RESEARCH PAPER

# Electrical Dry Needling Versus Iontophoresis in Treating Chronic Unilateral Knee Osteoarthritis

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**ABSTRACT**

Background: Knee osteoarthritis (OA) involves progressive articular cartilage degradation, leading to pain, stiffness, and functional impairment. Purpose: This study compared the effects of Electrical Dry Needling (EDN) and Glucosamine Sulfate Iontophoresis in patients with chronic unilateral knee OA. Subjects and Methods: Sixty patients (both genders, aged 40–60 years, BMI 25–29.9 kg/m²) with moderate knee OA (Kellgren–Lawrence grades II–III) were randomly assigned to three equal groups (n=20). Group A (Control) received conventional physical therapy (Transcutaneous Electrical Nerve Stimulation (TENS), stretching, strengthening, and balance exercises). Group B (Study) received conventional therapy plus EDN. Group C (Study) received conventional therapy plus Glucosamine Sulfate Iontophoresis. Outcome measures included Visual Analog Scale (VAS) for pain intensity, Knee Injury and Osteoarthritis Outcome Score (KOOS) for function, and Digital Goniometer for Range of Motion (ROM). Measurements were recorded at baseline and after six weeks. Results: ANOVA and Kruskal-Wallis tests showed that Group B achieved significant improvements ($P < 0.001$) in pain, functional ability (KOOS), and ROM (flexion/extension) compared to Group A. While Group C showed significant improvement in knee extension ($P = 0.012$) over Group A, no statistically significant differences were observed between Groups A and C regarding flexion ($P = 0.113$), pain ($P = 0.084$), or total KOOS score ($P = 0.247$). Conclusion: Electrical dry needling combined with conventional therapy is more effective than iontophoresis or conventional therapy alone in improving pain and function in chronic unilateral knee OA.

**Keywords**: Digital Goniometer; Electrical Dry Needling; Iontophoresis; Knee Injury and Osteoarthritis Outcome Score; Knee Osteoarthritis.

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## INTRODUCTION

Knee osteoarthritis (OA) is a very common chronic degenerative joint condition that causes severe impairment. It is thought to be caused by deterioration of the articular cartilage and subchondral bone and is a frequent clinical disorder in the elderly, with the knee being the most suffering load-bearing joint. It causes pain, uncomfortable joints, functional impairment, and weakness of the knee flexor and extensor muscles (de Freitas et al., 2023). It's particularly inconvenient because it's difficult to get up from a chair, climb staircases, kneel down, stand up, and move. Pain, along with muscular weakness, increased body sway, and poor balance, increases the danger of falling and reduced bodily activity (Schiphof et al., 2018).

Contemporary clinical practice guidelines and high-quality literature emphasize that conservative (non-surgical) management should be the first line of treatment for individuals with symptomatic OA before considering surgical options (Lim & Al-Dadah, 2022). Therapeutic exercise and rehabilitation programs are widely recommended across worldwide clinical recommendations as fundamental components of conservative therapy, including strengthening, proprioceptive, and aerobic exercises to promote muscle support and reduce excessive loading on the knee joint (McColm et al., 2025). Traditional physical therapy procedures, including TENS, that are used in conjunction with exercises, are considered core nonpharmaceutical therapy and are recommended for treating people suffering from OA (Shamsi et al., 2020).

Electrical dry needling and iontophoresis are gaining popularity as additional Physiotherapy techniques as a conservative management of knee (OA). Electrical dry needling involves inserting solid filiform needles into myofascial trigger points or periarticular tissues, often in conjunction with low-frequency electrical stimulation to enhance analgesic effects. This technique is believed to control peripheral and central pain processes, reduce muscle hypertonicity, enhance local blood flow, and activate endogenous opioid release, therefore contributing to pain reduction and functional improvement in knee osteoarthritis patients (Chys et al., 2023).

Iontophoresis, on the other hand, is a non-invasive electrotherapeutic technique that employs a low-amplitude direct current to improve the transdermal distribution of ionized pharmacological substances into specific tissues. In knee OA, iontophoresis has been utilized to deliver anti-inflammatory, analgesic, or chondroprotective drugs, such as corticosteroids and glucosamine sulfate, with the goal of reducing joint discomfort, irritation, and stiffness while enhancing mobility (Clijsen et al., 2012).

Because there is debate among researchers about which of the two modalities, electrical dry needling or iontophoresis, is more effective in treating those who have knee OA, So this study was conducted to compare the impact of electrical dry needling against glucosamine sulfate Iontophoresis affects pain intensity, knee function skills, and knee range of motion in chronic unilateral knee OA individuals.

## MATERIALS AND METHODS

### Study design:

This study was a randomized controlled trail, pre and post-test experimental design that took place in the outpatient clinic of the Faculty of Physical Therapy, Horus University, New Damietta, Egypt, in Nov 2024 to May 2025. Prior to commencement, ethical clearance was obtained from the Institutional Review Board of the Faculty of Physical Therapy at Cairo University, Egypt (No: P.T.REC/012/005222). The research adhered to the principles outlined in the Declaration of Helsinki concerning research involving human participants. Furthermore, the trial protocol was prospectively registered on the ClinicalTrials.gov database (NCT06578663).

### Participants:

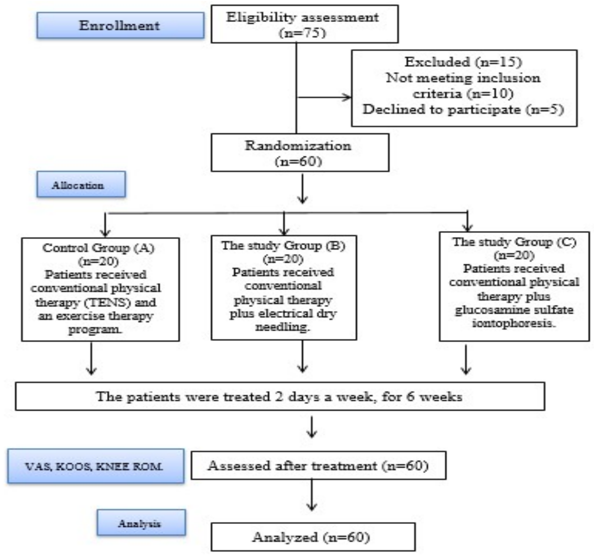
Sixty patients from both genders with chronic knee osteoarthritis contributed this research. They were chosen from the Faculty of Physical Therapy's outpatient clinic at Horus University in Damietta. The sample size was estimated using the variance in Visual Analog Scale (VAS) among the 3 groups to be 0.60 (effect size), significance level = 0.05, and with 80% power. The sample size was calculated to be 16 patients per group, a 1:1:1 ratio. Considering a twenty percent drop to follow-up, each group required at least 20 patients (Pang et al., 2022). The sample size was calculated using G*POWER statistical software [version 3.1.9.2; Universität Kiel, Germany].

Participants were eligible to the trial as they fulfilled the following requirements: 1) Diagnosed with moderate knee osteoarthritis, defined as Kellgren–Lawrence grade II–III based on radiographic findings, and referred by an orthopedist (Reza et al., 2021). 2) Age ranged from 40 to 60 years (Malekzadeh et al., 2014). 3) Their body mass index (BMI) was between 25 and 29.9 kg/m2 (Zheng & Chen, 2015). 4) Knee discomfort has been present for at least three months previous to the trial. They were eliminated from the trial if they met any of These circumstances:1) Patients with a history of cardiac disorder with pacemakers. 2) They underwent orthopedic knee operation. 3) They had diabetes, nutritional disorders, neuromuscular and other musculoskeletal diseases, or positive neurological signs. 4) Any red signs for dry needling or traditional therapy. 5) Undergone physical rehabilitation, massage treatment, chiropractic, acupuncture, or injections into the joints for the annoying knee in the previous three months. (Onigbinde et al., 2023). Before taking part in either group, patients who satisfied the inclusion criteria were given comprehensive information about the goals and methods of the study and were provided with an informed consent form to sign.

### Randomization

Sixty participants were divided into three equal groups, identified as Groups A, B, and C. A neutral person who was not involved in participant recruitment or treatment carried out this allocation procedure, Using a random generator. Another independent researcher utilized a computer-generated list to establish the random allocation sequence, which was subsequently sealed in opaque envelopes to maintain allocation concealment. Before the first session, the envelopes of all eligible participants were opened. Throughout the study, there were no participant dropouts after randomization (Figure 1).

**Figure 1. Flow chart of the study participants**




The patients were randomly allocated into three equivalent divisions, with 20 per group. Group A (Control) received conventional physical therapy, including Transcutaneous Electrical Nerve Stimulation (TENS), stretching, strengthening, balance, and stability exercises. Group B (Study) received the same conventional physical therapy as Group A plus Electrical Dry Needling, and Group C (Study) received the same conventional physical therapy as Group A plus Glucosamine Sulfate Iontophoresis. Pain intensity was measured by Visual Analog Scale (VAS), knee functional level was measured by Arabic version of the Knee Injury and Osteoarthritis Outcome Score (KOOS), and knee Range of Motion was measured by Digital Goniometer.

**Measurement Procedures**

**1) Weight and Height scale**

A weight and height scale (model no. GRZ-200, China) was used for measuring body weight (kg) and height (m) for all the subjects to calculate body mass index (BMI) before starting the study

**2)Visual Analogue Scale (VAS):**

It was used to determine pain intensity level; it uses a linear scale (usually 10 cm or 100 mm) where the endpoints represent extreme values (e.g., “no pain” to “worst pain imaginable”). The patient was told to represent how much pain they were experiencing through a 10-cm line with two extremes. On the line, the patient indicated the point that best reflected their current condition (Billesberger et al., 2020).

**3) Knee injury and Osteoarthritis Outcome Score (KOOS) (Arabic version).**

The Arabic KOOS is used to assess the functional ability of knee joints. Following an explanation of the questionnaire's subscales, the patient was asked to complete the subscale physical function, which had nine items on pain, seven on symptoms, seventeen on activities of daily living, five on sport and recreation, and four on knee-related quality of life. Each of the five scores, which ranged from 0 to 4, was determined by adding up all of the things. As is typical with orthopedic scales, the scores were then transformed into a 0–100 scale, where zero represented severe knee issues and 100 represented no knee issues. Scores ranging from 0 to 100 indicate the percentage of the maximum score that was attained. (Torad et al., 2015).

**4) Digital Goniometer**

Active knee ROM was assessed using a Digital Absolute Axis Goniometer (Baseline Evaluation, USA), measured in degrees, which is a valid and reliable tool for determining knee joint angles. The patient was positioned supine with knees extended and hips in a neutral position, and bony landmarks were marked to ensure measurement consistency. The goniometer axis was centered over the outermost femoral epicondyle, the close arm along the femur toward the greater trochanter, and the rear arm along the fibula toward the outer malleolus. The patient actively performed maximal knee flexion and extension, with a roll placed under the ankle to allow full extension. Three measurements were recorded and their average was used for analysis (Casaña et al., 2021).

**Treatment procedure:**

The same therapist conducted all of the therapy sessions. Group A (control group) underwent conventional physical treatment, including Transcutaneous Electrical Nerve Stimulation (TENS) and an exercise therapy program (stretching, hip and knee strengthening, and balance-stability exercises) (Mohamed & Alatawi, 2022). Group B (study group) received conventional therapy as group A plus electrical dry needling. Group C (study group) received conventional therapy as group A plus glucosamine sulfate iontophoresis. Patients in all groups underwent the treatment protocol twice a week for six weeks.

**1-Conventional Physical Therapy**

**Transcutaneous Electrical Nerve Stimulation (TENS)**

ASTAR, located in Poland, a member of the European Union, manufactures the PhysioGo 100A, a fully two-channel electrotherapy device. TENS settings included symmetrical biphasic waveforms with an 80 ms pulse width and a frequency between 32 and 50 Hz. Surface electrodes were placed on the patella's medial and lateral superior edges, as well as the medial and lateral inferior sides. To cover the huge surface area, the electrode pairs maintained their cross. The device's intensity was adjusted for 20 minutes until patients experienced a comfortable tingling feeling.

**Exercise Therapy**

**A-Stretching exercises:**

- Stretching Hamstring Muscle:

The patients lay in a supine position and used a belt to stabilize the opposite femur and pelvis and low back for stretching procedures while keeping the knee extended with one hand of the therapist and raising the stretched side with the other hand, then holding for 30 sec and relaxing for 30 seconds. It was performed four times.

-Stretching Calf Muscle:

The knee was stabilized by one hand of the therapist in extension, and the other hand moved the foot in dorsiflexion, holding the position for 30 sec then relaxing for 30 seconds. It was performed four times.

**B- Strengthening exercises:**

-Static Quadriceps exercise

The patient was placed supine with a pillow beneath the patient’s knee then asked the patient to tense the thigh muscles to their full potential for straightening the knee and hold its contraction for five seconds, while one hand of the therapist stabilized the patient, s pelvis and the other hand stabilized the ankle. completing one set of ten repetitions.

-Straight leg raises

The patient lay on supine with affected knee completely outspread and the opposite knee is bent 90 degrees. Then was asked to lift the straight leg and hold for three seconds against the therapist's hand and the other hand stabilized the pelvic before getting back to the initial position. Completing 1 set of 10 repetitions.

-Hamstring set

The patient lay on supine and both knees flexed to 90 degrees, then was instructed to contract the hamstring by pressing the heels into the bed and holding for 5 seconds. Muscle contraction palpated by hand and prevented pelvic elevation. Getting through 1 set of 10 repetitions.

-Bridging

The patient was laid in a supine position with legs flexed and raised the hips off the bed for 3 seconds, completing 1 set of 10 repetitions. The proximal hand of the therapist was put on the patient's greater trochanters or hips to ensure the pelvis remained level and did not rotate or tilt unevenly; the other hand supported the patient's affected knee, guiding the movement.

-Side-lying hip abduction straight leg raise

The patient lay on side lying position with the treated upper knee completely extended and the lower knee bent 90 degrees. Then was asked to raise the straight leg and hold for 3 seconds against the therapist's hand resistance before getting back to the initial position; the other hand on the patient's top iliac crest (hip bone) stabilized the pelvis and ensured proper alignment. Getting through 1 set of 10 repetitions.

-Heel rise

The patient stood with both hands on a chair for stability, gently elevated his heels off the ground, held for 3 seconds, and afterwards slowly returned to the initial position for one set of ten repetitions. A therapist placed a hand on the pelvis or shoulders to ensure that the patient moved straight up to the ceiling rather than bending forward.

**C-Balance and Stability exercise**

-Stability ball leg curl

Curling a ball toward your glutes while using a (half ball) is an effective, advanced exercise that targets the hamstrings, glutes, and core stability. The patient was laid on supine with the knees and heels flexed on the half ball's dome (heels on the flat or dome side) and curled the ball toward the glutes while elevating the hips off the bed, holding a bridge for 30 seconds. A therapist placed a hand on the patient's hips or pelvis to keep elevated and steady in a "bridge" position during the movement. This keeps the hips from drooping or turning while completing one set of ten repetitions.

-Ball kicking exercise

The patient kicked the ball up against the wall while sitting on a chair for five minutes and asked the patient to have a 30-second rest every minute, as well as a 30-second rest in between each set. A therapist placed a hand on pelvis to stabilize, ensuring the movement came from the knee/leg and not by shifting the spine, which is common as the patient fatigues.

**2- Electrical Dry Needling**

The Hwato brand, Suzhou Medical Appliance Factory, China, was utilized in three different sizes: 0.30 mm x 40 mm, 0.25 mm x 30 mm, and 0.30 mm x 50 mm. Over a 6-week period, the intervention consisted of 8 to 10 sessions held once or twice a week. Disposable sterilized stainless steel. Deepness of needle's entry ranges from 15 mm to 45 mm, contingent upon the anatomical location (periosteal, intramuscular, joint line, or intra/periarticular) and the individual's physique (bone depth, size, and muscle or connective tissue density) (Sun et al., 2025). The treated knee was gently bent on a towel roll while the patient lay supine. Nine needles were integrated: insertion within the tibialis anterior at right angles, lateral to the tibial tuberosity one fingerbreadth; the depression posterosuperior to the femoral epicondyle insertion within the distal adductor magnus; insertion within the popliteus, over the posteromedial aspect of the innermost tibial condyle; insertion within the quadriceps tendon, one fingerbreadth proximal to the superior border of the patella at right angles; insertion at right angle in the vastus lateralis, three fingerbreadths from the patella's superolateral border; in the vastus medialis, three fingerbreadths from the patella's superomedial border; in the medial and lateral infrapatellar sulcus; and in the extensor digitorum longus, one thumb width from the fibula head. To ensure consistency, the last ninth needle remained in place throughout the therapy, while the first eight needles were electrically linked in pairs (Dunning, Butts and Young, et al., 2018). After cleaning the skin topically with sterile alcohol prep pads, each needle was inserted and moved in both directions to create a feeling of warmth, tingling, deep pressure, aching, or heaviness. After that, the needles were left in place for 20 to 30 minutes while four channels in pairs (crossing through the knee joint) connected by electric stimulation (EV-906, Everyway Medical Instruments, Taiwan) to eight of the needles with a biphasic continuous waveform at the maximum intensity that could be endured, a low frequency (2 Hz), and a moderate pulse width (250 microseconds) (Dunning, Butts and Henry, et al., 2018).

**3- Iontophoresis.**

PhysioGo 100A (fully two-channel electrotherapy device was used) is produced by ASTAR in Poland, which is in the European Union, Galvanic current was employed to transport the cream through the skin. One gram (2 finger-tip units (FTU)) of GS cream (glucosamine 8% w/w), (Urah) was set on the active electrode (being positively charged using Trans-articular electrode placement) for administering iontophoresis [40 mA per minute (2 mA per 20 minutes)]. The active electrode was set on the knee side, where the individuals felt the most discomfort. The skin regions were washed with methylated spirit (70% alcohol), and electrodes were affixed to reduce the danger of burns. The electrodes were soaked in 3ml of tap water before being applied and kept in place using adhesive straps. Interventions occurred twice weekly for six weeks (Onigbinde et al., 2018).

**Statistical Analysis:**

It was performed using SPSS version 28. Data normality was verified via the Shapiro-Wilk test. Descriptive statistics (mean, standard deviation, and percentages) were calculated for all variables. Pearson Chi-Square assessed the distribution of gender and affected side. For group comparisons, One-way ANOVA (with Bonferroni post-hoc) was applied for normally distributed data, while the Kruskal-Wallis H test (with Mann-Whitney U post-hoc) was used for non-parametric data. Within-group changes (pre- vs. post-treatment) were evaluated using the Paired-samples t-test. The significance level was set at $P<0.05$.

**Results:**

**Demographic characteristics of patients in all groups: Comparison of baseline weight and height characteristics among the groups using one-way ANOVA, baseline age and BMI characteristics among the groups using Kruskal-Wallis H test:**

As presented in table (1), the one-way ANOVA of the baseline physical characteristics of the participants indicated that there were no statistically significant differences between the groups at the start of the study regarding weight and height where $p >0.05$ respectively. The statistical analysis confirmed that there were no significant differences between the groups regarding age and BMI ($p >0.05$).

**Table (1): Comparison between groups concerning the characteristics of the patients**

| BMI (kg/Cm2) | | Weight (kg) | Height (cm) | Age (years) | | |
|---|---|---|---|---|---|---|
| **Mean Rank** | **Median** | $\bar{x} \pm SD$ | $\bar{x} \pm SD$ | **Mean Rank** | **Median** | |
| 30.18 | 28.3 | 80.15 ± 6.95 | 168.5 ± 8.46 | 33.88 | 55 | Group A |
| 27.75 | 28.04 | 79.16 ± 8.91 | 168.08 ± 11.43 | 27.63 | 52 | Group B |
| 33.58 | 28.61 | 81.64 ± 5.96 | 169.95 ± 7.13 | 30 | 53.5 | Group C |
| 1.12 | | | | 1.31 | | H-Value |
| | | 0.575 | 0.228 | | | F-Value |
| 0.57 | | 0.566 | 0.797 | 0.52 | | P-Value |
| NS | | NS | NS | NS | | Sig |

$\bar{x}$: Mean; SD: Standard Deviation; f-value: one-way ANOVA test; H-value: Kruskal-Wallis H test
Kg: Kilogram; Cm: Centimetre; P-Value: Probability value; NS: Non-significant

**2.Comparison between groups concerning pretreatment data:**

**I. Comparison of pretreatment flexion, visual analogue scale, total score, pain, function in daily living, and function in sport among groups using one-way ANOVA:**

As presented in table (2), one-way ANOVA tests revealed no statistically significant difference between groups regarding pretreatment (Flexion), VAS, and functional indices where p >0.05.

**Table (2): Comparison of baseline clinical parameters and functional scores among the groups**

| P Value | F Value | Maximum | Minimum | Mean ± SD | Group | Variable |
|---|---|---|---|---|---|---|
| 0.96 $^{NS}$ | 0.04 | 134 | 90 | 111.85 ± 13.19 | **A** | **Flexion** |
| | | 136 | 95 | 112.85 ± 10.56 | **B** | |
| | | 134 | 90 | 111.85 ± 13.19 | **C** | |
| 0.48 $^{NS}$ | 0.74 | 8 | 5 | 6.77 ± 0 .87 | **A** | **Visual Analogue Scale** |
| | | 8.5 | 5.3 | 6.47 ± 0.79 | **B** | |
| | | 7.8 | 5 | 6.55 ± 0.797 | **C** | |
| 0.69 $^{NS}$ | 0.37 | 65 | 40 | 50.55 ± 7.08 | **A** | **Total Score** |
| | | 63 | 38 | 51.45 ± 6.37 | **B** | |
| | | 62 | 43 | 52.3 ± 5.79 | **C** | |
| 0.42 $^{NS}$ | 0.89 | 64 | 39 | 48.9 ± 7.06 | **A** | **Pain** |
| | | 60 | 40 | 48.85 ± 5.46 | **B** | |
| | | 64 | 19 | 46 ± 10.3 | **C** | |
| 0.89 $^{NS}$ | 0.11 | 45 | 26 | 33.2 ± 5.07 | **A** | **Function in Daily Living** |
| | | 38 | 24 | 33.3 ± 3.79 | **B** | |
| | | 45 | 18 | 32.6 ± 6.25 | **C** | |
| 0.72 $^{NS}$ | 0.33 | 73 | 24 | 47 ± 10.11 | **A** | **Function in Sport** |
| | | 71 | 33 | 49.05 ± 8.04 | **B** | |
| | | 57 | 36 | 48.4 ± 5.51 | **C** | |

S: Significant, P-Value: Probability value,
F-Value: One-way ANOVA test, NS: Non-Significant, SD: Standard Deviation

**II. Comparison of pretreatment extension, stiffness, and quality of life using Kruskal-Wallis H test:**

The Kruskal-Wallis H test results demonstrate absence of statistically significant differences between groups regarding their baseline extension, stiffness, and quality of life profiles as presented in table (3) where (p > 0.05).

**Table (3): Comparison of baseline extension, stiffness, and quality of life among the three study groups**

| P valu | H value | Mean Rank | Median | Group | Variable |
|---|---|---|---|---|---|
| 0.71 $^{N}$ | 0.68 | 32.85 | 6 | A | **Extension** |
| | | 28.58 | 5 | B | |
| | | 30.08 | 5 | C | |
| 0.41 $^{N}$ | 1.81 | 34.78 | 50 | A | **Stiffness** |
| | | 28.55 | 46.5 | B | |
| | | 28.18 | 46 | C | |
| 0.65 $^{N}$ | 0.86 | 27.55 | 42 | A | **Quality of life** |
| | | 31.78 | 43 | B | |
| | | 32.18 | 43 | C | |

S: Significant, NS: Non-Significant, P-Value: Probability value, H-Value: Kruskal-Wallis H test

**3- Within groups comparison between pretreatment data and post-treatment data:**

As presented in Table (4), paired t-tests and Wilcoxon Signed-Rank tests revealed significant intra-group improvements in all measured variables ($p < 0.05$). Group A showed significant differences between pre- and post-treatment data. Group B demonstrated highly significant improvements across all outcomes ($p < 0.001$). Similarly, Group C showed significant pre- to post-treatment differences

**Table (4): Each group's pre-and post-treatment comparison and post-hoc analysis of post-treatment data:**

| Group C Study (n = 20) | Group B Study (n = 20) | Group A Control (n = 20) | Items | Variables |
|---|---|---|---|---|
| 6.55 ± 0.79 | 6.47 ± 0.79 | 6.78 ± 0.87 | Pre | VAS (score) |
| 3.725 ± 0.51 | 0.69 ± 0.18 | 5.25 ± 0.97 | Post | |
| ↓43.1% | ↓89.3% | ↓22.6% | % of change | |
| 13.57 | 32.09 | 9.38 | T-value | |
| 0.000$^{S}$ | 0.000$^{S}$ | 0.000$^{S}$ | P-Value | |
| 46.4 ± 8.04 | 47.25 ± 9.36 | 48.85 ± 7.56 | Pre | KOOS Stiffness (score) |
| 67.6 ± 11.18 | 76.4 ± 10.22 | 56.8 ± 7.39 | Post | |
| ↑45.7% | ↑61.75% | ↑16.3% | % of change | |
| T (-9.01) | Z (-3.93) | T (-6.78) | Value | |
| 0.000$^{S}$ | 0.000$^{S}$ | 0.000$^{S}$ | P-Value | |
| 46 ± 10.3 | 48.85± 5.46 | 48.9 ± 7.06 | Pre | KOOS Pain(score) |
| 62.6 ± 9.26 | 79.95 ± 10.35 | 56.15 ± 7.23 | Post | |
| ↑36.1% | ↑63.7% | ↑14.8% | % of change | |
| -5.69 | -14.92 | -4.39 | T-value | |
| 0.000$^{S}$ | 0.000$^{S}$ | 0.000$^{S}$ | P-Value | |
| 32.6 ± 6.25 | 33.3 ± 3.79 | 33.2 ± 5.07 | Pre | KOOS Function in daily living (score) |
| 52.8 ± 7.11 | 63.65 ± 8.27 | 40 ± 5.27 | Post | |
| ↑62% | ↑91.1% | ↑20.5% | % of change | |
| -10.55 | -18.05 | -7.74 | T-value | |
| 0.000$^{S}$ | 0.000$^{S}$ | 0.000$^{S}$ | P-Value | |
| 44.6 ± 5.82 | 44.9 ± 7.69 | 43.35 ± 8.32 | Pre | KOOS Quality of life (score) |
| 73.2 ± 8.69 | 85 ± 12.34 | 59.05 ± 10.09 | Post | |
| ↑64.1% | ↑89.3% | ↑36.2% | % of change | |
| T (-11.35) | Z (-3.92) | T (-7.61) | Value | |
| 0.000$^{S}$ | 0.000$^{S}$ | 0.000$^{S}$ | | |
| 48.4 ± 5.51 | 49.05 ± 8.04 | 47 ± 10.11 | Pre | KOOS Function in Sport (score) |
| 65.2 ± 7.63 | 80 ± 11.65 | 55.9 ± 9.75 | Post | |
| ↑34.7% | ↑63.1% | ↑18.9% | % of change | |
| -7.12 | -9.39 | -3.26 | T-value | |
| 0.000$^{S}$ | 0.000$^{S}$ | 0.004$^{S}$ | P-Value | |
| 52.3 ± 5.79 | 51.45 ± 6.37 | 50.55 ± 7.08 | Pre | KOOS total(score) |
| 64.6 ± 8.15 | 77.2 ± 10.04 | 59.7 ± 7.95 | Post | |
| ↑23.5% | ↑50% | ↑18.1% | % of change | |
| -5.49 | -12.13 | -9.93 | T-value | |
| 0.000$^{S}$ | 0.000$^{S}$ | 0.000$^{S}$ | P-Value | |
| 111.85 ± 13.19 | 112.85 ± 10.56 | 111.85 ± 13.19 | Pre | Knee flexion ROM |

| | | | | |
|---|---|---|---|---|
| 127.4 ± 14.24 | 138.65 ± 4.97 | 119.4 ± 15.87 | Post | |
| ↑13.9% | ↑22.9% | ↑6.8% | % of change | |
| T (-3.68) | Z (-3.92) | T (-4.58) | Value | |
| $0.002^{S}$ | $0.000^{S}$ | $0.000^{S}$ | P-Value | |
| 5.25 ± 1.48 | 5.2 ± 1.47 | 5.7 ± 2.11 | Pre | Knee extension ROM |
| 2.6 ± 1.14 | 1.6 ± 1.23 | 3.7 ± 1.66 | Post | |
| ↓ 50.5% | ↓ 69.2% | ↓ 35.1% | % of change | |
| -3.95 | -3.97 | -3.44 | Z Value | |
| $0.000^{S}$ | $0.000^{S}$ | $0.001^{S}$ | P-Value | |

Data were presented mean ± standard deviation (SD); * Significant; 1: significantly different from group A; 2: significantly different from group B; 3: significantly different from group C , P-value: Probability value; T-Value: paired-samples t-test; Z-Value: Wilcoxon Signed-Rank test; S: Significant; NS: Non-significant

**4. Comparison between groups concerning post-treatment data (post-hoc analysis of post-treatment data):**

The post-intervention analysis showed significant differences between groups in total score, stiffness, pain, daily function, quality of life, ROM (flexion and extension), VAS, and sport function ($p<0.05$). As presented in table (5), post-hoc tests indicated that group B was significantly superior to both groups A and C in all outcomes. Group C was significantly better than group A in stiffness, daily and sport function, quality of life, and extension. No significant differences were found between groups A and C in total score, pain, and flexion.

**Table (5): Pairwise post-hoc comparisons of post-treatment outcomes among groups:**

| Group C Study (n = 20) | | Group B Study (n = 20) | | Group A Control (n = 20) | | Items | Variables |
|---|---|---|---|---|---|---|---|
| B | A | C | A | C | B | | VAS (score) |
| 0.000 | 0.000 | 0.000 | 0.000 | 25.5 | 0.000 | U value | |
| $0.000^{3}$ | $0.000^{1}$ | $0.000^{3}$ | $0.000^{1}$ | $0.000^{1}$ | $0.000^{1}$ | P-value | |
| -8.8 | 10.8 | 8.8 | 19.6 | -10.8 | -19.6 | MD | KOOS Stiffness (score) |
| $0.018^{1}$ | $0.003^{1}$ | $0.018^{3}$ | $0.000^{1}$ | $0.003^{1}$ | $0.000^{1}$ | P-value | |
| -17.35 | 6.45 | 17.35 | 23.8 | -6.45 | -23.8 | MD | KOOS Pain(score) |
| 0.0001 | 0.084NS | 0.0001 | $0.000^{1}$ | $0.084^{NS}$ | $0.000^{1}$ | p-value | |
| -10.85 | 12.8 | 10.85 | 23.65 | -12.8 | -23.65 | MD | KOOS Function in daily living (score) |
| $0.000^{3}$ | $0.000^{1}$ | $0.000^{3}$ | $0.000^{1}$ | $0.000^{1}$ | $0.000^{1}$ | p-value | |
| -11.8 | 14.15 | 11.8 | 25.95 | -14.15 | -25.95 | U value | KOOS Quality of life (score) |
| $0.002^{3}$ | $0.000^{1}$ | $0.002^{3}$ | $0.000^{1}$ | $0.000^{1}$ | $0.000^{1}$ | p-value | |
| 55.5 | 81.5 | 55.5 | 19 | 81.5 | 19 | U value | KOOS Function in Sport (score) |
| $0.000^{3}$ | $0.001^{1}$ | $0.000^{3}$ | $0.000^{1}$ | $0.001^{1}$ | $0.000^{1}$ | p-value | |
| -12.6 | 4.9 | 12.6 | 17.5 | -4.9 | -17.5 | MD | KOOS total(score) |
| $0.000^{3}$ | $0.247^{NS}$ | $0.000^{3}$ | $0.000^{1}$ | $0.247^{NS}$ | $0.000^{1}$ | p-value | |
| 108.5 | 141.5 | 108.5 | 57.5 | 141.5 | 57.5 | U value | Knee flexion ROM |
| $0.013^{3}$ | $0.113^{NS}$ | $0.013^{3}$ | $0.000^{1}$ | $0.113^{NS}$ | $0.000^{1}$ | p-value | |
| 94.5 | 112 | 94.5 | 57.5 | 112 | 57.5 | U value | Knee extension ROM |
| $0.003^{3}$ | $0.012^{1}$ | $0.003^{3}$ | $0.000^{1}$ | $0.012^{1}$ | $0.000^{1}$ | p-value | |

P-value: Probability value; U-Value: Mann-Whitney U test; MD: Mean Difference; S: Significant; NS: Non-significant

## DISCUSSION

This study was conducted to compare the effect of electrical dry needling versus glucosamine sulfate Iontophoresis on pain intensity level, knee function abilities and knee ROM in chronic unilateral knee OA patients. Understanding which modality yields superior effects can guide physical therapists in customizing interventions to enhance patient recovery and reduce pain associated with knee OA condition. Such research can enhance the accuracy of physical rehabilitation treatments, eventually leading to better patients' outcomes and quality of life.

The findings of current study revealed that: Regarding VAS: - Group B significantly outperformed both group A and group C ($p<0.001$). Regarding KOOS: - Group B achieved a statistically significant superiority over both Groups A and C across total score of KOOS, (stiffness, pain, function in daily living, and quality of life outcome) ($p= 0.018$ or less), function in sport ($p<0.001$). In addition, group C demonstrated a clear advantage over group A in terms of (stiffness, function in daily living, and quality of life) ($p<0.05$). Furthermore, group C demonstrated significantly better functional sport scores than group A ($p = 0.001$). Finally, the comparison between group A and group C for total score of KOOS ($p = 0.247$) and pain ($p = 0.084$) revealed no statistically significant difference. Regarding knee ROM: - (flexion and extension), group B demonstrated a statistically superior ROM compared to group A ($p<0.001$) and group C (flexion: $p = 0.013$; extension: $p = 0.003$). While group C showed a significant improvement in extension over group A ($p = 0.012$), no statistically significant difference was observed between groups A and C regarding flexion ($p = 0.113$).

Electrical dry needling showed the most pronounced improvements in pain reduction, stiffness, functional activities of daily living, range of motion, and sports-related function, the results of this study came in accordance with Siddiqua et al.(2024), who demonstrated the positive clinical effects of Periosteal EDN among patients with knee OA, and revealed that conventional therapy with periosteal electric dry needling was beneficial in reducing pain, and enhanced range of motion may be attributed to both peripheral neuromuscular mechanisms and central pain modulation. That activates A-delta fibers and modulates nociceptive input at the spinal cord level, resulting in segmental pain inhibition via the gate control mechanism. Moreover, EDN stimulates the release of endogenous opioids (β-endorphins and enkephalins), serotonin, and norepinephrine, contributing to both immediate and sustained analgesic effects

The results of the current study were in agreement with Kaye et al.(2025), systematic review showed that periosteal electrical dry needling significantly improves pain and mobility in knee OA in the short term, described by dry needling's mechanical and neurophysiological effects on myofascial trigger points, including localized muscle relaxation, enhanced joint mobility, modification of pain pathways, and decreased central sensitization, and the results were also in accordance with numerous research Ma et al. (2023), Vervullens et al. (2021), Farazdaghi et al. (2021), demonstrating superiority over control or standard therapy in terms of range of motion (ROM), disability, and pain intensity for patients with mild to moderate knee osteoarthritis. explained how trigger points can exacerbate the degenerative process of the knee joint by causing abnormal cartilage load through muscle weakness or tightness. Dry needling can reduce resistance by releasing the contracture nodule at the trigger points.

In agreement with Agost-González et al. (2025), recent trials reported that combining dry needling with exercise produces greater improvements in pain, function, stiffness, strength, and kinesiophobia at 6-month follow-up compared with exercise alone in patients with knee OA, suggesting a role for electrical dry needling (EDN) in long-term functional improvement. These effects may be attributed to the mechanical and neurophysiological mechanisms of dry needling, including modulation of pain pathways, reduction of central sensitization, and improvement of local muscle function. Similarly, Dunning et al. (2018) found that EDN combined with manual therapy and exercise significantly improved pain and function compared with manual therapy and exercise alone, potentially through reducing inflammatory mediators such as interleukin-6 and inhibiting osteoclast activity associated with cartilage degeneration.

Due to variations in methodology, treatment protocols, and small sample sizes, a systematic review by Ughreja and Prem. (2021), found conflicting evidence about the immediate and long-term effects of dry needling in knee OA, underscoring the need for larger RCTs. Similar to this, Jiménez-del-Barrio et al. (2022), discovered extremely low-quality evidence that suggested dry needling in hip and knee OA could improve pain and physical function in the short term, though bias, heterogeneity, and imprecise data limited the conclusions' strength.

When compared to the control group, iontophoresis demonstrated modest but significant improvements in stiffness, knee extension range of motion, activities of daily living, quality of life, and sports function. Its capacity to improve transdermal medication delivery by raising the stratum corneum's permeability may be connected to these effects. In this study, glucosamine sulfate, a slow-acting medication for osteoarthritis symptoms that may enhance cartilage metabolism and lower inflammatory mediators, was administered via iontophoresis.

The results of this study came in accordance with Habib et al. (2025). That studies the effectiveness of iontophoresis of glucosamine sulphate and menthol in people with knee arthritis. The study's findings revealed that after twelve weeks of therapy, those with knee OA who received Glucosamine Sulfate Iontophoresis (GS IoT) had significantly fewer degenerative changes at their knee joints than patients who got Glucosamine Sulfate Conventional Formulation/Administration (GS CFM).On the other hand, the intensity of the pain significantly decreased on VAS of pain and WOMAC scaling of pain, stiffness and difficulty performing daily activities.

The results of this study about glucosamine sulfate iontophoresis were agreement with Onigbinde et al. (2009), they demonstrated that glucosamine administration using iontophoresis was more effective in relieving pain in knee osteoarthritic individuals than transdermal massage. This agreement may be explained by the enhanced transdermal drug delivery achieved through iontophoresis, which uses a low-intensity direct electrical current to actively drive ionized glucosamine molecules across the skin barrier and into deeper periarticular tissues.

Although Wandel et al. (2010), found that glucosamine, chondroitin, and their combination produced no clinically significant benefits in pain or joint space narrowing when compared to placebo. More recent studies, notably the work of Ogata et al. (2018), have also showed relatively little or non-significant differences in pain and functional results compared to control groups. Rabade et al. (2024) reported that glucosamine sulfate did not significantly affect pain or physical function in knee OA, while Vo et al. (2023) similarly noted insufficient effects on key clinical outcomes, and Sumsuzzman et al. (2024), observed that most glucosamine interventions did not reach clinically meaningful thresholds for pain reduction. These discrepancies could be attributed to differences in glucosamine formulations (sulfate vs hydrochloride), dosing regimens, therapy length, and patient disease severity may all contribute to variation in outcomes between trials.

Recent evidence strongly supports exercise therapy as a first-line nonpharmacological treatment for knee OA. A systematic review and network meta-analysis by Mo et al. (2023), reported that structured exercise programs significantly improve pain, stiffness, and functional outcomes by addressing key mechanisms such as muscle weakness, impaired proprioception, altered joint biomechanics, and reduced neuromuscular control. Similarly, the OARSI guidelines reported by Bannuru et al. (2019), recommend exercise therapy including strengthening, stretching, and functional training to reduce pain and improve physical function through enhanced muscle strength and joint stability. While TENS alone may have limited long-term effects, it is widely supported as a complementary modality to exercise therapy.

However, no statistically significant differences were observed between the iontophoresis and control groups regarding pain intensity and KOOS total score. This may be explained by the slow-acting nature of glucosamine sulfate, which typically requires prolonged use to achieve maximal analgesic and structural effects. This study also has limitations, including the focus on patients with moderate chronic unilateral knee OA, which may limit generalizability, and the evaluation of only short-term effects of electrical dry needling and glucosamine sulfate iontophoresis without assessing long-term outcomes or individual treatment responses.

## CONCLUSION

Based on the scope and findings of this study, it can be concluded that Electrical dry needling with conventional physical therapy produced superior improvements in pain relief, functional capacity, quality of life, and joint mobility compared to iontophoresis combined with conventional physical therapy.

**Conflict of interest**

The authors state that there is no conflict of interest concerning the publication of this paper.

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