Retrospective Review

A Review of Long-Term Pain Relief after Genicular Nerve Radiofrequency Ablation in Chronic Knee Osteoarthritis

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Background: Studies of radiofrequency ablation (RFA) of genicular nerves have reportedly significantly decreased pain up to 3 months post ablation, but no longer term effects have been reported. We performed an analysis of long-term pain relief of 31 RFA procedures of the genicular nerves to analyze the degree of pain relief past 3 months, culminating at 6 months.

Objective: To evaluate the long term efficacy of genicular nerve ablation for management of chronic knee pain due to osteoarthritis.

Study Design: Chart review and study design was approved by Newark Health Sciences IRB. Chart review and follow-up was performed on all patients who underwent genicular nerve RFA during the period of February 2014 through August of 2015. During this inclusion period 41 genicular nerve RFAs were performed on 31 patients, 5 patients received RFA procedure in both knees. Patient follow-up was performed via telephone interview or in-office visit at least 3 months and 6 months post RFA.

Settings: Procedures were performed in Medical Special Procedures at University Hospital in Newark, NJ, and the Pain Management Center at Overlook Medical Arts Center in Summit, NJ.

Methods: Chart review and study design was approved by Newark Health Sciences Institutional Review Board. Chart review was performed from February 2014 and continued through August 2015. Patient follow-up was conducted at 3 and at least 6 months post treatment to gauge degree of pain relief (0 – none, 100% – complete), their current day's pain score, other treatment modalities tried before RFA, and the medications used. Patients were asked to quantify their satisfaction with procedure length, pre-procedure anxiety, complications, and if they would recommend this procedure to others. Primary and secondary goals were the duration of pain relief after RFA, the quality of pain relief, and the efficacy of our approach for RFA of genicular nerves versus prior published techniques.

Results: At 3 month follow-up, the average pain relief was 67% improvement from baseline knee pain, 0% being no relief and 100% being complete relief, and average 0 – 10 pain score was 2.9. At 6 month follow-up, of those who described pain relief at 3 months, 95% still described pain relief. This group's average percent pain relief was 64% and average day's 0 – 10 pain score 3.3.

Limitations: Our study included a retrospective component in chart review followed by prospective follow-up, only 76% of patients were able to participate in the interview process. Furthermore, some patients suffered from other chronic pain ailments, most commonly chronic back pain, which at times disturbed the patient's ability to focus on solely knee pain.

Conclusions: Based on patient interviews and data collection, RFA of genicular nerves can supply on average greater than 60% pain relief in our patient population for as long as 6 months.

Key words: Osteoarthritis, knee osteoarthritis, chronic knee pain, radiofrequency ablation, nerve ablation, genicular nerves, long-term pain relief

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Radiofrequency ablation (RFA) of the genicular nerves is a useful alternative to surgery for patients who suffer from chronic knee osteoarthritis (OA) pain (1). RFA of the genicular nerves has significantly decreased pain scores at 4 and 12 weeks post ablation compared to the control treatment (1). However, the duration of pain relief beyond 3 months is unknown.

RFA dates as far back as 1931 when used for ablation of the Gasserian ganglion in treating trigeminal neuralgia (2). RFA creates a high frequency current in an electrode tip that passes to a grounding pad placed on the body. An electromagnetic field is created at the tip of the electrode introduced into the body and causes high frequency ionic vibrations, resulting in frictional heat at the cellular level surrounding the electrode tip. The area of protein denaturation and coagulation necrosis depends on electrode size, temperature, the duration of RFA, and proximity or alignment of the electrode tip to the tissue of interest (3).

Sensory innervation of the knee involves the articular branches of the femoral, common peroneal, saphenous, tibial, and obturator nerves. The culminations of these articular branches are referred to as the genicular nerves (4). The targeted branches consist of the superior lateral, superior medial, and inferior medial nerves because of their relatively reliable anatomic positions at periosteal areas connecting the femur or tibia shafts to their respective epicondyle. The inferior lateral was not targeted due to its close proximity to the common peroneal nerve.

OA represents the most common form of arthritis with symptomatic knee OA occurring in 10% of men and 13% of women aged 60 years or older (5). Population surveys of those affected by symptomatic knee OA found that 88% of OA patients used nonsteroidal anti-inflammatory drugs (NSAIDs) regularly (6). A survey of 2,679 patients with magnetic resonance image confirmed tibiofemoral OA, indicated that 51% of women and 41% of men used complementary medicine either alone or with conventional medicine (7). These included supplements, manual manipulation, meditation, or homeopathic treatments for this chronic ailment (7,8). Thus, OA patients appear to be open to alternative treatment modalities.

Chronic OA patients often opt for surgical repair to regain adequate ability to accomplish activities of daily living with limited pain or allowable joint mobility. A 2013 report estimates that 4.0 million adults in the US currently live with a total knee replacement, representing 4.2% of the population 50 years of age or older (9). However, revision-free implanted knee joints have a life span of roughly 8 – 10 years (10) and 20% of patients appear unsatisfied with the outcome following total knee replacement (11). The use of minimally invasive interventions with minimal use of chronic pharmacologic therapy represents a gap in treatment options for most elderly with chronic knee OA pain.

We performed a review of our patient population who underwent RFA of the genicular nerves to analyze the degree and duration of pain relief to 6 months or longer. We also compared the efficacy of our methodology in performing RFA to prior published studies. We decided to utilize a lower stimulating threshold than prior published studies to optimize the positioning of the RFA electrode relative to the genicular nerves.

Methods

Chart review and study design was approved by Newark Health Sciences Institutional Review Board. Chart review was performed on all patients who underwent genicular nerve RFA during the period of February 2014 through August of 2015 at University Hospital in Newark, NJ, and Overlook Medical Arts Center in Summit, NJ. Some patients had procedures performed on both knees and each knee was counted as a separate procedure. Diagnostic blocks consisted of injections of 1 mL bupivicaine at each genicular nerve. Genicular nerve RFA was performed on patients with knee OA if diagnostic blocks provided the patient with 80% or better pain relief. RFA was performed using a stimulating threshold of 0.15 V at 50 Hz before nerve ablation to optimize needle positioning. A 100 mm, 22 g with 10 mm bent tip RFA needle was positioned at the superior lateral, superior medial, and inferior medial periosteal areas connecting the femur and tibia shafts to their respective epicondyle under fluoroscopy (Fig. 1). With sensory capture confirmed at 0.15 V and absence of motor simulation, the electrode target temperature was set to 60°C for 120 seconds.

Patients gave their written informed consent to participate in follow-up interviews. Follow-up phone calls or in-person interviews were conducted at roughly 3 and at least 6 months post treatment. If 3 month follow-up was not possible, we attempted a 6 month follow-up. Exclusion criteria from data analysis included the following: patient was suffering from advanced systemic disease such as decompensated heart failure, pneumonia, or dementia leaving them too debilitated to participate in follow-up; knee had a mechanical

injury (e.g., meniscal tear or tendon damage); and/or the patient was suffering from a chronic rheumatologic disorder.

Interviews consisted of questions relating to the patient's experience undergoing RFA of the genicular nerves and the perceived results. Patients were asked to describe their degree of pain relief (0 – none, 100% – complete relief of pain) post RFA and their current day's pain score. They were asked what other treatment modalities they had tried before RFA and what pain medications they were taking before. Patients described their experience with the procedure itself by quantifying their satisfaction with procedure length, pre-procedure anxiety, complications incurred, and if they would recommend this procedure to a family member or loved one.

Statistical Analysis

First, statistical analysis was performed to determine average degree pain relief and standard deviation in those who showed any response to treatment. Next, we calculated the percentage of those who described pain relief at 3 months and percentage of those who described continued pain relief 6 months post RFA. If patients described no relief at 3 months, they were not included in 6 months follow-up. We also attempted to quantify patient satisfaction with RFA by calculating response percentage to procedure length, pre-procedure anxiety, and if they would recommend this intervention to others.

Results

In our data sampling period of February 2014 to August 2015, we performed RFA of the genicular nerves on 41 knees with OA. Of these 41, 6 patients were excluded due to advanced systemic disease such as decompensated heart failure, pneumonia, or dementia leaving them too debilitated to participate in follow-up, diagnosis of an underlying rheumatologic disease, and occurrence of mechanical injury. Four were lost to any follow-up whatsoever. Eighteen procedures were performed on women and 13 on men (Table 1). Five patients received the RFA procedure in both knees. With the caveat that 5 patients were included twice for both knees, the average age of our patients receiving RFA for knee OA was 72 ± 15 years old, which ranged from 41 years old to 96 years. The average body mass index for our patients was 28.5 ± 4, the highest 37 and lowest 24, one out of 31 was undisclosed.

We found that 42% of our patients had tried physical therapy in the past for their knee pain and 45% underwent a steroid or hyaluronic acid injection (Table 2). At baseline most patients were taking an oral analgesic for their knee pain and approximately one third of our patients (32%) had undergone knee surgery in the past (Table 2). At baseline, average pain level for the 31 knees was greater than 7 on a scale of 10.

Out of 31 procedures, we were able to perform a 3 month follow-up on 23 knee procedures. Most patients

Table 1. *Demographics of patients.*

	Laterality	Gender	Age	Ht (in)	Wt (lb)	BMI
Knee 1	R	F	70	66	149	24
Knee 2	L	M	93	61	127	24
Knee 3	R	M	93	61	127	24
Knee 4	R	M	52	69	230	34
Knee 5	R	F	89	60	125	24
Knee 6	L	F	83	56	113	25
Knee 7	L	M	96	65	162	27
Knee 8	R	M	96	65	162	27
Knee 9	R	F	78	64	150	26
Knee 10	L	F	66	61	171	32
Knee 11	R	F	80	67	210	33
Knee 12	R	F	53	67	198	31
Knee 13	R	F	63	64	217	37
Knee 14	R	M	45	75	255	32
Knee 15	L	M	41	70	200	28
Knee 16	L	F	75	60	140	27
Knee 17	R	F	75	65	150	25
Knee 18	L	F	75	65	150	25
Knee 19	L	M	69	74	245	32
Knee 20	R	M	45	75	252	32
Knee 21	R	M	59	74	247	32
Knee 22	L	F	86	63	145	26
Knee 23	L	F	78	***	***	***
Knee 24	R	M	85	70	175	25
Knee 25	R	F	73	61	138	26
Knee 26	R	F	86	61	140	26
Knee 27	R	M	63	65	208	35
Knee 28	L	M	63	65	208	35
Knee 29	R	F	60	64	148	25
Knee 30	L	F	60	64	148	25
Knee 31	R	F	71	69	210	31

Key: *** : Data undisclosed

Table 2. *Patient experience with RFA*.

	Other Attempted Modalities Prior to RF				Post RFA Complications				Pre-procedure Anxiety				Procedure Length Description		
	PT	Scheduled Oral Analgesics	Intra-articular Injections	Surgery	Numbness	Motor Weakness	Neuralgia	Paresthesia	None	Mild	Mod.	Severe	Short	Appropriate Time	Too Long
Knee 1		✖	✖						✖					✖	
Knee 2		✖								✖				✖	
Knee 3		✖								✖				✖	
Knee 4									✖					✖	
Knee 5									✖					✖	
Knee 6	✖	✖	✖						✖					✖	
Knee 7	✖	✖	✖						✖					✖	
Knee 8									✖					✖	
Knee 9		✖							✖					✖	
Knee 10		✖	✖						✖					✖	
Knee 11	✖	✖	✖						✖					✖	
Knee 12	✖		✖	✖						✖				✖	
Knee 13	✖		✖	✖	✖				✖					✖	
Knee 14	✖	✖	✖	✖					✖					✖	
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Knee 29	✖	✖	✖						✖				✖		
Knee 30	✖	✖	✖						✖				✖		
Knee 31		✖								✖			✖		

interviewed at roughly 3 months post RFA continued to describe pain relief in their knees (14 knees/23 knees; 61%). Their average percent pain relief was 67% ± 27.2 improvement from baseline knee pain (Table 3, Fig. 1.) and their average 0 – 10 day's pain score was 3.7 ± 2.9. Of note, the subgroup of patients who previously underwent knee surgery described 63% pain relief; in this sub-group, 8 out of 10 were available for 3 month follow-up. These data suggest that surgery did not significantly reduce the efficacy of RFA in this small cohort.

We were able to perform a 6 month follow-up on 20 of the 31 RFA knee procedures. Of these twenty, 95% described pain relief at least 6 months post RFA (Fig. 2). This group's average percent pain relief at

Table 3. *Percent pain relief.*

	3 Month Follow-Up % Relief (0 – 100%)	Today's Pain Score 3 Months (0 – 10)	6 Month Follow-Up % Relief (0 – 100%)	Today's Pain Score 6 Months (0 – 10)	Would you recommend this Tx to others?
Knee 1	0	---	*	---	No
Knee 2	---	---	60	7	Yes
Knee 3	---	---	65	7	Yes
Knee 4	0	----	*	---	No
Knee 5	---	---	60	---	Yes
Knee 6	---	6	30	6	No
Knee 7	0	---	*	---	No
Knee 8	0	---	*	---	No
Knee 9	0	---	*	---	No
Knee 10	10	5	25	8	Yes
Knee 11	25	7	---	---	No
Knee 12	60	5	70	4	Yes
Knee 13	70	6	30	5	Yes
Knee 14	85	3	50	7	Yes
Knee 15	0	---	*	---	Yes
Knee 16	---	---	50	3	Yes
Knee 17	---	---	60	0	Yes
Knee 18	---	---	60	0	Yes
Knee 19	---	---	90	0	Yes
Knee 20	50	7	50	5	Yes
Knee 21	90	0	0	1	Yes
Knee 22	0	7	*	---	Yes
Knee 23	0	9	*	---	Yes
Knee 24	0	5	*	---	No
Knee 25	100	0	95	2	Yes
Knee 26	80	2	---	---	Yes
Knee 27	50	2	90	0	Yes
Knee 28	50	2	90	0	Yes
Knee 29	90	0	75	3	Yes
Knee 30	90	0	75	3	Yes
Knee 31	90	2	90	2	Yes
Key : --- : No patient response available * : No relief at 3 months					

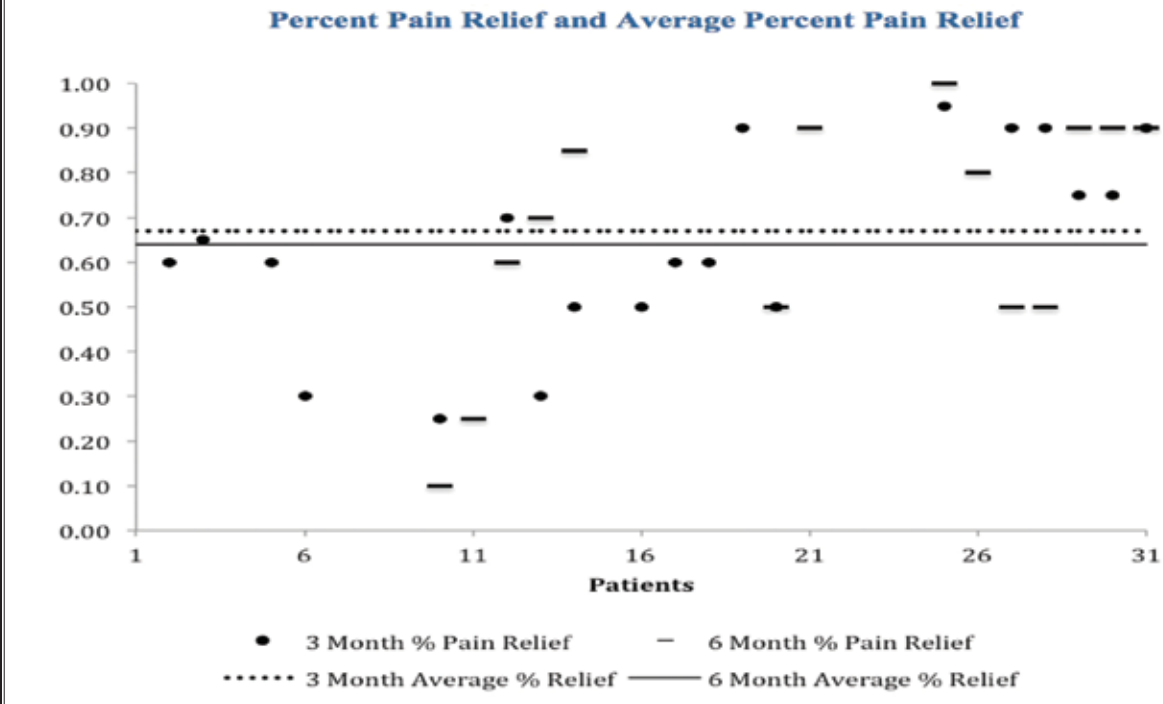

Fig.1 *Percent pain relief and average percent pain relief.*

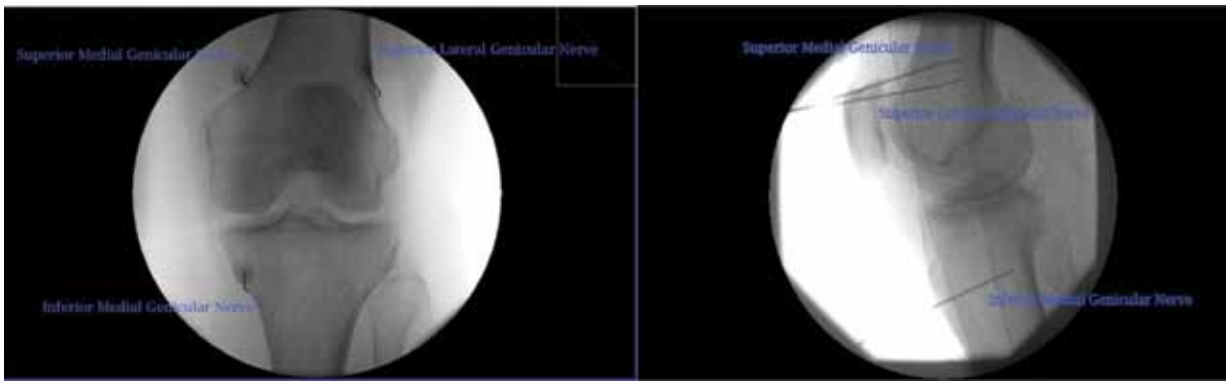

Fig. 2. *Needle placement in anterior and lateral view*

least 6 months post procedure was 64% ± 21.6 (Fig. 1) and average day's 0 – 10 pain score was 3.3 ± 2.7. Our subgroup of patients who underwent any type of knee surgery in the past described 63% pain relief, with 9 out of 10 being available for 6 month follow-up.

Of our entire patient population, only one described transient numbness of the knee post procedure. Very importantly, no one reported weakness, neuralgia, or paresthesias (i.e., tingling or pricking). Patients described all procedures as short or an appropriate length and the patients reported none to mild pre-procedure anxiety. Out of all 31 procedures, 74% provided the response that they would recommend RFA of genicular nerves to a family member or loved one.

Discussion

Our results expand on simple visual analog scale (VAS) pain scores post 3 months ablation reported by Choi et al (1). We have been able to describe patients' experiences undergoing RFA of the genicular nerves and their perceived results in short term and long term pain relief of 6 months and beyond. Comparing our data to Choi et al's (1) end points, our approach using a stimulating threshold of 0.15 V and electrode temperature of 60°C for 120 seconds resulted in 52% of patients who described at least 50% pain relief at 12 weeks post ablation. Of those who described pain relief, average pain relief was 67%. Of patients who described continued pain relief at least 6 months post RFA, 80% of procedures resulted in at least 50% pain relief. Again, this 6 month post ablation group's average percent pain relief was 64% and average day's 0 – 10 pain score 3.3. A group of 5 patients were available for follow-up beyond 6 months when they returned to our office for maintenance of other pain ailments. Three of these patients still described roughly 60% pain relief, the longest being 12 months post ablation.

Genicular nerve RFA is a useful treatment option to fill the gap between intra-articular injections and costly, invasive surgery. Choi et al (1) published that genicular RFA-treated patients in a randomized double-blinded controlled trial had significantly lower VAS pain scores at 4 and 12 weeks than the control group. Most patients receiving this procedure (59%) described at least 50% pain relief at 12 weeks post ablation (1). Our data at 3 months provided a modestly smaller although similar percentage of patients with pain relief to those studied by Choi et al (1).

Analyzing the RFA stimulating threshold suggests that genicular nerve RFA with a stimulating threshold of 0.15 V situates the RFA electrode in appropriate proximity to the targeted nerve, resulting in burn efficacy and reliability of ongoing pain relief. An even lower threshold of 0.10 V appeared too low to obtain consistent capture of the targeted nerve. With the RFA tip in close proximity to the targeted nerve, 60^{0}C was an adequate burn temperature and we avoided higher temperatures that could result in microvasculature destruction and local vessel thrombosis (3).

Limitations to our study were multiple; our study included a retrospective component in chart review followed by prospective follow-up, only 76% of patients participated in the interview process. Furthermore, some patients suffered from other chronic pain ailments, most commonly chronic back pain, which at times compromised a patient's ability to focus solely on knee pain. This further impacted our ability to reliably assess decreased opioid or other medication requirements as most patients opted to remain on their stable medication regimen pertaining to their other chronic pain ailment.

Based on patient interviews and data collection, RFA of genicular nerves can supply significant pain relief beyond 6 months, on average greater than 60% pain relief in our patient population. Genicular nerve RFA is a reasonable option for patients suffering from chronic knee OA pain who do not wish to pursue knee surgery. RFA ablation can be offered as part of a multimodal approach to pain control. RFA ablation did not induce any mild (grade 1 – 2) or serious (grade 3 – 4) adverse events in any of our middle aged to elderly or obese patients as well as the small subset that had undergone knee surgery. The degree and incidence of pain relief noted with our approach at least 6 months post RFA is very positive and warrants further study.

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