Randomized Controlled Trial

Evaluation of Genicular Nerve Blocks Durations With and Without Corticosteroid: A Single-blind, Randomized Controlled Trial

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Background: Genicular nerve blocks (GNBs) are commonly performed prior to performing radiofrequency ablation (RFA) to assess RFA's potential efficacy. Typically, GNBs are commonly performed with local anesthetic only. The duration of efficacy of GNBs has not been investigated much in the literature.

Objectives: The primary goals of this study were to evaluate for any differences in response to GNBs between using local anesthetic only versus local anesthetic and corticosteroid, and assess for the potential therapeutic benefit of GNBs by examining pain relief percentage, pain relief duration, and change in pain scores.

Study Design: Randomized prospective trial.

Setting: Fluoroscopy suite at an urban academic teaching hospital.

Methods: Fifty patients with chronic knee osteoarthritis were randomly assigned to undergo a GNB done under fluoroscopic guidance with either bupivacaine only (n = 24, the control group) or bupivacaine and triamcinolone (n = 26, the experimental group). Baseline and postprocedure pain scores were collected on the day of the procedure. Patients were then called at postprocedure 24 hours, 2 weeks, and 6 weeks and asked their maximum percentage of pain relief, duration of pain relief, and Numeric Rating Scale (NRS-11) scores, which were compared between the 2 groups. Associations between these factors and Kellgren-Lawrence Classification of Osteoarthritis scores, body mass index, age, gender, race, and baseline pain scores were also assessed.

Results: The mean duration of pain relief was significantly higher in the group administered a corticosteroid (0.87; SD, 0.29 days) compared to the group not administered a corticosteroid (0.64; SD, 0.43 days) at 24 hours postprocedure. No significant differences were found between the 2 groups in pain relief percent, pain relief duration, or NRS-11 scores at any of the 3 time points. No significant difference in changes from baseline NRS-11 scores over time were found between the 2 groups. No significant associations were found between pain relief percent, pain relief duration, and NRS-11 scores regarding age, gender, body mass index, race, Kellgren-Lawrence scores, and baseline pain scores at postprocedure days one, 14, and 42.

Limitations: This was a single-blind, single-center study. It lacked a follow-up at 6 weeks postprocedure, lacked a placebo group, and had a small sample size.

Conclusion: The addition of a corticosteroid to local anesthetic for GNB may prolong initial analgesic effects within the first postprocedure 24 hours. However, there is no analgesic difference in the weeks following a GNB between procedures done with local anesthetic only or local anesthetic and corticosteroid. These findings suggest that there is a lack of therapeutic benefit and effect on relief duration with using corticosteroids in GNBs.

Key words: Genicular nerve block, radiofrequency ablation, corticosteroid, triamcinolone, local anesthetic, bupivacaine, osteoarthritis

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Osteoarthritis (OA) is a degenerative joint condition that causes bone remodeling, osteophyte formation, and cartilage degradation. OA can be debilitating, leading to functional loss from symptoms such as pain, swelling, stiffness, and decreased range of motion (1,2). Approximately 14 million persons in the United States have symptomatic knee OA, with 2 million of those being less than 45 years old and 6 million between 45 and 65 years old (3). Prevalence increases with age: 13.9% of those over 25 years old and 35.1% of those over 50 years old are affected worldwide (2,4).

Noninterventional treatment options for knee OA can include exercise and medications such as acetaminophen and oral and topical nonsteroidal anti-inflammatory drugs. However, these medications can have significant side effects if used daily; some patients cannot take them at all if they have certain comorbidities (5–7). Nonsurgical interventional treatment options for knee OA include intraarticular injections with corticosteroids, hyaluronic acid, or platelet rich plasma (7). Intraarticular corticosteroid injections have shown to provide significant, but short-lasting, pain reduction for knee OA. Over time, corticosteroids can degrade articular cartilage, making these injections less ideal for younger patients (6,8). Evidence for hyaluronic acid and platelet rich plasma injections is conflicting; these options are typically used when other interventions have failed (7,9,10).

Radiofrequency ablation (RFA) was first introduced in 2010 and is another nonsurgical, minimally invasive treatment option for knee OA. RFA works by applying heat to ablate the inferior medial, superior lateral, and superior medial genicular sensory nerves, which should reduce painful sensations associated with knee OA (11,12). Multiple studies have shown that RFAs can be effective in pain relief for a minimum of 6-12 months (11–14). One or 2 diagnostic genicular nerve blocks (GNBs) using local anesthetic instead of heat around the targeted genicular nerves are typically done to evaluate if an RFA may be successful. While diagnostic GNBs are expected to be short-lasting given the half-life of local anesthetics, there has been some evidence suggesting several months of pain relief (15,16). One study suggested that GNBs with local anesthetic and corticosteroid provided similar pain relief duration—up to one year—as an RFA in patients who underwent a total knee arthroplasty (17). A different study showed that ultrasound-guided GNBs with local anesthetic and corticosteroid resulted in significantly lower pain scores for up to 4 weeks when compared to local anesthetic only (18).

Given the more recent advancement of RFAs and the more traditional use of GNBs as test blocks to determine the success of RFAs, there continue to be gaps in knowledge and conflicting evidence in the literature regarding the therapeutic efficacy of GNBs. In our study, we aimed to evaluate the extent and duration of pain relief post GNBs done with local anesthetic only versus local anesthetic and corticosteroid. Secondary goals included assessing if factors such as age, gender, body mass index (BMI, k/m^2), or Kellgren-Lawrence Classification of Osteoarthritis (K-L) score affect the therapeutic efficacy of GNBs.

Methods

This is a prospective, randomized, single-blind study assessing the therapeutic effects of GNBs with bupivacaine only to bupivacaine and triamcinolone. Patient data were collected from June 2022 through October 2023 at an urban, academic, teaching hospital in Cleveland, Ohio. Institutional review board approval was obtained (#STUDY00000108).

Any patient with ongoing knee pain and radiographic evidence of knee OA and/or who had surgery related to knee OA undergoing a GNB was invited to take part in this study on the day of his or her procedure. Exclusion criteria included anyone who did not speak English, was under the age of 18, had other connective tissues diseases that affected the knee, had acute or subacute knee injuries, or knee pain that was unexplained by OA. After oral consent was obtained on the procedure day, each patient's age, gender, self-reported race, BMI, and K-L score (as graded by a radiologist) were recorded. K-L scores were graded from 0–4 as follows: 0, no radiographic evidence of OA; one, questionable narrowing of joint space with osteophytic lipping; 2, possible narrowing of joint space with definite osteophytes; 3, definite narrowing of joint space with multiple moderate osteophytes, small pseudocystic areas with sclerotic walls, and possible deformity of bone contour; 4, large osteophytes, marked narrowing of joint space, severe sclerosis and definite deformity of bone contour (19). K-L scores were not graded for patients with hardware or those who had received a total knee arthroplasty.

Preprocedure and postprocedure Numeric Rating Scale (NRS-11) scores from 0–10 were recorded on the day of the procedure. Patients were contacted by telephone at postprocedure 24 hours, 2 weeks, and 6 weeks. The fol-

lowing questions were asked and recorded at each time point: subjective maximum percentage of pain relief since the procedure, duration of pain relief, current NRS-11 score, and any side effects from the procedure.

Patients were blinded to which injectate they were receiving. The physician performing the procedure was not blinded. Patients were randomized by an online randomizer to receive either local anesthetic only (LAO, the control group) or local anesthetic and corticosteroid (LAC), with the first half of patients receiving the former and the second half receiving the latter in consecutive order. One mL of 0.25% bupivacaine was injected at each genicular nerve for those receiving local anesthetic only. One mL of 0.25% bupivacaine and 40 mg/mL of triamcinolone was injected at each genicular nerve in the LAC group.

All GNBs were performed with fluoroscopic guidance. Patients were placed in a seated position and the skin around the knee was prepped and draped in sterile fashion. The skin and soft tissue overlying the superior medial genicular nerve (SMGN), superior lateral genicular nerve (SLGN), and inferior medial genicular nerve (IMGN) were infiltrated with 1 mL lidocaine using a 25G 1.5-inch needle. Then, 3 25G, 3.5-inch needles were advanced under fluoroscopy until the needle tip was at the middle depth of the junction of the epiphyses and shafts of the femur (medially and laterally) or tibia (medially) in the lateral fluoroscopic views in order to target the SMGN, SLGN, and IMGN. Needle tips were confirmed with posterolateral and lateral fluoroscopic views. After negative aspiration, the injectate was spread to the 3 genicular nerves.

The primary outcomes of this study were to evaluate for any differences in response to GNBs between using local anesthetic only versus local anesthetic and corticosteroid, and assess for the potential therapeutic benefit of GNBs by examining pain relief percentage, pain relief duration, and change in pain scores.

Secondary outcomes were to assess if age, gender, BMI, baseline pain score, race, or K-L score are associated with percentage of pain relief, duration of pain relief, or NRS-11 score. For statistical analysis, a Fisher's exact test, Pearson's χ^2 test, and Wilcoxon rank-sum test were used to compare age, gender, race, BMI, K-L score, baseline NRS-11 score, and postprocedure NRS-11 score between the LAO group and the LAC group. A Wilcoxon rank-sum test was used to compare pain relief percent, pain duration, and pain scores between the 2 groups at the 3 time points (postprocedure days one, 14, and 42). The Kruskal-Wallis test, Wilcoxon rank-sum test, and Pearson correlation were used to find associations between pain relief percent, pain relief duration, and NRS-11 scores with age, gender, BMI, race, K-L scores, and baseline pain scores at postprocedure days one, 14, and 42. Statistcal calculations were made using the R project for Statistical Computing with R version 4.2.3

Results

Fifty patients consented to take part in this study and were reached at each of the 3 time points: postprocedure days one, 14, and 42. Twenty-four were in the LAO group and 26 were in the LAC group (Table 1).

The average age in the LAO group was 61, with ages ranging from 35 to 80. The average age in the LAC group was 62 with ages ranging from 35 to 89. The LAO group had 17 (71%) women and 7 (29%) men. The LAC group had 20 (77%) women and 6 (23%) men. There were 3 (13%) and 4 (15%) African American, one (4.2%) and 3 (12%) Hispanic, and 20 (83%) and 19 (73%) White patients in the LAO and LAC groups, respectively. Average BMI was 33 (31–41) and 34 (28–41) in the LAO and LAC groups, respectively. K-L scores in the LAO and LAC groups were as follows, respectively: 3 (13%) and 3 (12%) for K-L one; 6 (25%) and 3 (12%) for K-L 2; 3 (13%) and 2 (7.7%) for K-L 3; 8 (33%) and 9 (35%) for KL 4; one (4.2%) and 0 with hardware; and 3 (13%) and 9 (35%) with a total knee arthroplasty for whom K-L score were not recorded. No significant difference ($P < 0.05$) was found between age, gender, race, BMI, or K-L scores in the 2 groups (Table 1).

The mean baseline NRS-11 score was 6.5 (SD, 1.87) in the LAO group and 6.73 (SD, 2.51) in the LAC group. Immediately postprocedure, these pain scores were 1.25 (SD, 1.89) in the LAO group and 2 (SD, 2.5) in the LAC group. No significant difference was found between pre or postprocedure NRS-11 scores (Table 1). No patients in the LAO group and 7 (27%) in the LAC group had a second GNB or RFA prior to the 6-week telephone follow-up (but after the 2-week telephone call) ($P = 0.01$, Table 1).

At the 24-hour telephone call follow-up, the LAO group had the following results: 79% (range, 0%–100%) mean maximum pain relief, 0.64 (SD, 0.43) days of pain relief, and mean NRS-11 score of 3.21(SD, 2.77). At this time point, the LAC group had the following results: 83% (range, 10%–100%) mean maximum pain relief, 0.87 (SD, 0.29) days of pain relief, and mean NRS-11 score of 2.27 (SD, 2.29). A significant difference was found only in days of pain relief ($P = 0.038$) between the 2 groups (Table 2).

At the 2-week telephone call follow-up, the LAO group had the following results: 73% (0%–100%) mean maximum pain relief, 6.1 (SD, 6.4) days of pain relief, and mean NRS-11 score of 4.75 (2.95). At this time point, the LAC group had the following results: 75% (20%–100%) mean maximum pain relief, 7.5 (SD, 4.3) days of pain relief, and mean NRS-11 score of 5.31 (SD, 2.71). No significant differences were found between these 2 groups for any of these factors (Table 3).

At the 6-week telephone call follow-up, the LAC group had the following results: 69% (0%–100%) mean maximum pain relief, 14 (SD, 17) days of pain relief, and mean NRS-11 score of 4.54 (SD, 2.6). At this time point, the LAC group had the following results: 74% (20%–100%) mean maximum pain relief, 15 (SD, 18) days of pain relief, and mean NRS-11 score of 4.38 (SD, 5.5). No significant differences were found between these 2 groups for any of these factors (Table 4).

Table 5 shows a comparison of baseline and postprocedure NRS-11 scores, as well as a comparison of changes from baseline, on the day of procedure (day 0), and at postprocedure 24 hours, 2 weeks, and 6 weeks between the LAO and LAC groups. No significant differences ($P < 0.05$) were found between NRS-11 scores at any of these time points between the 2 groups. The LAO and LAC groups also did not have any significant differences from each another in changes from baseline NRS-11 scores at any of these time points (Table 5).

Table 6 shows associations between pain relief percent, pain relief duration, and NRS-11 scores with age, sex, BMI, race, K-L scores, and baseline pain scores at postprocedure days one, 14, and 42. Given that 54 tests were run to assess for all possible associations, using

Table 1. *Patient demographic information, including age, gender, race, BMI, Kellgren-Lawrence Score, baseline Numeric Rating Scale (NRS-11) score, and postprocedure NRS-11 score.*

Characteristic	LAO Group n = 24[1]	LAC Group n = 26[1]	*P* Value[2]
Age			0.7
Mean (SD)	61 (13)	62 (13)	
Median (IQR)	60 (53–70)	61 (56–69)	
Range	35–80	35–89	
Gender			0.6
Woman	17 (71%)	20 (77%)	
Man	7 (29%)	6 (23%)	
Race			0.8
African American	3 (13%)	4 (15%)	
Hispanic	1 (4.2%)	3 (12%)	
White	20 (83%)	19 (73%)	
Body Mass Index (kg/m^2)	33 (31–41)	34 (28–41)	0.8
Unknown	1	0	
Kellgren-Lawrence Grade			0.4
One	3 (13%)	3 (12%)	
2	6 (25%)	3 (12%)	
3	3 (13%)	2 (7.7%)	
4	8 (33%)	9 (35%)	
Hardware	1 (4.2%)	0 (0%)	
TKA	3 (13%)	9 (35%)	
Baseline NRS-11 Score			0.6
Mean (SD)	6.50 (1.87)	6.73 (2.51)	
Median (IQR)	7.00 (5.00–8.00)	7.00 (5.25–8.00)	
Range	3.00, 10.00	0.00, 10.00	
Postprocedure NRS-11Score			0.3
Mean (SD)	1.25 (1.89)	2.00 (2.50)	
Median (IQR)	0.00 (0.00–2.00)	1.00 (0.00–3.75)	
Range	0.00–6.00	0.00–8.00	
Had_a second_ RFAbefore_6_week follow-up_phone_ call	0 (0%)	7 (27%)	0.010

1 n (%); Median (IQR)
2 Wilcoxon rank-sum test; Pearson's χ^2; Fisher's exact test. IQR = interquartile range; BMI = body mass index; TKA = total knee arthroplasty; RFA = radiofrequency ablation LAO = local anesthetic only; LAC = local anesthetic and corticosteroid.

Table 2. *Comparison of percentage of pain relief, duration of pain relief, and Numeric Rating Scale (NRS-11) score at 24-hour follow-up phone call.*

Characteristic	LAO Group n = 24	LAC Group n = 26	*P* Value[1]
Maximum pain relief percent			0.8
Mean (SD)	0.79 (0.32)	0.83 (0.22)	
Median (IQR)	1.00 (0.73–1.00)	0.90 (0.80–1.00)	
Range	0.00, 1.00	0.10, 1.00	
Duration of pain relief (days)			0.038
Mean (SD)	0.64 (0.43)	0.87 (0.29)	
Median (IQR)	0.92 (0.20–1.00)	1.00 (1.00–1.00)	
Range	0.00, 1.17	0.17, 1.00	
Current NRS-11 Score			0.2
Mean (SD)	3.21 (2.77)	2.27 (2.29)	
Median (IQR)	4.00 (0.00–5.00)	2.00 (0.00–3.75)	
Range	0.00–8.00	0.00–8.00	

1 Wilcoxon rank-sum test. IQR = interquartile range; LAO = local anesthetic only; LAC = local anesthetic and corticosteroid.

Bonferroni correction, the threshold for significance is 0.05/54 = 0.00093. Given this threshold, there were no significant associations at any of the 3 time points (Table 6).

There were no harms or unintended effects in either group. No patients in either group experienced postprocedure side effects.

Discussion

GNBs can be performed with either ultrasound or fluoroscopic guidance (20). One randomized controlled trial (RCT) using 2% lidocaine and 20 mg of triamcinolone as an injectate compared efficacy in pain and function scores between those who had GNBs done with either ultrasound or fluoroscopic guidance. After following the patients for 3 months, no significant differences were found between the 2 groups, showing that ultrasound or fluoroscopy can be used for GNBs (20). Additionally, pain relief and functional improvement lasted for at least 3 months in both groups. It is unclear if this is due to the addition of steroid to the injectate (20). A different cadaveric study found 100% accuracy in finding the genicular nerves of 21 cadavers using fluoroscopy (21). All GNBs were used with fluoroscopic guidance in our study. Given the evidence found in the literature, it is unlikely that the results of our study were affected from procedural inferiority or superiority when compared to similar studies done under ultrasound guidance.

The primary goals of our study were to evaluate for any differences in response to GNBs between using local anesthetic only versus local anesthetic and corticosteroid and assess for the potential therapeutic benefit of GNBs by examining pain relief percentage, pain relief duration, and change in pain scores. Local corticosteroid use has shown to have an anti-inflammatory effect, local vasoconstrictive effect, decreased nociceptive C-fiber activity, and a direct inhibitory effect on potassium channels, all factors that may potentially provide longer-lasting analgesia (22-24). These pharmacokinetic properties drove the idea that adding corticosteroids to GNB injectate may prolong its therapeutic effect.

The evidence in the literature regarding adding a corticosteroid to an injectate for various nerve blocks remains controversial. One meta-analysis showed that postoperative perineural nerve blocks with dexamethasone and bupivacaine result in a longer duration of pain relief than using systemic steroids (25). A different meta-analysis suggests that perineural dexamethasone can prolong postoperative analgesia by 6-8 hours than local anesthetic only (26). An RCT showed that adding dexamethasone to bupivacaine or ropivacaine ran result in approximately 22 more hours of pain relief after an interscalene nerve block than local anesthetic only (27). However, these studies mainly focused on nerve blocks in the acute, postoperative period and did not examine long-term analgesic effects (25-27).

Table 3. *Comparison of percentage of pain relief, duration of pain relief, and Numeric Rating Scale (NRS-11) score at 2-week follow-up phone call.*

Characteristic	LAO Group n = 24	LAC Group n = 26	*P* Value[1]
Maximum pain relief percent			> 0.9
Mean (SD)	0.73 (0.29)	0.75 (0.24)	
Median (IQR)	0.80 (0.50–1.00)	0.80 (0.53–1.00)	
Range	0.00, 1.00	0.20, 1.00	
Duration of pain relief (days)			0.11
Mean (SD)	6.1 (6.4)	7.5 (4.3)	
Median (IQR)	2.5 (0.8–14.0)	6.5 (4.3–10.0)	
Range	0.0, 14.0	1.0, 14.0	
Current NRS-11 Score			0.6
Mean (SD)	4.75 (2.95)	5.31 (2.71)	
Median (IQR)	5.00 (2.75–7.25)	5.00 (4.00–7.75)	
Range	0.00–10.00	0.00–10.00	

1 Wilcoxon rank-sum test. IQR = interquartile range; LAO = local anesthetic only; LAC = local anesthetic and corticosteroid.

Table 4. *Comparison of percentage of pain relief, duration of pain relief, and Numeric Rating Scale (NRS-11) score at 6-week follow-up phone call.*

Characteristic	LAO Group n = 24	LAC Group n = 26	*P* Value[1]
Maximum pain relief percent			0.7
Mean (SD)	0.69 (0.30)	0.74 (0.23)	
Median (IQR)	0.80 (0.50–1.00)	0.75 (0.53–1.00)	
Range	0.00–1.00	0.20–1.00	
Duration of pain relief (days)			0.2
Mean (SD)	14 (17)	15 (18)	
Median (IQR)	5 (1–25)	7 (4–16)	
Range	0, 42	0, 72	
Current NRS-11 Score			> 0.9
Mean (SD)	4.54 (2.60)	4.38 (3.49)	
Median (IQR)	5.00 (3.00–6.00)	5.50 (0.00–7.00)	
Range	0.00–10.00	0.00–10.00	

1 Wilcoxon rank sum test. IQR = interquartile range; LAO = local anesthetic only; LAC = local anesthetic and corticosteroid.

Meanwhile, an RCT comparing pudendal nerve blocks performed with either a local anesthetic or a local anesthetic and corticosteroid determined that there was no significant difference in therapeutic effect between the 2 groups at 3 months postprocedure (28). A different study noted prolonged analgesic effects after adding corticosteroid to a local anesthetic for a greater occipital nerve block, with a median of 30 days for complete or partial responses. However, these results were not compared to the duration of relief with local anesthetic only (29).

In general, the evidence is questionable for long-term analgesic relief with adding corticosteroids to various nerve blocks, mainly due to the majority of available studies following patients only in the acute, postoperative period. To the best of our knowledge, only 2 other studies exist that examine the long-term therapeutic effects of corticosteroids on GNBs. One

Table 5. *Comparison of NRS-11 score and changes from baseline at postprocedure days 0, one, 14, and 42 between the local anesthetic only (LAO) and local anesthetic and corticosteroid (LAC) groups.*

Time Point	NRS-11			Change From Baseline		
	LAO n = 24[1]	LAC n = 26[1]	*P* Value[2]	LAO n = 24[1]	LAC n = 26[1]	*P* Value[2]
Baseline	6.50 (1.87)	6.73 (2.51)	0.6	--	--	--
Postprocedure (day 0)	1.25 (1.89)	2.00 (2.50)	0.3	5.25 (2.71)	4.73 (3.05)	0.6
Day One	3.21 (2.77)	2.27 (2.29)	0.2	3.29 (2.63)	4.46 (3.15)	0.2
Day 14	4.75 (2.95)	5.31 (2.71)	0.6	1.75 (2.44)	1.42 (3.40)	0.6
Day 42	4.54 (2.60)	4.38 (3.49)	> 0.9	2.0 (2.7)	2.3 (3.5)	0.9

[1] Mean (SD)
[2] Wilcoxon rank sum test

Table 6. *Associations between pain relief percent, pain relief duration, and Numeric Rating Scale (NRS-11) scores with age, gender, BMI, race, Kellgren-Lawrence scores, and baseline pain scores at postprocedure days one, 14, and 42.*

	Day 1	Day 14	Day 42	Statistical Test
Max % Pain Relief				
Age	R = 0.23, *P* = 0.12	R = 0.05, *P* = 0.73	R = 0.17, *P* = 0.24	Pearson correlation
Body Mass Index (k/m^2)	R = -0.17, *P* = 0.24	R = -0.14, *P* = 0.33	R = -0.18, *P* = 0.22	Pearson correlation
Baseline Pain Score	R = 0.14, *P* = 0.33	R = -0.024, *P* = 0.87	R = 0.005, *P* = 0.97	Pearson correlation
Sex	*P* = 0.69	*P* = 0.24	*P* = 0.67	Wilcoxon Rank Sum Test
Race	*P* = 0.32	*P* = 0.12	*P* = 0.58	Kruskal-Wallis Test
Kellgren-Lawrence Grading	*P* = 0.14	*P* = 0.33	*P* = 0.43	Kruskal-Wallis Test
Duration of Relief (days)				
Age	R = -0.16, *P* = 0.91	R = 0.29, *P* = 0.04	R = 0.22, *P* = 0.13	Pearson correlation
Body Mass Index (BMI, kg/m^2)	R = 0.05, *P* = 0.24	R = -0.086, *P* = 0.56	R = -0.037, *P* = 0.80	Pearson correlation
Baseline Pain Score	R = -0.2, *P* = 0.16	R = -0.063, *P* = 0.67	R = -0.29, *P* = 0.04	Pearson correlation
Sex	*P* = 0.99	*P* = 0.61	*P* = 0.96	Wilcoxon Rank Sum Test
Race	*P* = 0.90	*P* = 0.98	*P* = 0.67	Kruskal-Wallis Test
Kellgren Lawrence Grading	*P* = 0.91	*P* = 0.63	*P* = 0.63	Kruskal-Wallis Test
Current Pain Score				
Age	R = -0.19, *P* = 0.20	R = -0.31, *P* = 0.03	R = -0.27, *P* = 0.06	Pearson correlation
BMI	R = 0.12, *P* = 0.39	R = 0.078, *P* = 0.59	R = 0.076, *P* = 0.61	Pearson correlation
Baseline Pain Score	R = 0.24, *P* = 0.10	R = 0.33, *P* = 0.02	R = 0.34, *P* = 0.02	Pearson correlation
Gender	*P* = 0.55	*P* = 0.18	*P* = 0.36	Wilcoxon Rank Sum Test
Race	*P* = 0.65	*P* = 0.45	*P* = 0.38	Kruskal-Wallis Test
Kellgren Lawrence Grading	*P* = 0.98	*P* = 0.31	*P* = 0.72	Kruskal-Wallis Test

*** NOTE: This analysis ran 54 tests – using Bonferroni correction, the threshold for significance is 0.05/54 = 0.00093

RCT by Qudsi-Sinclair, et al (17) compared patients who had either an RFA or a GNB with local anesthetic and corticosteroid in the SMGN, SLGN, and IMGN at one year post total knee arthroscopy (17). Both groups experienced a reduction in pain, improvement in joint function, and a decrease in disability in the first post-procedure 6 months, with no significant differences between the 2 groups. These results potentially suggest that a GNB using corticosteroids may be therapeutically equivocal to an RFA (17). Meanwhile, a different RCT by Kim, et al (18) compared therapeutic effects after an ultrasound-guided GNB performed with either lidocaine only or lidocaine and triamcinolone in the SMGN, SLGN, and IMGN (18). The results of this study showed that the steroid group had significantly more pain relief at postprocedure weeks 2 and 4 (18).

Unlike the results found in Qudsi-Sinclair, et al and Kim, et al (17,18), our study did not show any long-term therapeutic benefit of using corticosteroids for GNBs. After comparing percentage of pain relief, duration of pain relief, and NRS-11 scores at postprocedure 24 hours, 2 weeks, and 6 weeks, the only significant difference we found is that duration of pain relief may be longer in the first postprocedure 24 hours in the LAC group. No significant differences were found in the remaining factors at each of the 3 time points, or in changes from baseline NRS-11 score between the 2 groups at each time point (Tables 2–5). Kim, et al (18) hypothesized that the shorter difference in duration of pain relief in their study as compared to that found in Qudsi-Sinclair, et al (17) was due to their using a smaller triamcinolone dose. Qudsi-Sinclair, et al (17) used 20 mg of triamcinolone at each of the 3 genicular nerves that were blocked. Kim, et al (18) used 20 mg of triamcinolone total, spread among the 3 genicular nerves blocked, suggesting a possible dose-dependent systemic effect from the corticosteroids. However, we used a higher dose of triamcinolone (40 mg at each of the 3 genicular nerves) than either of these studies and yet do not see any major differences in duration of pain relief between the LAO and LAC groups. These results may debunk the suggestion that pain relief duration may be steroid dose-dependent (18).

The difference in results between among these 3 studies remains unclear. However, both our study and Kim, et al (17) suggest that corticosteroids may potentiate the analgesic effects of GNBs short-term (anywhere from postprocedure 24 hours to several weeks), whereas, Qudsi-Sinclair, et al (18) suggests more long-term relief with corticosteroids. One possible explanation may be that the patients in Qudsi-Sinclair, et al (18) underwent knee surgery and may have had pain originating from a different source than pain from knee OA as shown in Kim, et al (17) and our study.

By the 6-week follow up in our study, the patients in the LAO group had about 14 days of pain relief and the patients in the LAC group had about 15 days, with a subjective pain relief percent of 69% in the LAO group and 74% in the LAC group. These results show that analgesic effects from GNBs may only last several weeks, regardless of whether corticosteroids were used or not, making these procedures a poor therapeutic option alone for knee pain from OA.

The secondary goals of this study were to assess if age, gender, BMI, baseline pain score, race, or K-L score were associated with percentage of pain relief, duration of pain relief, or NRS-11 score at the 24-hour, 2 week, and 6 week follow-ups. No significant associations or relationships were found among any of these factors.

Some of these results were surprising. Other studies have shown a positive association between K-L score and/or degree of knee OA with pain scores (30-33). K-L scores showed no correlation to pain scores, duration of pain relief, or percentage of pain relief in our study. BMI also surprisingly was not correlated to pain scores, duration of pain relief, or percentage of pain relief in our study. Multiple studies suggest that BMI has a positive association to pain intensity in knee OA (34-38). Some studies show that older individuals tend to have higher pain scores (38), but no such association was found in our study. These results are difficult to explain, but may potentially be due to the smaller number of patients in our study compared to other studies (30-38), making these associations challenging to assess.

Limitations

Our study has several limitations. First, this was a single-center study design with a small sample size. Second, this was a single-blind study, which can potentially lead to selection bias. Third, we did not have a placebo group, and therefore could not evaluate the effects of local anesthetic only or in combination with corticosteroid post GNB. Fourth, we did not ask patients to come off their prescribed or over-the-counter pain medications for this study, which may have influenced their responses to the GNB. Fifth, some patients had their second GNBs done prior to the 6-week follow up. However, this did not seem to influence results as no significant differences were found between the 2 groups

at that time. Sixth, we did not follow patients after 6 weeks to evaluate more long-term effects. However, at the postprocedure 6-week follow-up, results were mostly back to baseline without any on-going pain relief, making it unlikely that a longer follow-up period would have changed our results. Future studies with a larger sample size and more long-term follow-up will be of great value to confirm the findings in our study.

Conclusion

The addition of a corticosteroid to a local anesthetic for a GNB may prolong initial analgesic effects in the first postprocedure 24 hours. However, there is no analgesic difference in the weeks following a GNB between procedures done with a local anesthetic only or a local anesthetic and a corticosteroid. These findings make the therapeutic benefit of using corticosteroids in GNBs questionable and likely unnecessary.

Author Contributions

Suzanna Shermon and Chong Kim were involved in the conceptualization, methodology, and statistical analysis. Terence Hillery, Mi Mi Kim, Gustaf Van Acker, and Chong Kim were involved in recruiting patients and getting patient consent. Chong Kim performed the genicular nerve block on all study patients. Suzanna Shermon was involved in data curation and analysis. Suzanna Shermon, Terence Hillery, Mi Mi Kim, Gustaf Van Acker, and Chong Kim were involved in writing and editing the manuscript.

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