

## Comparison of efficacy of radiofrequency alone or steroid or ozone intra-articular after radiofrequency ablation of genicular nerves in patients with chronic pain due to knee osteoarthritis: A prospective, randomized, controlled clinical trial

S.I.Saad, M.A.Elrabiey, H.M.Elazzazi, E.A.Shaboob, Z.M.Elbagoury

Anaesthesia & Intensive Care, Dept., Faculty of Medicine, Benha Univ., Benha, Egypt

### Abstract

Background: Osteoarthritis (OA) is a heterogeneous disorder for which the exact cause is unknown, the condition is thought to consist of a group of overlapping distinct diseases which may occur in response to a variety of different biological and mechanical factors including metabolic, genetic or hereditary predisposition, age, physical factors such as obesity, and environmental factors. Osteoarthritis is a slowly evolving articular disease characterized by the gradual development of joint pain, stiffness and limitation of motion. Corticosteroids are commonly used in the practice of pain management for their anti-inflammatory properties. These agents, produced by the adrenal cortex, are widely used in epidural, joint, peripheral nerve and various types of soft tissue injections. The aim of the present study was to compare between the efficacy of ozone, steroid and placebo after radiofrequency ablation of genicular nerves in patient with knee osteoarthritis. Methods: This study was a Prospective, single blind randomized clinical trial study which included 75 patients suffering from pain caused by osteoarthrosis of the knee joint conducted at Benha university hospital. Results: No significant differences were reported between the study groups regarding age, gender, body mass index, pain duration, and Kellgren-Lawrence grade. The median VAS score showed an overall significant difference between the three study groups. Post hoc revealed that it was significantly higher in group I (7) than groups II (6) and III (5). No significant differences were reported between the study groups regarding VAS at baseline. No significant difference was reported between the study groups regarding oxford knee score (OKS) at baseline. No significant difference was reported between the study groups regarding global patient satisfaction. Conclusion: There was no statistically significant difference the efficacy of ozone, steroid and placebo after radiofrequency ablation of genicular nerves in patient with knee osteoarthritis.

**Key words:** radiofrequency - steroid - ozone intra-articular - radiofrequency ablation- genicular nerves - knee osteoarthritis.

### 1.Introduction

Osteoarthritis (OA) is the most common form of arthritis and one of the leading causes of disability. This degenerative and progressive joint disease affects around 250 million people worldwide and more than 27 million people in the United States. Elderly (approximately 35% of patients over 65 years old) females, patients with obesity and African Americans are the population with the highest risk of developing OA. Given the trend of the population to live longer and the progressive increment of obesity in our country, the number of affected patients most likely will substantially increase within the upcoming years. This is concerning given the functional impairment and disability associated with this condition and its negative toll on the social and economic aspects of our society <sup>(1)</sup>.

The knee is the largest synovial joint in humans, it is composed by osseous structures (distal femur, proximal tibia, and patella), cartilage (meniscus and hyaline cartilage), ligaments and a synovial membrane. The latter is in charge of the production of the synovial fluid, which provides lubrication and nutrients to the avascular cartilage. Unfortunately, given the high use and stress of this joint, it is a frequent site for painful conditions including OA <sup>(2)</sup>.

Pharmacological treatment of pain due to osteoarthritis of the knee often proves to be inadequate and/or cause intolerable side effects. Arthroplasty of the knee may offer a solution, but waiting lists may be long or certain patients may not suitable for a surgical intervention or patient refusal for doing the total knee replacement operation. Therefore an alternative pain treatment that is effective and has little side effects allowing to offer pain relief to those difficult to manage patients would be an added value in the therapeutic options <sup>(3)</sup>.

Radiofrequency thermocoagulation (RFTC) is a minimally invasive and target-selective modality procedure that has been used for over three decades. This has been demonstrated to be successful for reducing pain in the treatment of various chronic pain syndromes. Continuous radiofrequency ablation (CRF) uses high-frequency alternating current to induce coagulative necrosis in the target tissue <sup>(4)</sup>.

Intra-articular injection of steroid is a common treatment for osteoarthritis of the knee. Clinical evidence suggests that benefit is short lived, usually one to four weeks. The short term effect of steroids shown by controlled trials and clinical experience vary. The mechanism of corticosteroid action includes a reduction of the inflammatory

reaction by limiting the capillary dilatation and permeability of the vascular structures. These compounds restrict the accumulation of polymorphonuclear leukocytes and macrophages and reduce the release of vasoactive kinins. They also inhibit the release of destructive enzymes that attack the injury debris and destroy normal tissue indiscriminately. <sup>(5)</sup>.

The aim of this study is to compare between the efficacy of ozone, steroid and placebo after radiofrequency ablation of genicular nerves in patient with knee osteoarthritis

## 2. Patients and Methods

### A. Technical design

#### 1- Study type and region

This Prospective, single blind randomized clinical trial was conducted at Benha university hospital.

#### 2- Study population

This study was conducted on 75 patients suffering from pain caused by osteoarthrosis of the knee joint.

#### 3- Sample size

The sample size calculation was performed using G.power 3.1. The sample size was calculated as  $N \geq 19$  in each group based on the following considerations:

- 95% confidence limit and 95% power of the study.
- Group ratio 1:1
- The mean ( $\pm$ SD) of NRS at rest at 6 month (the primary outcome of our study) was  $3.31 \pm 0.64$  with radiofrequency ablation of genicular nerves of knee and expected 25% decrease with the other techniques.

Six cases were added to each group to overcome dropout, so the total required cases are 25 in each group.

#### 2.1 Inclusion criteria

- patients suffering from pain caused by osteoarthrosis of the knee joint. (grade 3-4 according to the Kellgren Lawrence classification).
- pain of moderate to severe intensity ( $VAS \geq 5$ , on a 10-point scale) during  $>3$  months.
- pain resistant to conservative treatments.

#### 2.2 Exclusion criteria

- Acute knee pain associated with radicular neuropathy or intermittent claudication.
- Connective tissue diseases affecting the knee.
- Serious neurologic or psychiatric disorders.
- Mental deterioration impeding adequate communication or collaboration.

- Injection with steroids or hyaluronic acids during the previous 3 months.
- Anticoagulant medications and prior electro-acupuncture treatment.
- Infection at the site of injection.
- Patient with previous total knee replacement.

#### 2.3 Groups allocations:

Patients will be randomly allocated into three main groups

- **Group 1: RFP** group: in this group the patient will not be injected intra-articularly after radio-frequency ablation of genicular nerves and this is the placebo group.
- **Group 2: RFS** group: in this group the patients will be injected with steroids intra-articularly after radiofrequency ablation of genicular nerves.
- **Group 3: RFO** group: in this group the patients will be injected with ozone intra-articularly after radiofrequency ablation of genicular nerves

### B. Operational design

*All patients will be subjected for*

#### 1. Full history taking.

#### 2. Preoperative assessment

- One day before the intervention, all the patients were interviewed to explain the procedure.
- Routine investigations as complete blood count (CBC) and coagulation profile (prothrombin time and INR), random blood sugar was fulfilled.

#### 3. Technique

- Thirty minutes before the procedure, an IV access was inserted and 1 gm cefazoline was given by infusion.
- The patient was monitored with ECG, pulse oximeter and non-invasive blood pressure.
- 1-2 mg midazolam and 20-50 microgram fentanyl were given to the patient.
- Under sterile conditions, the patient was placed in a supine position on a fluoroscopy table with a pillow under the popliteal fossa. The true AP fluoroscopic view of the tibiofemoral joint was obtained and showed an open tibiofemoral joint space with equal width interspaces on both sides. Skin and soft tissues were anesthetized with 1 mL 1% lidocaine. A 10 cm 22-gauge RF cannula with a 10 mm active tip (epimed, USA) was employed for the technique. Under fluoroscopic guidance, the cannula was advanced percutaneously towards areas connecting the shaft to the epicondyle, the so-called "tunnel technique", until bone contact

was made the curve if the needle tip was directed away from the bone .After reaching correct position , the needle was turned 180 degree until the curve hugs the bony surface then lateral view was done, the needle tip was inserted a point midway between anterior two third and posterior one third . Sensory stimulation at 50 Hz was performed to identify the nerve position. The sensory stimulation threshold was required to be less than 0.7 V. In order to avoid inactivating motor nerves, the nerve was tested for the absence of fasciculation in the corresponding area of the lower extremity on stimulation of 2.0 V at 2 Hz. Lidocaine (2 mL of 2%) was injected before activation of the RF generator. The RF electrode was then inserted through the canula, and the electrode tip temperature was raised to 80 C for 2 minutes thermal radiofrequency. Two RF lesion were made for each genicular nerve.

- Then, the (RFS) group were injected with 40 mg methylprednisolone dissolved in 4 ml normal saline intra-articular and this were the first group.
- The second group (RFO) were injected with 5 ml ozone intra-articular after RF.
- The third group (RFP) were not injected after RF.

#### 4. Primary Outcome Measures:

- Pain reduction [ Time Frame:1 week 1, 6 months]
- Pain intensity is measured using a 10-point VAS score.

#### 5. Secondary Outcome Measures:

- Global patient satisfaction [ Time Frame: 1week,1 and 6 months]
- Satisfaction is scored on a 4-point Likert scale: 1 (poor), 2 (average), 3 (good) and 4 (very good)
- Oxford knee score to assess knee function.

- Our primary outcome was the Oxford Shoulder Score (OSS), a patient-reported measure of functional limitation following shoulder surgery. Development and validation included patients with frozen shoulder, and it had been used in the long-term follow-up of these patients.
- The OSS is a 12-item measure with five response categories and a range of scores from 0 (worst) to 48 (best). It has been validated against the professionally endorsed Constant Score and the 36-item Short Form Health Survey (SF-36) and responsiveness over a 6-month period following surgical intervention has been established.
- The OSS were be completed at the hospital at baseline (i.e. day of randomization) and posted to trial participants at 3, 6 and 12 months after randomization. The primary endpoint is 12 months after randomization. The OSS was also be collected at the hospital on the day that treatment starts (i.e. day of the operation or for patients allocated to ESP on the day when the steroid injection is given or first visit to physiotherapy, whichever is the first to be delivered) and posted to participants to complete 6 months from when treatment starts. The OSS was being collected on the day the treatment starts and 6 months later due to the variation in waiting times as to when the trial interventions start.

#### 3.Results

No significant differences were reported between the study groups regarding age (P-value = 0.179), gender (P-value = 0.846), body mass index (P-value = 0.281), pain duration (P-value = 0.114), and Kellgren-Lawrence grade (P-value = 0.156) (Table 1 & figure 1).

**Table (1) General characteristics in the studied groups**

		<b>Group I (n = 25)</b>	<b>Group II (n = 25)</b>	<b>Group III (n = 25)</b>	<b>P-value</b>
<b>Age (years)</b>	Mean ±SD	65 ±14	63 ±12	69 ±8	0.179
<b>Gender</b>	Males	9 (36.0)	11 (44.0)	10 (40.0)	0.846
	Females	16 (64.0)	14 (56.0)	15 (60.0)	
<b>Body mass index</b>	Mean ±SD	33 ±7	33 ±7	30 ±4	0.281
<b>Pain duration (months)</b>	Median (range)	60 (24 - 120)	60 (24 - 120)	72 (36 - 120)	0.114
<b>Kellgren-Lawrence grade</b>	Grade III	12 (48.0)	7 (28.0)	6 (24.0)	0.156
	Grade IV	13 (52.0)	18 (72.0)	19 (76.0)	

One-way ANOVA was used for age and BMI. Kruskal Wallis test was used for pain duration. Chi-square test was used for categorical data

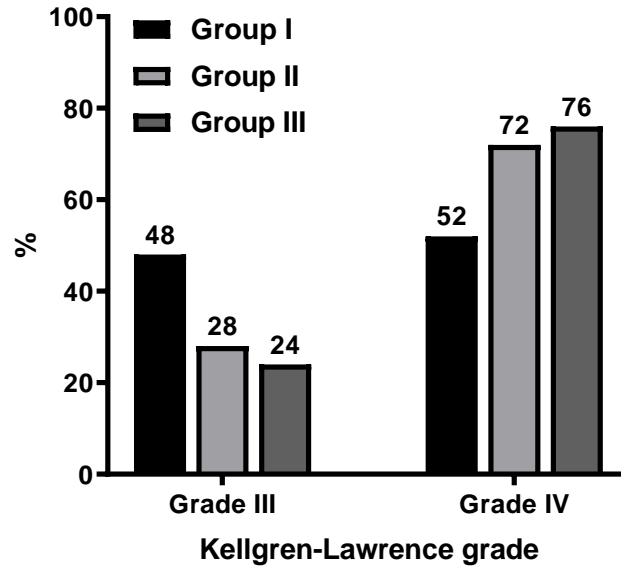


Fig (1) Kellgren-Lawrence grade in the studied groups

**VAS at baseline and follow up**

The median VAS score showed an overall significant difference between the three study groups (P -value < 0.001). Post hoc revealed that it was significantly higher in group I (7) than groups II (6) and III (5).

No significant differences were reported between the study groups regarding VAS at baseline (P-value = 0.199, one month (P-value = 0.112), and six months (P-value = 0.06) (Table 2& figure 2).

Table (2) VAS at baseline and follow up in the studied groups

VAS		Group I (n = 25)	Group II (n = 25)	Group III (n = 25)	P-value
Baseline	Median (range)	9 (7 - 10)	9 (6 - 10)	9 (7 - 10)	0.199
One week	Median (range)	7 (4 - 9) <sup>a</sup>	6 (3 - 9) <sup>b</sup>	5 (3 - 8) <sup>b</sup>	<0.001
One month	Median (range)	3 (1 - 10)	3 (1 - 10)	2 (1 - 9)	0.112
Six months	Median (range)	3 (1 - 10)	3 (1 - 10)	2 (1 - 9)	0.06

Kruskal Wallis test was used. Post hoc was done using Bonferroni's method. Different letters indicate significant pair

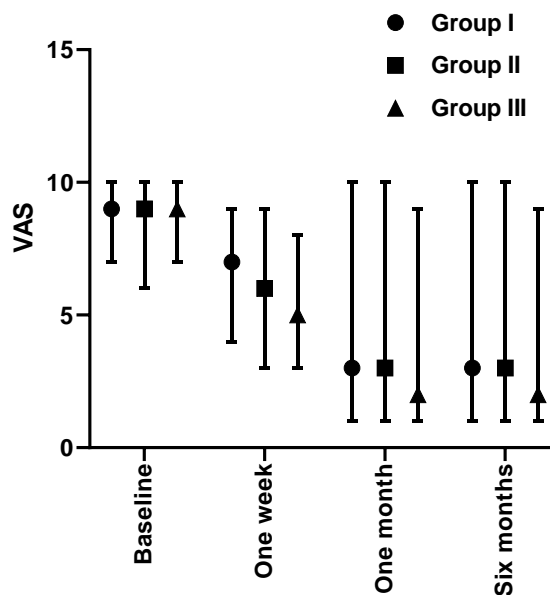


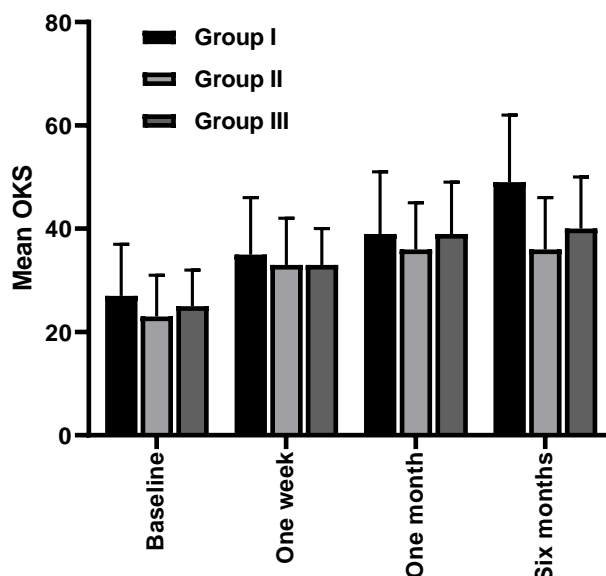
Fig (2) VAS at baseline and follow up in the studied groups

❖ **Oxford knee score (OKS) at baseline and follow up**

No significant difference was reported between the study groups regarding oxford

**Oxford knee score (OKS) at baseline and follow up in the studied patients**

knee score (OKS) at baseline (P-value = 0.305), one week (P-value = 0.520), one month (P-value = 0.483), and six months (P-value = 0.350) (*figure 3*).



**Fig (3)** Oxford knee score (OKS) at baseline and follow up in the studied patients

❖ **Patient satisfaction**

No significant difference was reported between the study groups regarding global

patient satisfaction at one week (P-value = 0.758), one month (P-value = 0.778), and at six months (P-value = 0.637) (*Table 3*).

**Table (3) Patient satisfaction in the studied groups at different follow-up times**

Patient satisfaction	Group I (n = 25)	Group II (n = 25)	Group III (n = 25)	P-value
<b>One week</b>	Poor to average	23 (92.0)	21 (84.0)	0.758
	Good to very good	2 (8.0)	4 (16.0)	
<b>One month</b>	Poor to average	9 (36.0)	7 (28.0)	0.778
	Good to very good	16 (64.0)	18 (72.0)	
<b>Six months</b>	Poor to average	9 (36.0)	6 (24.0)	0.637
	Good to very good	16 (64.0)	19 (76.0)	

Chi-square or Fisher's exact test was used

**4. Discussion**

Regarding general characteristics; no significant differences were reported between the study groups regarding age (P-value = 0.179), gender (P-value = 0.846), body mass index (P-value = 0.281), pain duration (P-value = 0.114), and Kellgren-Lawrence grade (P-value = 0.156).

In accordance with our results, study of Hashemi et al.,<sup>(5)</sup> as they reported that a total of 72 patients (in the age range of 51- 78 year), half in each group with similar distribution of gender, age and BMI (Body Mass Index) completed the study, which the mean of BMI of participants in Ozone and RF groups was 28.64± 4.98 and 26.13±3.03 (p= 0.06). Also, the mean of age was 66.69±8.95 and 68.33±3.48 (p= 0.459) respectively. Twenty patients (66.7%) in ozone group and

32 patients (88.9%) in RF group were above 65 years old. Considering the gender distribution, females have formed 86.1% and 77.8% of contributors of mention groups respectively (p=0.461).

The present study showed that as regard VAS at baseline and follow up; the median VAS score showed an overall significant difference between the three study groups (P -value < 0.001). Post hoc revealed that it was significantly higher in group I (7) than groups II (6) and III (5). No significant differences were reported between the study groups regarding VAS at baseline (P-value = 0.199, one month (P-value = 0.112), and six months (P-value = 0.06).

Our results were supported by study of Erdem & Sir,<sup>(6)</sup> as they reported that pulsed radiofrequency of the genicular nerves

significantly reduced perceived pain and disability in the majority of the patients. The proportion of the patients with improvement of  $\geq 50\%$  in pretreatment VAS scores at 3 weeks and 3 months following treatment were 14 out of 17 patients (82%) and 15 out of 17 patients (88%) in Group 1, and 4 out of 6 patients (67%), 4 out of 6 patients (67%) in Group 2, respectively. Patients who had persistent knee pain were divided into 2 groups: those with severe osteoarthritis and those with arthroplasty.

**Kim et al.**,<sup>(7)</sup> demonstrated that the VAS scores were significantly lower in the lidocaine plus TA group than in the lidocaine alone group at both 2 ( $P < 0.001$ ) and 4 ( $P < 0.001$ ) weeks after GNB. The alleviation of intense pain in the lidocaine plus TA group was sustained up to 2 weeks after the procedure, in accordance with the definition of a minimal clinically important improvement.

Whereas, **Konya et al.**,<sup>(8)</sup> reported that forty-eight patients who underwent RF ablation of the genicular nerves were evaluated retrospectively. The mean VAS scores were significantly lower at the 1-, 3-, and 6-month evaluations compared with the preoperative values ( $P < 0.001$ ). A significant decrease was observed in the WOMAC index compared with preoperative values ( $P < 0.001$ ). It was found that 66.7% of opioid users and 56.3% of NSAID users stopped using medication. No serious complications were encountered during or after the procedure.

Furthermore, **Kamel**,<sup>(9)</sup> stated that This study involved 60 patients with chronic knee osteoarthritis. Radiofrequency neurotomy of the genicular nerves was done for 30 patients (Group A) while the other 30 patients (Group C) received conventional analgesics only. There were significant differences regarding the VAS in the 2nd week, 3rd, and 6th months between the 2 groups. There were significant changes when comparing pretreatment values with the values during the whole follow-up period with regard to the VAS.

In the study of **Lopes de Jesus et al.**,<sup>(10)</sup> the endpoint pain reduction was evaluated using VAS and GPM (Geriatric Pain Measure). According to the analysis of these tests, the average behavior of the groups over the follow-up was statistically different ( $p < 0.001$ ). A large decline in the values from the second stage of treatment onwards was observed ( $p < 0.001$ ). Results were statistically different between the evaluated groups, clearly evidencing pain reduction in patients treated with ozone soon after the beginning of the intervention ( $p < 0.001$ ).

In the study of **Anzolin & Bertol**,<sup>(11)</sup> they concluded that the use of ozone produces clinically relevant benefits in patients with osteoarthritis. Therefore, ozone therapy in osteoarthritis represents a low-cost, efficient therapeutic alternative that should be implemented in the country's Public Health, considering the prevalence of the disease.

The current study showed that as regard Oxford knee score (OKS) at baseline and follow up; no significant difference was reported between the study groups regarding oxford knee score (OKS) at baseline ( $P$ -value = 0.305), one week ( $P$ -value = 0.520), one month ( $P$ -value = 0.483), and six months ( $P$ -value = 0.350).

Our results were supported by study of **Fonkoue**,<sup>(12)</sup> as they reported that there was no significant effect of group allocation on the mean changes in OKS. Within each group, there was a significant effect of time. There was no interaction between time and group allocation. Within both groups, the OKS improved at 4 and 12 weeks compared to baseline They randomly assigned 55 patients with chronic knee osteoarthritis pain to receive a GNB (using a fluid mixture of 2 mL: lidocaine 1% + 20 mg triamcinolone) with either classical targets (CT-group,  $n = 28$ ) or revised targets (RT-group,  $n = 27$ ).

In a study conducted by **Ahmed & Arora**,<sup>(13)</sup> the OKS had improved from  $7.75 \pm 1.25$  at baseline to  $28.88 \pm 2.53$  and  $28.13 \pm 1.80$  at 1 and 6 months, respectively, after the procedure ( $p$  value  $< 0.05$ ). The ultrasound-guided radiofrequency ablation (RFA) of all the genicular nerves of knee joint was done in patients with grade III and IV osteoarthritis of knee joint, with severe pain (numerical rating scale (NRS)  $> 7$ ) who had failed conservative management and intra-articular injections after a positive genicular nerve block with local anesthetics.

While, **Ragab et al.**,<sup>(14)</sup> demonstrated that when comparing the mean change of VAS and OKS at 2, 4 and 8 weeks from baseline values for both groups, GNB group showed significantly improved pain and functional capacity at all follow up periods as compared to IACSI group.

In the study of **Hashemi et al.**,<sup>(5)</sup> based on both VAS and OKS we found that both groups responded well to treatments and the pain severity decreased significantly after 12 weeks compared with baseline. By comparing the two methods, although relief of pain based on VAS and OKS was more prominent in RF group but not significant ( $p > 0.05$ ). Having studied patients in two different age groups, below and above 65

years, RF resulted in more acceptable pain relief based on OKS among subjects older than 65 years( $p=0.0001$ ).

In the study in our hands, as regard Patient satisfaction; no significant difference was reported between the study groups regarding global patient satisfaction at one week ( $P$ -value = 0.758), one month ( $P$ -value = 0.778), and at six months ( $P$ -value = 0.637).

In the study of **Fonkoue**,<sup>(12)</sup> the proportion of patients achieving more than 50% knee pain reduction was higher in the RT-group at each follow up interval, yet these differences were statistically significant only at 1-hour post intervention (82.1% [95% CI = 63.1–93.9] vs 100% [95% CI = 97.2–100]  $P = .02$ ). Both protocols resulted in significant pain reduction and joint function improvement up to 12 weeks post-intervention.

Also, **Yilmaz et al.**,<sup>(15)</sup> revealed that all evaluation parameters were significantly improved in IACSI and IACSI + GNB groups. However, the improvement was better in IACSI + GNB group compared to those in IACSI group in terms of all evaluation parameters except QMA (quadriceps muscle cross-sectional area) ( $0.10 \pm 0.18$  and  $0.11 \pm 0.22$ , respectively) and NHP (Nottingham Health Profile) scores in 1st month evaluation ( $-3.11 \pm 6.99$  and  $-3.54 \pm 1.74$ , respectively).

In the study of **Giombini et al.**,<sup>(16)</sup> reported that the combination of O2O3 and HA treatment led to a significantly better outcome especially at 2-month follow-up compared to HA and O2O3 given separately to patients affected by OA of the knee.

## 5. Conclusion

There was no statistically significant difference the efficacy of ozone, steroid and placebo after radiofrequency ablation of genicular nerves in patient with knee osteoarthritis.

## 6. References

- [1] **P.Richebé, X.Capdevila, C.Rivat**, Persistent Postsurgical Pain: Pathophysiology and Preventative Pharmacologic Considerations. *Anesthesiology*. vol.13, pp. 123-125,2018.
- [2] **V.Sharma, K.Anuvat, L.John, M.Davis**, Scientific American Pain Management - Arthritis of the knee. Decker: Pain related disease state, vol.13, pp.124-174,2017.
- [3] **J.Raynauld, C.Buckland-Wright, R.Ward, D.Choquette, B.Haraoui, J.Martel-Pelletier**, Safety and efficacy of long-term intraarticular steroid injections in osteoarthritis of the knee. *Arth Rheum*, vol. 48, pp. 370-7,2017.
- [4] **JD.Iannuccilli, EA.Prince, GM.Soaes**, Interventional spine procedures for management of chronic low back pain-a primer. *Semin Intervent Radiol*, vol. 30, pp.307–317,2013.
- [5] **M.Hashemi, B.Nabi A.Saberi**, The comparison between two methods for the relief of knee osteoarthritis pain: Radiofrequency and intra-periarticular ozone injection: A clinical trial study. *Int J Med Res Health Sci*, vol. 5, pp.539-546,2016.
- [6] **Y.Erdem, E. Sir**, The efficacy of ultrasound-guided pulsed radiofrequency of genicular nerves in the treatment of chronic knee pain due to severe degenerative disease or previous total knee arthroplasty. *Medical science monitor: international medical journal of experimental and clinical research*, vol.25, pp.18-57,2019.
- [7] **DH.Kim, SS.Choi, SH.Yoon**, Ultrasound-guided genicular nerve block for knee osteoarthritis: a double-blind, randomized controlled trial of local anesthetic alone or in combination with corticosteroid. *Pain Physician* vol. 21, pp.41–52,2018.
- [8] **Z.Konya, S.Takmaz, H.Başar**, Results of genicular nerve ablation by radiofrequency in osteoarthritis-related chronic refractory knee pain. *Turkish journal of medical sciences*, vol. 50, pp.86-95,2020.
- [9] **E.Kamel**, Fluoroscopic guided radiofrequency of genicular nerves for pain alleviation in chronic knee osteoarthritis: a single-blind randomized controlled trial. *Pain physician*, vol.21, pp.169-77,2018.
- [10] **C. Lopes de Jesus, F.Dos Santos, L.de Jesus**, Comparison between intra-articular ozone and placebo in the treatment of knee osteoarthritis: A randomized, double-blinded, placebo-controlled study. *PLoS one*, vol.12, pp.179-185,2017.
- [11] **A.Anzolin, C.Bertol**, Ozone therapy as an integrating therapeutic in osteoarthritis treatment: a systematic review. *BrJP*, vol. 1, pp.171-175,2018.
- [12] **L.Fonkoue**, Genicular nerves anatomy (Doctoral dissertation, Université catholique de Louvain, vol.17, pp.147-152,2021).
- [13] **A.Ahmed, D.Arora**, Ultrasound-guided radiofrequency ablation of genicular nerves of knee for relief of intractable pain from knee osteoarthritis: a case series. *British journal of pain*, vol. 12, pp.145-154,2018.

- [14] **A.Ragab, S.Hegab, R.Elnemr, Abdel-A.Kerim**, Intra-articular corticosteroid injection and genicular nerve block under ultrasound guidance in pain control of knee osteoarthritis. Egyptian Journal of Radiology and Nuclear Medicine, vol. 52, pp. 1-7,2021.
- [15] **V.Yilmaz, E.Umay, I.Gundogdu**, The comparison of efficacy of single intraarticular steroid injection versus the combination of genicular nerve block and intraarticular steroid injection in patients with knee osteoarthritis: a randomised study. Musculoskeletal surgery, vol. 105, pp.89-96,2021.
- [16] **A.Giombini, F.Menotti, A.Di Cesare**, Comparison between intrarticular injection of hyaluronic acid, oxygen ozone, and the combination of both in the treatment of knee osteoarthrosis. Journal of biological regulators and homeostatic agents, vol. 30, pp.621-625,2016.