient demographic information, including weight at the time of the procedure, was obtained from the preprocedural section of the medical chart. Baseline pain scores were obtained from the preprocedural clinic visit. Quantitative pain reduction and follow-up information was obtained from the patient's postprocedural clinic visit.

STATISTICAL ANALYSIS

Summaries of categorical variables included counts and percentages, while means and standard deviations were used for continuous variables. Patients having a successful nerve block were compared to those with an unsuccessful nerve block by chi-squared tests for categorical variables and 2-sample t-tests for continuous variables. Logistic regression was used to model the association between BMI category and genicular nerve block.

All analyses were performed using SAS version 9.4 (SAS Institute, Cary, NC). A p-value less than 0.05 was considered statistically significant.

RESULTS

Data was collected and analyzed from 224 genicular nerve blocks, with 5 exclusions, completed between January 2014 and May 2022. There were 136 successful blocks and 83 unsuccessful blocks across all BMI categories following exclusions. The patients' demographics including sex, age, race, and BMI are shown in **Table 1**.

Nerve block success was not found to be related to race, age, and sex. Furthermore, those who had unsuccessful genicular nerve blocks returned for follow up in 39.8 d-

Table 1. Genicular Nerve Block Demographics and Comparison of Characteristics Based on Nerve Block Success

Characteristic	Successful Nerve Block (N = 139)	Unsuccessful Nerve Block (N = 85)	Total (N = 224)	p-value
Age, mean	60.6 ±11.6	61.9 ±10.8	61.1 ±11.3	0.41
BMI, mean	37.7 ±10.7	35.0 ±10.5	36.7 ±10.7	0.06
Days until follow up, mean	51.1 ±32.4	39.8 ±30.4	46.8 ±32.1	0.01
Sex, no. (%)				0.34
Male	41 (29.5)	25 (29.4)	66 (70.5)	
Female	98 (70.5)	60 (70.6)	158 (29.5)	
Race/Ethnicity, no. (%)				0.12
Non-Hispanic White	36 (25.9)	22 (25.8)	58 (25.9)	
Non-Hispanic Black	54 (38.8)	41 (48.2)	95 (42.4)	
Hispanic	37 (26.6)	21 (25.0)	58 (25.9)	
Asian Pacific Islander	3 (1.4)	1 (1.2)	3 (1.3)	
Other	10 (7.2)	0 (0.0)	10 (4.5)	

Table 2. Difference in Successful Versus Unsuccessful Nerve Blocks According to BMI Categories

BMI Category	Successful Nerve Block (N = 139)	Unsuccessful Nerve Block (N = 85)	p-value
BMI, no. (%)			0.011
Non-obese	33 (24.3)	36 (43.4)	
Obese	50 (36.8)	25 (30.1)	
Morbidly Obese	53 (39.0)	22 (26.5)	

ays on average while those receiving successful blocks returned in 51.1 days on average (p-value 0.01). The average BMI of those receiving a successful block was 37.7 kg/m2 (SD = 10.7) while the average BMI of those receiving unsuccessful blocks was 35.0 kg/m2 (SD = 10.5). This difference in BMI was marginally significant but did not reach true statistical significance with a P value of 0.06. To further investigate the predictive value of BMI, patients were divided into three categories, non-obese, obese and morbidly obese. Non-obese patients had a BMI<30, morbidly obese patients had a BMI>40 and obese patients were those between these categories. Of those who were categorized as non-obese, 36 out of 69 (52.2%) had unsuccessful blocks while 33 out of 69 (47.8%) in this BMI category had successful blocks. Of those who were categorized as obese, 25 out of 75 (33.3%) had unsuccessful blocks while 50 out of 75 (66.7%) in this BMI category had successful blocks. Of those who were deemed morbidly obese, 22 out of 75 (29.3%) had unsuccessful blocks while 53 out of 75 (70.7%) in this BMI category had successful blocks (as seen in **Figure 1**). The difference in success rate between the different BMI groups had a p-value of 0.011 (as seen in **Table 2**). Subjects in the obesity category when compared to the non-obesity category had an odds ratio of 2.18 (1.11, 4.28) (p=0.023). For those in the morbidly obese category, there is an odds ratio of 2.63 (1.32, 5.22) (p=0.0058).

DISCUSSION

This retrospective, single center study spanned over 8 years, analyzing the outcomes of genicular nerve blocks among patients with varying demographic variables. Notably, patients with osteoarthritis in the obese or morbidly obese cohorts demonstrated a significantly greater nerve block success rate than those in the normal weight cohort, despite the potential increased difficulty in performing the block due to body habitus. This could be due to higher levels of pain in people with more mechanical stimulation due to increased BMI, followed by a greater perceived pain reduction. Data suggests patients with a higher BMI are better candidates for genicular nerve block and therefore subsequent genicular nerve ablation, which is utilized for longer-term pain management caused by knee osteoarthritis.

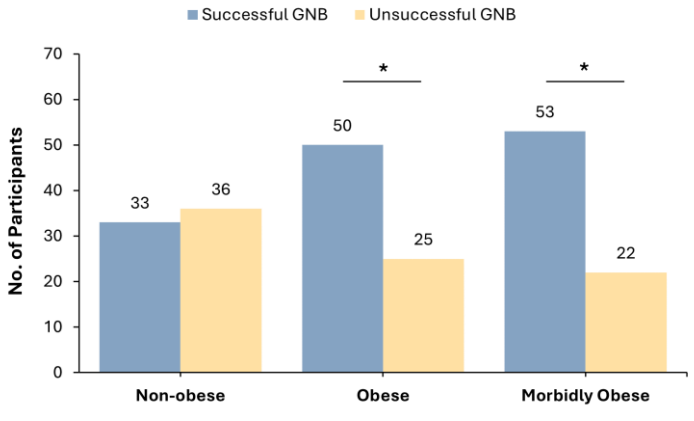

Figure 1. Paired Bar Chart Stratified by Obesity Category Comparing Successful and Unsuccessful Nerve Blocks.
The bar chart demonstrates patients in the obese and morbidly obese BMI category had a significantly higher number of successful nerve blocks when compared to the patients in the non-obese BMI range (* represents statistical significance).

A successful nerve block may allow patients to delay or even avoid knee replacements. TKA surgeries have long recovery times and only last on average 25 years.[16] Additionally, patients with a higher BMI have a greater risk of adverse outcomes during TKA procedures so genicular nerve block and ablation may offer a desirable alternative for these patients. A recent study found that genicular nerve ablations were able to offer 50% pain improvement for over 6 months.[17] Interventional pain management is a growing field of study that could allow patients to find long-term relief without orthopedic surgery.

Currently, it is estimated that over half of the adults diagnosed with osteoarthritis in the U.S. will undergo TKA.[14] However, knee replacements may fail after a significant

amount of time and require revision. Revision surgeries are costly and associated with poorer outcomes than the original TKA. A systematic review and meta-analysis completed in 2019 found that TKAs lasted 25 years before revision surgery was needed.[16] For younger patients with osteoarthritis, minimally invasive interventional pain approaches such as genicular nerve block and ablation may be a temporary measure to delay TKA until the patient is older. It could also

provide patients with time to perform lifestyle modifications such as weight loss which will improve their likelihood of surgical success.

A secondary finding within the study suggests that patients with an unsuccessful block were more likely to attend their follow up appointments sooner. Those who had unsuccessful genicular nerve blocks returned for follow up in 39.8 days on average while those receiving successful blocks returned in 51.1 days on average (p-value 0.01). It is possible these patients were hoping for alternative options for their osteoarthritis while those with adequate pain reduction were satisfied with the results and did not feel the need for follow-up. This is an important objective measure to support the "success measure" of 50% reduction in pain after GNB, as pain scores are highly personal and not an objective measure.

A retrospective review of patients who underwent genicular nerve ablation, block or both found that patients with psychological comorbidities, smoking, and diabetes had higher rates of failure with genicular nerve blocks. Similar to this study, they did not note any relationship between age or gender.[3] Additionally, the study did not find a significant difference in averaged BMI and genicular nerve block success with a p value of 0.179.[3] However, our average BMI was closer to statistical significance at a p-value of 0.06 which led us to further investigate the relationship of BMI and divide the data into categories showing clear statistical significance. The sample size may have possessed a larger distribution than their data as the BMI range was 17.6-69.6. Further studies should be conducted on this patient population to see if genicular nerve block success correlates with genicular nerve ablation success in patients with higher BMIs. Additionally, future studies are required to illustrate why certain patients receive little to no relief from genicular nerve blocks, and why those with higher BMIs may have a greater likelihood of success.

LIMITATIONS

The primary limitation of this study is that it is a retrospective analysis. As such, desired data to be collected may not be found (leading to exclusion of some patients and potential bias) or may have to be inferred. In this study, a major limitation is the lack of standardized pain scale. Patients were asked about their pain either in person or over the phone at their pre-procedure and post-

procedure appointments. However, patients were not always provided with a pain scale and several patients used descriptive phrases to describe their pain rather than a numerical or percentile scale. Additionally, the demographics of our institution may not be indicative of all patients who receive a genicular nerve block. For example, the study population had a limited number of Asian Pacific Islanders, thereby limiting the ability to broaden conclusions to encompass all patient populations. Further studies should be conducted with a larger, more diverse sample size. Additional studies should be conducted looking into whether patient comorbidities such as diabetes, hypercholesteremia or other common comorbidities including psychiatric diagnosis impact the effectiveness of genicular nerve blocks.

CONCLUSIONS

Genicular nerve blocks and cooled radio frequency genicular nerve ablation offer a viable treatment for pain associated with chronic knee osteoarthritis. Genicular nerve blocks are a conservative low-risk procedure that is more effective in patients with a higher BMI, and therefore should be considered as a viable solution to patient's knee pain due to osteoarthritis before trying more invasive methods especially in the obese population.

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