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Original research

Interferential Current Therapy versus Kinesio Taping in Treatment of Knee Osteoarthritis: A Randomized Control Trial.

***Nourhan Elsaid Ahmed*[1]*, *Salwa Fadl*[2], *Marihan Zakaria Aziz*[3].**

[1]*Physiotherapist, Department of Physical Therapy ,Al-Husseinia Hospital, Sharqia Governorate, Ministry of Health.*
[2]*PhD, Professor, Department of Physical Therapy for Musculoskeletal Disorders and its Surgeries, Faculty of Physical Therapy, Cairo University, Giza, Egypt.*
[3]*PhD, Lecturer, Department of Physical Therapy for Musculoskeletal Disorders and its Surgeries, Faculty of Physical Therapy, Cairo University, Giza, Egypt.*

***Correspondence to:**
Nourhan Elsaid Ahmed;
Physiotherapist, Department of Physical Therapy ,Al-Husseinia Hospital, Sharqia Governorate, Ministry of Health.
.

Email:
nourhanelsaid1993@gmail.com

Telephone:
+201014272988

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Abstract

Background: Knee osteoarthritis (KOA) is a frequent degenerative joint disease, causing pain and functional disability. Kinesio taping (KT) and interferential current (IFC) are effective in managing symptoms; however, comparative evidence of their combined effect with exercise remains limited. **Purpose:** to evaluate the adding effects of KT versus IFC to exercise on knee pain, range of motion (ROM), quadriceps muscle strength, and functional mobility in patients with KOA. **Methods:** Sixty-three patients were diagnosed with mild to moderate KOA; their ages ranged from 40 to 65 years. They were randomly allocated into three equal groups: Group A received IFC therapy combined with an exercise and sham KT, Group B received KT combined with the same exercise and sham IFC, and control group C received the exercise with sham IFC and KT. Treatment lasted for four weeks in all groups. The visual analogue scale (VAS), the Western Ontario and McMaster Osteoarthritis Index (WOMAC), the universal goniometer, the hand-held dynamometer (HHD), and the timed up and go (TUG) test were used to measure knee pain, function, ROM, quadriceps muscle strength, and functional mobility. **Results**: After four weeks of treatment, all outcome measures demonstrated statistically significant differences (p-value < 0.05) in all groups except extension ROM. Quadriceps muscle strength had no significant differences between groups. **Conclusion:** the addition of IFC or KT to exercises can improve pain, function, quadriceps muscle strength, and ROM; but, adding IFC has more improvement in quadriceps strength in patients with KOA.

Keywords: Chronic knee osteoarthritis, Interferential current, Kinesio taping, Knee pain, Quadriceps muscle strength, Western Ontario and McMaster Osteoarthritis Index.

INTRODUCTION:

Knee osteoarthritis (KOA) is a prevalent degenerative joint disease affecting 15%-40% of adults over 40, affecting 86.7 million people globally in 2020 [1]. According to a study on the Egyptian population, the maximum prevalence of knee OA is 9.24%. Women are more likely to develop knee OA. Although it happens more bilaterally than unilaterally, the right side is most frequently affected [2]. It is the leading cause of pain and impairment in the elderly and has significant financial and health impacts [1,3-4].

The main symptoms of KOA include pain, functional disability, and a decrease in the patient's quality of life owing to its negative

impact on mood, sleep, and mobility [1]. Other common symptoms include muscle atrophy, joint deformities, stiffness, and edema [5]. Pain is the most common and debilitating symptom reported by patients with KOA [6].

The primary goals of KOA treatment include reducing pain and enhancing physical function [3]. Patients with KOA who receive physical therapy report fewer pain and functional impairment [7]. The treatment methods include manual therapy, electrotherapy, and therapeutic activities [5].

Exercise therapy is the cornerstone of conservative treatment. Its benefits may be strengthened when combined with adjunct modalities [7]. Exercise, including resistance and aerobic exercises, can assist patients with KOA in managing pain and functional impairments. Open and closed-chain training is particularly beneficial, for strengthening the quadriceps muscles [3]. Numerous strategies have been studied to encourage physical exercise to improve a person's functioning and minimize discomfort and impairment [4].

Interference current (IFC) is a simple, noninvasive electrotherapeutic approach used to alleviate pain [8]. The frequency of one signal generator is stable at 4000 Hz, while the other, known as a kilohertz-frequency alternating current, fluctuates between 4000 and 4250 Hz [8, 9]. It can penetrate deeper tissue, lower skin resistance, and can serve as a supplement or substitute for pharmaceuticals to relieve pain [9,10]. Furthermore, it is the best pain management approach for KOA management [11]. It has advantages in both the short- and long-term benefits for knee pain and function [12,13].

Kinesio taping (KT), a therapeutic approach established in Japan in 1979, is used to treat and prevent various muscular-skeletal disorders and sports injuries [14-16]. The American College of Rheumatology recommends KT for treating KOA patients due to its cost-effectiveness, safety, and minimal side effects [14, 16-17]. It is a high-stretch elastic adhesive material made of cotton strips with an elastic woven and heat-sensitive acrylic adhesive [14,16]. After four weeks, the patient's pain can be reduced, reducing the need for pain medications [14,18].

Research shows that combining KT with physical therapy can significantly improve function and reduce pain in individuals with KOA [19], primarily by enhancing afferent feedback and activating cutaneous mechanoreceptors [6].

Despite their widespread use of IFC and KT, there is a lack of consensus in the literature regarding combined whether IFC or KT with exercise on clinical knee outcomes in KOA. Therefore, this study aims to compare the therapeutic effects of adding IFC and KT combined with exercise therapy on knee pain, function, ROM, functional mobility, and quadriceps muscle strength. This research finding is crucial for physiotherapists and clinicians to apply cost-effective, evidence-based protocols tailored to individual patient needs with KOA.

METHODS

Study setting and design:

This study was conducted at the outpatient clinics of Faculty of Physical Therapy, Cairo University, Egypt. Between December 2023 and March 2025 to compare the benefits of adding IFC versus KT in conjunction with an exercise program on knee pain, function, ROM, quadriceps muscle strength, and functional mobility in individuals with chronic KOA.

Patients

Sample Size

The F-test (MANOVA), a repeated measure between factors, was used to determine the sample size. It had an 80% power and 5% type I error. Using data from published research, the effect size (0.32) was computed from the primary outcome (WOMAC) [14]. To account for dropouts, the sample size was expanded by 15% from the minimum of 54. Sixty-three patients were the appropriate sample size. G* Power 3.1.9.2 (Franz Faul, Uni Kiel, Germany) was used for the computations.

Randomization and Blinding

Patients were randomized to one of the three groups. To assign individuals to groups, we utilized a basic randomized mechanism. A random number generator was utilized, which is found online at www.randomization.com .

By making sure they were unaware of the intervention carried out by the other group, all patients were blinded to group allocation. Members of each treatment group received the intervention sessions independently to keep the blinding.

Inclusion Criteria

Sixty-three male and female patients, aged 40 to 65 years, with body mass index (BMI) ranging from 20 to 32 kg/m², were diagnosed by orthopedic surgeons with unilateral KOA exhibiting clinical and radiological Kellgren and Lawrence's grades of mild to moderate chronic KOA [22,23]. Knee pain was most of the previous month along with at least three of the following: stiffness in the morning that lasts less than 30 minutes, crepitus with active joint motion, knee soreness and bony enlargement upon examination, and the absence of perceptible warmth [24].

Exclusion Criteria

Patients with prior KOA surgery, concurrent conditions like rheumatoid arthritis, cancer, osteoporosis, joint infection, severe deformity, autoimmune rheumatoid disease, polyarticular disease, arthroscopy within a year, wounds, ulcers, or KT allergy were excluded [22,23].

Assessment Procedures

Knee Pain

It was measured using VAS which has strong validity and reliability [25]. The patient was instructed to draw a horizontal mark on a continuous 10-cm line that represented the degree of his worst pain during the last 24 hours. The mark may be anywhere from zero, which denotes no pain or discomfort, to ten, which denotes the most severe pain [26].

Functional disability

The WOMAC index, which uses questions to assess three dimensions: pain, stiffness, and physical function, was used to determine the functional impairment. An ordinal scale of 0 to 4 is used to grade the Arabic version of the WOMAC; lower scores correspond to less physical disability or symptoms. A maximum score is calculated by adding up all the subscales. Additionally, there is an index score, also known as a global score, which is often determined by adding the results of the three subscales. It takes five to ten minutes to complete the self-administered quiz. The patient was instructed to answer the questions. On a scale of 0 to 4, the test questions are graded as follows: none (0), mild (1), moderate (2), severe (3), and extreme (4). With a possible score range of 0–20 for Pain, 0–8 for Stiffness, and 0-68 for Physical Function, the results for each subscale were added up. A total WOMAC score is typically obtained by adding the results from the three subscales; however, alternative techniques have been employed to aggregate scores. Worse pain, stiffness, and functional impairments are indicated by higher WOMAC ratings. With 0 representing the greatest and 96 representing the worst, the index is one of 96 potential points [27]. The Arabic WOMAC questionnaire is valid and reliable in assessing disability [28,29].

Knee range of motion

Each patient's active knee flexion and extension ROM were measured. The universal goniometer, which is valid and reliable for measuring knee ROM, was used to take measurements while the patient was lying supine on a bed with both legs supported [30,31]. The lateral femoral condyle, the lateral malleolus, and the greater trochanter were the bone markers that were found. The patient was kept in a supine position, and the flexion of the affected knee was measured at its maximum. To measure extension ROM, patients were positioned supine with one leg extended, ensuring the goniometer was placed consistently. Patients were asked to actively extend the affected knee at its maximum. The degree of knee extension was measured. A normal knee extension is zero degrees while hyperextension is recorded as a negative score. To get the average, three readings for each direction were obtained [30, 31].

Isometric quadriceps muscle strength

The patient was seated while the HHD (Lafayette Model 01165A) was used to test the isometric quadriceps muscular strength. When seated, the knee joint was positioned in a 90° flexion, the upper limbs were supporting the

trunk on the body side, and the toe of the lower limb on the non-measurement side touched the floor or table. To maintain and achieve the maximal isometric contractions, each measurement was carried out and held for five seconds. The patients were told orally by the researcher to give the exercise the maximum effort. Two measurements were conducted. The rest time between measurements was more than 30 seconds. The highest value obtained during measurement was recorded [32]. The HHD is a valid and highly reliable tool for estimating knee muscle strength. The reliability of HHD is (ICC 0.85–0.99) [32, 33, 35].

Functional mobility

The TUG test calculated the time it takes a patient to stand up from a chair, walk three meters, turn around, return to the chair, and sit down in seconds [36]. A practice trial was conducted, followed by two recorded trials, and the average of the two recorded trials was taken. The TUG test is valid and reliable for measuring functional mobility and is quick and easy for patients [37].

Treatment Procedures

Interferential Current therapy

It was applied in group A (IFC+EX). The device had a model (Multi Stim, LKL-2016 Series). The patient was in a supine lying position, the IFC was applied with a frequency of 50-60 Hz, and the intensity was increased gradually until the patient reported that a more rise would be discomfort for 20 minutes in each session for 12 sessions (3 sessions per week for four weeks) and the electrodes were applied on the knee region by using two channel, two electrode pads on either side of the affected knee joint with crossing electrodes. The IFC duration was 20 minutes in each session [8,38]. **(Figure 1).** Also, patients received sham KT that was performed using medical plaster. Medical plaster tape was placed on the affected knee in a non-therapeutic manner and without any tension **(Figure 2.B).**

Kinesio Taping

It was applied in group B (KT+EX). The patient was in a supine lying position with 30-degree hip flexion and 60-degree knee flexion, the edges of the tape had to be rounded off and the anchor point adhered properly to the skin, KT was stretched to 75% of the tape with no stretch on the anchor points, the strap was applied from distal to proximal. It was applied twice sessions a week for four weeks [18]. The application began around 10 cm inferior to the anterior superior iliac spine, applied from proximal to distal, split into two tails at the point where the patella and quadriceps femurs tendon meet, and concluded by rounding the patella without causing any strain. Second, another "Y" cut of tape was made, beginning at the patellar tendon and finishing at the patella's proximal edge [18] **(Figure 2.A).**

Figure 1: Application of the interferential current.

a b

Figure 2: Application of knee kinesio taping **A**:(KT application) **B**: (sham KT).

The researcher ensured that the skin was dry, free of open wounds, lacerations, oil or ointment, excessive hair, and Sweet-free. The KT was rubbing the whole length after application. Intensive activities should not be performed immediately after the application of tape (keep 20 minutes) [18]. For removal, apply oil or water before removal and the tape was removed from proximal to distal. Then, the skin was removed from the tape not the tape from the skin. Additionally, patients received sham IFC. Sham IFC was applied using two channels, two electrode pads on either side of the affected knee joint without crossing electrodes [39].

The Exercise Program

The exercise program was selected based on the current clinical guidelines for conservative treatment of KOA [7]**.** It included passive stretching of hamstrings and gastrocnemius muscles, strengthening of the quadriceps muscle, and aerobic exercise for treating chronic KOA. Treatment lasted for 40 minutes in every session. Firstly, stationary bicycling was used for 5 min as warming up as it is the most common form of aerobic land-based exercise. Then, the patients engaged in passive stretching of the gastrocnemius muscle for 2x45 sec, and passive stretching of the hamstring muscle in a supine position (like straight leg raise position) 2x45 sec. Strengthening exercise program of the lower limbs with resistance training with a load of 50% to 60% of the 1 RM, performing one set of 8–12 repetitions. The last two weeks progressed about 70% of 1RM and one set of 10 to 15 repetitions according to each patient. Strengthening exercise program included wall squat 0° to 45° of knee flexion, straight leg raising in the supine position, seated knee extension exercise and finally, short arc quadriceps extension. At the end of each session, patients were instructed to do the same exercises program at home in the other days**.**

Data Collection and Statistical Analysis

Measured outcome data were gathered and computed for three groups at baseline and four weeks after therapy. The Shapiro-Wilk test was used to verify that the data was normal. To check for group homogeneity, Levene's test for homogeneity of variances was used. There was homogeneity of variance and a normal distribution of the data. To compare the subject characteristics between groups, a one-way ANOVA test was used. The chi-squared test was used to compare the distribution of sexes. The effects of time (before versus post) and treatment (between groups) as well as the interaction between time and treatment on mean values of VAS, WOMAC, TUG test, quadriceps strength, and knee ROM were compared using mixed MANOVA. For every statistical test, the significance level was set at $p < 0.05$. The statistical software for social studies (SPSS) version 23 for Windows was used to conduct the statistical analysis.

RESULTS

Seventy-nine patients were recruited in this study. Only sixty-three patients were included recruited and allocated to the three treatment groups and the collected data were analyzed (**Figure 3).**

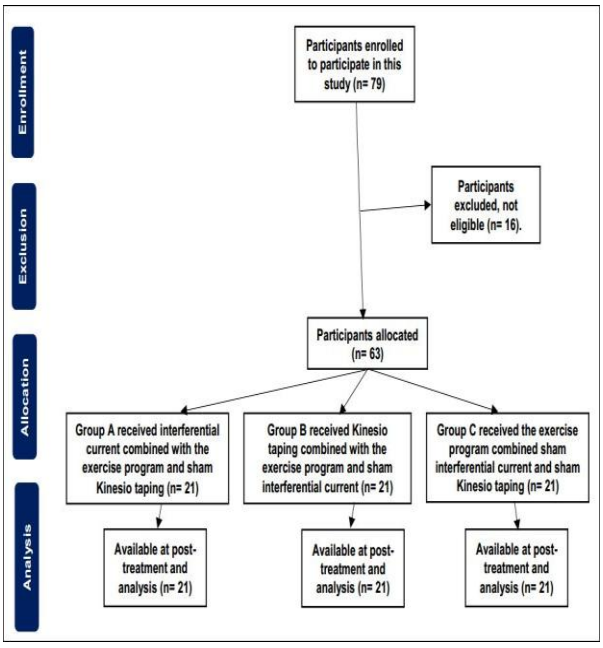

Figure 3: The study flow chart.

Demographic Characteristics: **Table (1)** showed the patients characteristics of three groups. There were no statistically significant differences regarding patient's general characteristics between both groups (p-value ≥ 0.05).

Table 1: Demographic Characteristics of Patients (N=63) *

	Group (A) (IFCT+EX)	Group (B) (KT+EX)	Control group (C) (EX)	p-value
	$\overline{X}$ ±SD	$\overline{X}$ ±SD	$\overline{X}$ ±SD	
Age (years)	51.38±7.98	49.29 ±8.28	51.86 ±8.44	0.56
BMI (kg/m²)	29.12±2.8	27.91±3.42	27.93±3.36	0.38
Gender, n (%)				
Male	4 (19%)	7 (33.33%)	5(23.8%)	0.56
Female	17(81%)	14 (66.67%)	16(76.2%)	χ2=1.17

BMI, body mass index; X2, Chi-Square; MD, Mean Difference; * Data are mean± SD for all demographics except gender (%), P-Value < 0.05 indicates statistical significance.

Mixed design multivariate analysis was conducted to investigate the effect of treatment on the measured variables. There was statistically significant difference between groups as Wilk's A = 0.34, F (12, 110) =6.52, P-value < 0.001, Partial Eta Squared (η2) = 0.42. Also, there was statistically significant effect on time (pre-post treatment) as Wilk's A = 0.07, F (6, 55) =122.09, p-value < 0.001, η2 = 0.93, as well as for the interaction between groups and time as Wilk's A= 0.28, F (12, 110) = 11.43, p-value < 0.001, η2 = 0.48.

Between-group comparison: Baseline and after four weeks of intervention

At baseline, there were no statistically significant differences between three groups in all measured variables (P-value ≥ 0.05) (Table 2). After eight weeks of intervention, there were statistically significant differences between three groups at all measured variables except knee extension with more favor to group A (IFC+EX) (P-value < 0.05) **(Tables 2,3).**

Within-groups comparison

There were statistically significant differences in all outcome measures when comparing the pre and post intervention results (p-value<0.05) in all groups except quadriceps strength in control group with more favor to group A (IFC=EX) **(Table 2).**

Table 2: Within and between group analysis of VAS, WOMAC, TUG test, quadriceps strength, knee ROM (N=63) *

Variables	Group (A) (IFCT+EX)	Group (B) (KT+EX)	Group (C) (EX)	p-value (between groups)	η^2
VAS (cm)					
Pre-treatment	6.81±0.87	7±0.84	6.95±0.86	0.76	
Post-treatment	3.19±1.17	4.38±0.92	5.52±1.21	0.001 *	**0.44**
p-value (within-group)	<0.001	<0.001	<0.001		
WOMAC (score)					
Pre-treatment	51.76±5.37	52.62±7.09	51.33±6.48	0.81	
Post-treatment	33.05±2.85	39.05±8.3	44.95±6.55	0.001 *	**0.38**
p-value (within-group)	<0.001	<0.001	<0.001		
TUG test (seconds)					
Pre-treatment	28.88±4.53	27.81±3.59	25.45±4.59	0.45	
Post-treatment	15.87±2.67	19.01±5.29	22.35±2.62	0.001	**0.34**
p-value (within-group)	<0.001	<0.001	0.03		
Quadriceps strength (kg)					
Pre-treatment	16.17±2.13	16.38±2.6	16.16±2.98	0.95	

Post-treatment	27.02±4.34	21.41±2.18	17.82±2.09	0.001	**0.62**
p-value (within-group)	<0.001	<0.001	0.06		
Knee flexion (degree)					
Pre-treatment	112.48±8.02	117.29±8.71	116.33±9.06	0.17	
Post-treatment	130.67±3.98	125.86±5.1	121.81±6.21	0.001	**0.34**
p-value (within-group)	**<0.001**	**<0.001**	**<0.001**		
Knee extension (degree)					
Pre-treatment	**4.43±1.07**	**4.48±1.03**	**4.67±1.06**	0.74	
Post-treatment	**3.33±0.8**	**3.67±0.75**	**3.95±0.8**	0.31	**0.04**
p-value (within-group)	**0.002**	**0.02**	**0.04**		

N: number. P: Probability value. * Data are mean± SD. P-value ≤0.05 indicates a statistical significance difference. VAS: visual analogue scale.cm: centimeter. WOMAC: Western Ontario and McMaster Universities Arthritis Index questionnaire, TUG: time up and go test. Kg: kilogram. Ƞ2: partial eta square.

Table 3: Post hoc analysis of all outcome variables (N=63)

Outcome	**Group A versus Group B**		**Group A versus Group C**		**Group B versus Group C**	
	MD (95% CI)	**p-value**	**MD (95% CI)**	**p-value**	**MD (95% CI)**	**p-value**
VAS (cm)						
	-1.19 (-2.03, -0.35)	0.003	-2.33 (-3.17, -1.49)	<0.001	-1.14 (-1.98, -0.3)	0.004
WOMAC (score)						
	-6 (-10.81, -1.19)	0.01	-11.91 (-16.71, -7.1)	<0.001	-5.91 (-10.71, -1.1)	0.01
TUG test (seconds)						
	-3.15 (-5.99, -0.3)	0.03	-6.48 (-9.32, -3.63).	<0.001	-3.33 (-6.17, -0.49).	0.02
Quadriceps strength (kg)						
	5.61 (3.29, 7.93)	<0.001	9.2 (6.88, 11.52).	<0.001	3.59 (1.27, 5.91).	<0.001
Knee flexion (degree)						
	4.81 (0.36, 0.9)	0.01	8.86 (4.92, 12.79).	<0.001	4.05 (0.11, 7.98).	0.04
Knee extension (degree)						
	-0.33 (-1.33, 0.66)	0.99	-0.62 (-1.61, 0.37)	0.39	-0.29 (-1.28, 0.71)	0.99

N: number.MD: Mean difference.CI: Confidence interval. P: Probability value. * Data are mean± SD. P-value ≤0.05 indicates statistical significance difference. VAS: visual analogue scale.cm: centimeter. WOMAC: Western Ontario and McMaster Universities Arthritis Index questionnaire, TUG: time up and go test. Kg: kilogram.

DISCUSSION

The purpose of this study was to compare the benefits of KT and IFC combined with a standard exercise program on knee pain, function, ROM, quadriceps muscle strength, and functional mobility in patients with chronic KOA. This study found that all outcome measures showed significant differences,

except knee extension ROM, recommending the combined effect of IFC and the exercise program ($p < 0.05$). However, quadriceps muscle strength was improved in all groups with significant changes in groups A (IFC+EX) and B (KT+EX) after 4 weeks of treatment; however, there was no significant improvement in group C (EX).

Regarding knee pain and functional disability, this study found that both KT & IFC combined with exercises statistically improve knee pain and function with superiority to combined IFC therapy to exercise.

The mean difference in VAS between the IFC+EX and control groups, the KT+EX and control groups and the IFC+Ex and KT+Ex was 2.33, 1.14 and 1.19, respectively. This exceeds the minimal clinical important difference (MCID) of VAS (1.4 cm) suggesting that these change in pain reduction are clinically meaningful[40].

This is explained by that the IFC can reduce pain by blocking pain signals, enhancing the body's natural pain relief system, and reducing nerve activation in the skin for patients with KOA [8].

The mean difference in WOMAC scores between the IFC+EX and control groups and the KT+EX and control groups was -11.91 and -5.91, respectively. These differences were statistically significant ($p \leq 0.05$). However, neither group exceeded the MCID of 16.1 points for the total WOMAC score, [41] suggesting that the findings may not be clinically meaningful.

Recent research demonstrated that the IFC showed early improvement in pain management or functional improvement only after three weeks but not after six weeks [21]. Comparing to this study, IFC showed improvement in pain after 4 weeks of intervention if combined with exercises.

The results of this trial agree with those of **Lin et al.,** [19] who revealed that physiotherapy plus KT had a greater therapeutic effect on pain management and functional improvement in patients with KOA than PT alone. At least six weeks following the first treatments, there may be further pain relief and functional improvement. On KOA, the effects of KT combined with a supervised exercise program may be noticeably greater than those of a supervised exercise program alone in terms of pain, muscle strength, ROM, and physical function [42]. These findings emphasize that improvement progress should be monitored for longer than four weeks to cause clinical improvements.

Quadriceps muscle strength was improved in all groups with significant changes in groups (IFC+EX) and (KT+EX) after 4 weeks of treatment; however, no significant improvement was seen in control group (EX). Additionally, there was no statistical significance between groups. Clinically, the mean difference in isometric quadriceps strength between the IFC+Ex and the control groups, the KT+Ex and the control groups, and the IFC+Ex and KT+Ex was 9.2, 3.59, and 5.61 kg, respectively. These differences are exceeding the established MCID of 2.55 kg (25.02 Nm) .[43] The improvement of isometric quadriceps strength is clinically significant, suggesting the superiority of IFC+EX over KT+EX.

This may be explained by the addition of any pain-inhibiting modalities like IFC therapy or KT to the exercise program might facilitate more activation of quadriceps muscle fiber and facilitate gaining more strength after 4 weeks. The study aligns with Lee et al.'s research [44], revealing that 12 weeks of stair-climbing training with IFC is more effective in promoting physical activity recovery compared to training without IFC. Research suggests that therapists should combine IFC with active treatment for better benefits in managing patients with KOA [9]. This highlights that the quadriceps muscle strength in the IFC+EX group significantly improved compared to other groups. This aligns with previous research that concluded strengthening exercises combined with long-term IFC treatment may greatly reduce pain and enhance knee joint ROM and physical strength [45].

In terms of ROM, after 4 weeks of intervention, all three groups exhibited a statistically significant improvement in knee

flexion ROM but no change in knee extension ROM. The mean difference in knee flexion between the IFC+Ex and the control groups, the KT+Ex and the control groups, and the IFC+Ex and KT+Ex was 8.86, 4.05, and 4.81 degree, respectively. These differences are exceeding the established MCID range from 3.8 to 6.4 only between IFC+EX and control group [46]. This improvement is clinically significant, suggesting the superiority of IFC+EX over KT+EX.

This might be because adding IFC or KT to an exercise program improves knee flexion ROM; however, knee extension ROM cannot since it has a restricted range (0 to 5 degrees) when compared to knee flexion. This shows that longer-term workout regimens may be required to enhance extension ROM beyond four weeks.

According to the literature, only a few studies found that giving KT had a significant favorable influence on improving ROM [6]. However, KT is intended to help joints with restricted ROM regain pain-free motion [42].

Regarding improvement in knee functional mobility (TUG) in all three groups, it might be due to knee pain inhibition by adding IFC therapy or KT application to exercise. The mean difference in TUG between the IFC+Ex and the control groups, the KT+Ex and the control groups, and the IFC+Ex and KT+Ex was -6.48, -3.33, and -3.15 seconds, respectively. These differences are exceeding the established MCID range from 2.0 to 2.7 seconds [47]. This improvement is clinically significant, suggesting the superiority of IFC+EX.

The KT stimulates neuromuscular pathways, reduces pain-induced quadriceps muscle inhibition in KOA patients [48-50], and improves joint mobility by supporting muscle contraction and reducing kinesiophobia through sensory input and support [51, 52].

The study suggests that combining KT application with consistent exercise can effectively manage KOA, resulting in reduced pain, improved knee function, and reduced medication need, making this method a valuable adjunct to traditional treatment methods in the rehabilitation of KOA [53]. Furthermore, these study findings disagree with a recent meta-analysis that found that KT or KT plus conventional therapy significantly improves isokinetic muscle strength and pain management for patients with KOA, but not isometric muscle strength. Since muscular strength is crucial for knee stability, the results of enhanced isokinetic muscle strength are very relevant [6]. As a result, future studies should focus on the assessment of isokinetic muscle strength rather than isometric strength.

On the other hand, **Dogan et al.,** [54] reported that utilizing KT for three weeks in a succession did not substantially improve pain, knee-related health status, functional performance, pain-free ROM, or postural stability compared to sham therapy. However, while interpreting the results, consider the temporal influence on WOMAC, ROM, and VAS activity. This contradiction might be attributed to the fact that the patients in this study followed a home exercise program, which may have contributed to the time impact in WOMAC, VAS activity, and knee ROM throughout the study group.

Lastly, despite the advantages of IFC, research has revealed disagreements regarding the optimal carrier frequencies and duration of therapy that led to a substantial reduction in knee pain and an improvement in function. In this study, they were unable to prove that one carrier frequency group was better than the others, as each had significant benefits [55]. A recent systematic review and meta-analysis concluded that IFC had no negative effect on patients with KOA. Thus, IFC can assist with both acute and chronic pain, as well as short-term functionality [56].

Limitations

This study advanced the development of evidence on the best physiotherapy approaches for treating chronic KOA. However, it had some limitations, the four-week treatment time may not be sufficient to evaluate the long-term effects; thus, a long follow-up period should be considered. Future trials recommend comparison of the IFC with other physiotherapy modalities and using more

objective assessment tools rather than self-reported patient outcomes.

CONCLUSION

Both the KT and the IFC combined with exercise are effective in improving pain, ROM, function, and quadriceps muscle strength with the IFC having more beneficial effects in the treatment of individuals with chronic KOA.

Ethical Consideration

The Research Ethical Committee of Cairo University's Faculty of Physical Therapy examined and approved the study's protocol (P.T.REC/012/005028).

Trial registration

ClinicalTrials.gov's Protocol Registration and Results System has the trial registered (Identifier: NCT06289218).

Authors' contributions

The authors cooperated in the article drafting and approved the final version submission for online publication.

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Conflict of interests

No conflicts of interest have been declared by the authors.

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