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Effectiveness of acupressure versus isometric exercise on pain, stiffness, and physical function in knee osteoarthritis female patients

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ABSTRACT

Osteoarthritis (OA) is the most common form of arthritis and a leading cause of disability in older adults. Conservative non-pharmacological strategies, particularly exercise, are recommended by clinical guidelines for its management. The aim of this study was to assess the effectiveness of acupressure versus isometric exercise on pain, stiffness, and physical function in knee OA female patients. This quasi experimental study was conducted at the inpatient and outpatient sections at Al-kasr Al-Aini hospital, Cairo University. It involved three groups of 30 patients each: isometric exercise, acupressure, and control. Data were collected by an interview form and the Western Ontario and McMaster Universities Osteoarthritis index (WOMAC) scale. The study revealed high initial scores of pain, stiffness, and impaired physical functioning. After the intervention, pain decreased in the two intervention groups compared to the control group ($p < 0.001$), while the scores of stiffness and impaired physical function were significantly lower in the isometric group ($p < 0.001$) compared to the other two groups. The decrease in the total WOMAC score was sharper in the two study groups compared to the control group. In multiple linear regression, the duration of illness was a positive predictor of WOMAC score, whereas the intervention is associated with a reduction in the score. In conclusion, isometric exercise and acupressure provide an improvement of pain, stiffness, and physical function in patients with knee OA. Since isometric exercise leads to more improvement of stiffness and physical function, while acupressure acts better on pain, a combination of both is recommended. The findings need further confirmation through a randomized clinical trial.

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Introduction

Worldwide, osteoarthritis (OA) is the most common form of arthritis and a leading cause of disability in older adults [1]. It accounts for more limitations in walking, stair climbing, and other daily activities than any other disease [2]. The individual, societal, and financial burdens of this disease warrant

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rigorous scientific investigation in order to identify coping strategies for those afflicted [3].

The pathology is the OA which causes body structural and functional limitations such as muscle weakness, decreased joint range of motion (ROM), joint instability, fatigue, stiffness, and pain. The consequences are activity avoidance, muscle atrophy, difficulty in performing functional tasks involving ambulation and transfer, and reduced quality of life [4]. According to the World Health Organization, about 5.5 million people suffer from OA in Egypt, representing about 7% of the population [5].

Therefore, conservative non-pharmacologic strategies, particularly exercise, are recommended by all clinical guidelines for the management of OA and meta-analyses support these exercise recommendations [6–9]. Isometric strengthening exercises and acupressure intervention are beneficial for improving pain and function [10]. An individualized approach to exercise prescription is required based on an assessment of impairments, patient preference, co-morbidities [11]. Maximizing adherence is a key element dictating success of exercise therapy. This can be enhanced by the supervised exercise sessions in the initial exercise period followed by home exercises [11,12].

Hernandez-Molina et al. [13] mentioned that therapeutic exercise, especially that incorporating specialized supervised exercise training and an element of strengthening, is an efficacious treatment for OA. Another study done by McCarthy et al. [14] found that supplementing a home-based exercise program for 8 weeks led to significantly greater improvements in locomotors function and walking pain at 12 months. The number of directly supervised exercise sessions can also influence treatment effect sizes.

Complementary and alternative medicine is commonly used to manage joint and arthritis pain among persons with knee OA [15]. Previous reviews cited evidence-based effectiveness of acupuncture for OA in reducing pain [16,17]. Acupuncture and acupressure use the same acupoints (acupuncture points, sometimes called trigger or active points) for treatment purpose, but acupuncture employs needles, while acupressure uses the fingers to press acupoints on the surface of the skin to stimulate the body's natural self-curative abilities. Traditional Chinese medicine holds that certain channels called meridians in the human body regulate the flow of vital energy (called Qi), and it is the unbalanced flow of Qi that results in disease [18].

Stimulation such as needling or pressing at the acupoints on the meridians is believed to open the channels and balance energy, thus restoring health to the body. In addition, mechanical pressure, such as massage and acupressure, has been known to decrease tissue adhesion, promote relaxation, increase regional blood circulation, increase parasympathetic nervous activity, increase intramuscular temperature, and decrease neuromuscular excitability [18].

Self-administered acupressure, if proven feasible and effective, is convenient and inexpensive. A few researchers have investigated the usefulness of acupressure for knee pain [19]. Recently, Zhang et al. [20] reported a potential positive impact on physical function and pain scores of WOMAC subscale. Mann–Whitney *U* tests indicated that physical function changes from baseline to 12 weeks were different between the acupressure and control group ($p = 0.03$), with the acupressure group showing greater improvement. Another study carried out by Litscher [21] highlighted the electroencephalographic similarities of acupressure induced sedation and general anesthesia as assessed by bispectral index and spectral edge frequency.

Preserving function, preventing disability, and managing arthritis pain represent an imposing challenge to those who care for chronically diseased patients [22]. Affordable community-based approaches geared to help OA patients would be desirable [23]. Nursing may contribute through comprehensive exercise and complementary therapy program which include supervised physical therapy and unsupervised home exercise focusing on range of motion, muscle strengthening, and endurance [24].

The aim of this study was to assess the effectiveness of acupressure versus isometric exercise on pain, stiffness, and physical function in knee OA female patients. It was hypothesized that the symptoms of pain, stiffness, and physical function in knee OA female patients improve by either acupressure or isometric exercise interventions in adherence, with no difference between the two approaches.

Subjects and methods

Research design and setting

The researchers used a quasi experimental design with pre–post assessment and control group. The study was conducted at the inpatient and outpatient sections in Al-kasr Al-Aini hospital, affiliated to Cairo University.

Participants

The study involved three groups: two interventions and one control. The sample size for each group was calculated to estimate an improvement in the WOMAC score of 20% or more, with 30% standard deviation. Using Epi-Info software package, with a confidence level 95% and power 90%, the sample size required per group was calculated to be 26. This was increased to 30 to account for a dropout rate of about 10%. Women were consecutively recruited according to the following criteria: female, age 45–60 years, and diagnosed by rheumatologist as having moderate OA in one or both knees based on X-ray, no prior knee surgeries, not having any other chronic disease, pregnancy. All patients were on the same protocol of medical treatment and physiotherapy technique of hospital, which includes stretching, strengthening, and resistive exercise for quadriceps, abductors, extensors, hamstrings, and calf muscles, which are important for function. TENS to relieve pain for 20 min and ultrasound continuous to accelerate tissue repair 1.5 w/cm^2 for 3–5 min.

Data collection tool

An interview questionnaire form was utilized to collect data. It consisted of two parts: The first part was concerned with personal data such as age, occupation, duration of illness, body weight, height, as well as patient compliance to exercise or acupressure during the program.

The second part of the tool consists of the Western Ontario and McMaster Universities Osteoarthritis index (WOMAC) scale developed by Bellamy et al. [25] to assess the symptoms of pain, stiffness, and physical function in patients with hip

Table 1 Intervention protocol of isometric strengthening exercise in people with moderate OA.

Exercise type and intensity	Volume	Frequency
Static stretching initially (stretch to subjective sensation of resistance)	Stretch/muscle group; hold 5–15 s	Once daily
Stretching longer term goal (stretch to full range of motion according to limit of pain)	3–5 stretches/muscle group; hold 20–30 s	3–5/week
Strengthening against gravity with maintenance	1–10 sub-maximum contractions/muscle group; hold 1–6 s	Daily
Strengthening with multi angle level against gravity with resistance	10–15 repetitions	2–3/week
	8–10 repetitions	
	6–8 repetitions	

and/or knee OA. The Arabic version of the scale was used [26]. The time to administer is approximately 12 min. The scale is scored on a 5-point Likert scale: 0–4 for none, mild, moderate, severe, and extreme, respectively. The scores are summed for items in each subscale, converted into a percent score by dividing the total by the number of items, and multiplying the quotient by 100. Higher scores on the WOMAC indicate worse pain, stiffness, and functional limitations.

Pilot study

An initial pilot study was done on 10% of the sample size of the study to test the study tool in terms of clarity, and the time required to be applied. Patients involved in the pilot study were not included in the main study sample. The tool reliability was assessed through measuring its internal consistency and showed to be high: Cronbach's alpha coefficients for pain stiffness and functioning 0.95, 0.85, and 0.97, respectively.

Procedures

The researchers met with patients diagnosed with OA who met the criteria for inclusion. Women were assigned to the three groups in an alternating way. The researchers explained to them the aim and procedures and invited them to participate. Those who agreed signed a written consent, the researchers then started the actual study maneuver, which involved the following three phases:

Assessment phase: Baseline data were obtained from patients in the three groups through interviewing using the designed study tool, by one of the researchers who was blinded to group allocation (isometric exercise, acupressure, and control group).

Intervention phase: All patients in the three groups were kept on their routine care and regular treatment. The intervention groups were provided individualized educational sessions, under supervision of researchers which included isometric exercise for one group (Study 1) and acupressure for the other group (Study 2). Each session was 15 min long, three times per week, for 3 months [27,28].

The researchers educated the patients in the isometric exercise intervention group (Study 1), to do active exercises, introduce different types of exercise gradually (Table 1) [12].

As for the acupressure intervention group (Study 2), the researchers educated the patients to use of deep firm pressure to massage every point, massaging every point until numbing feeling is produced, with emphasis on the identified high potency points of the eight knee acupoint locations (i.e., ST34, ST35, ST36, SP9, SP10, GB34, EX-LE2, and EX-LE4, Fig. 1) [20]. The acupressure points were to be pressed 10 min, three times a day, 5 days/week. The patient should be seated comfortably and breathe deeply. These maneuvers should not be done immediately prior to or following heavy exercise or meals [29]. If the patient is unable to perform the procedure, she may ask the help of another person at home who has been trained by the researchers.

The researchers prepared an illustrated educational booklet and delivered it to patients to help them in complying with the program. The duration of the intervention phase was about 5 months. Compliance to treatment in the two intervention groups was assessed by asking patients to keep a diary of the daily performance of the physical intervention. The compliance was then calculated as a percent of number of daily sessions to the expected total number of sessions, which is the days of follow-up multiplied by 3.

Evaluation phase: Individualized interviews were performed for each patient in the three groups to collect post-intervention assessment data using the same tool. This was done blindly, with the interviewer not knowing the group to which the participant was allocated (isometric exercise, acupressure, and control group) to avoid the ascertainment bias. The duration of data collection took about 5 months.

Ethical considerations

An official approval was obtained from Director of Al-kasr Al-Aini hospital and the heads of the departments through a letter addressed from the Faculty of Nursing Cairo University explaining the aim of the study, its procedures, and the expected duration. All patients were informed about the purpose, tools, procedures, and duration of the study and signed a written consent. They were given full explanations about the benefits of the study maneuver, as well as their rights to refuse or withdraw at any time without giving reasons and without consequences on their care. The researchers assured them about the confidentiality of the data.

Statistical analysis

Data entry and statistical analysis were done using SPSS 16.0 statistical software package. Quantitative continuous data were compared using Student's *t*-test in the comparisons between the three groups. When normal distribution of the data could not be assumed, the nonparametric Kruskal–Wallis test

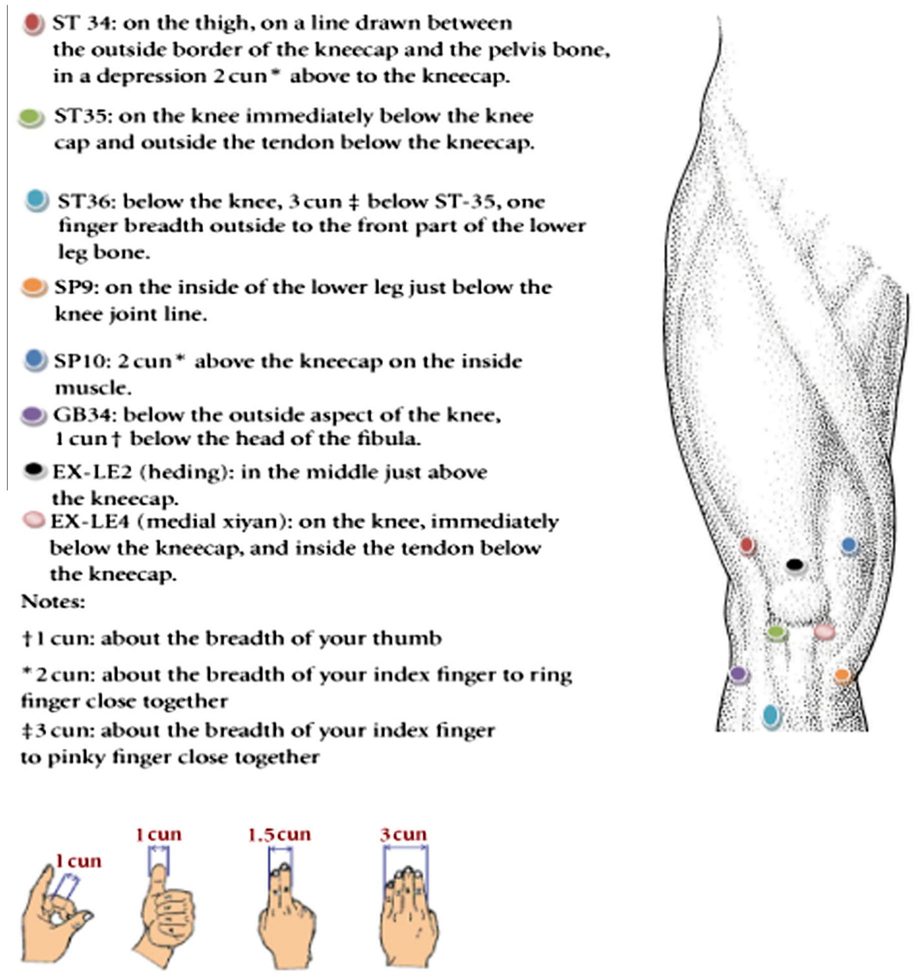

Fig. 1 Acupoints used in the protocol [20].

Table 2 Demographic characteristics and BMI of patients in the study and control groups.

	Group					
	Study 1 (isometric) (n = 30)		Study 2 (acupressure) (n = 30)		Control (n = 30)	
	No.	%	No.	%	No.	%
Age (years)						
< 50	13	43.3	12	40.0	10	33.3
50+	17	56.7	18	60.0	20	66.7
Range	45.0–60.0		44.0–60.0		45.0–60.0	
Mean (95% confidence interval)	52.0 (50.2–53.8)		51.6 (49.5–53.6)		51.7 (50.0–53.3)	
Job: Working						
% (95% confidence interval)	83.3 (64.5–93.7)		46.7 (28.8–65.4)		73.3 (53.8–87.0)	
Duration of illness (years)						
< 5	13	43.3	12	40.0	12	40.0
5+	17	56.7	18	60.0	18	60.0
Range	1.0–8.0		1.0–8.0		2.0–8.0	
Mean (95% confidence interval)	5.0 (4.0–6.0)		4.7 (4.0–5.4)		5.2 (4.5–5.9)	
BMI						
< 30	10	33.3	9	30.0	18	60.0
30+	20	66.7	21	70.0	12	40.0
Median	31.8		31.3		28.5	
Q1/Q3	29.4/35.2		28.0/34.0		27.8/31.2	

Q1 = first quartile; Q3 = third quartile.

Table 3 Comparison of total pain, stiffness, and functionality scores of patients in the study and control groups before and after the intervention.

	Group									Kruskal Wallis test	p-Value
	Study 1 (isometric) (n = 30)			Study 2 (acupressure) (n = 30)			Control (n = 30)				
	Median	Q1	Q3	Median	Q1	Q3	Median	Q1	Q3		
Time: pre											
Pain	70.0	64.0	80.0	76.0	68.0	80.0	72.0	68.0	80.0	0.57	0.75
Stiffness	70.0	60.0	80.0	80.0	70.0	80.0	80.0	60.0	80.0	4.27	0.12
Impaired physical function	67.1	60.0	75.3	67.7	61.2	71.8	74.2	63.5	80.0	6.20	0.045*
Time: post											
Pain	68.0	64.0	76.0	0.0	0.0	32.0	72.0	67.0	80.0	61.96	< 0.001*
Stiffness	40.0	30.0	40.0	60.0	50.0	60.0	60.0	40.0	60.0	22.78	< 0.001*
Impaired physical function	35.3	20.9	45.9	47.1	43.5	50.6	50.6	43.5	57.6	21.76	< 0.001*

Q1 = first quartile; Q3 = third quartile.
* Statistically significant at $p < 0.05$.

was used instead. Qualitative categorical variables were compared using chi-square test. In order to identify the independent predictors of WOMAC scores, multiple linear regression analysis was used after testing for normal distribution, normality, and homoscedasticity, and analysis of variance for the full regression models was done. Statistical significance was considered at p-value < 0.05.

Results

The demographic characteristics of the participants at baseline were shown in Table 2. There were no significant differences at baseline except for job status; group 2 had a low mean of working status (46.7). Their mean age was in the early fifties, and the duration of their illness was around 5 years on average. The percentage of BMI was slightly higher in the isometric and acupressure study groups (66.7% and 70.0%, respectively, compared to control group (40.0%)), but the difference was not of statistical significance. The two study groups had a closely similar mean score of compliance: 66.7 ± 14.3 for the isometric group (Study 1), and 64. ± 15.3 for the acupressure group (Study 2), $p = 0.475$.

Table 3 demonstrates that patients in the three groups had similar scores of pain, stiffness, and impaired physical functioning before the intervention. The only difference of statistical significance was in impaired physical function, the control group had a higher score compared to the other two groups (Kruskal 6.20, $p = 0.045$). After implementation of the intervention, patients in the acupressure study group had a considerable decrease in their pain score compared to the control group, as well as the other study group (Kruskal 61.96, $p < 0.001$), whereas the scores of stiffness and impaired physical function were significantly lower in the isometric group (Kruskal 22.78 and 21.76, respectively, $p < 0.001$) compared to the other two groups.

In total, Fig. 2 depicts post-intervention decreases in total WOMAC score in the three groups; the two study groups had more pronounced pre–post differences (34.93 and 44.44) compared to the control group (35.40). All these differences were statistically significant ($p < 0.001$).

The statistically significant independent predictors of the total WOMAC score in the isometric and acupressure groups

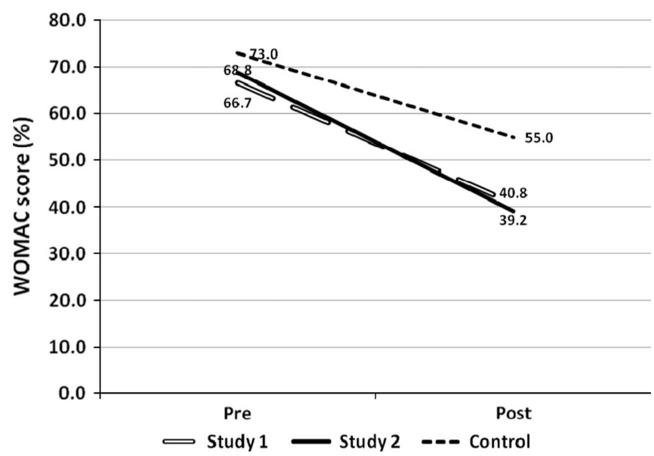

Fig. 2 Comparison of total WOMAC median scores of patients in the study and control groups before and after the intervention (Study 1: isometric; Study 2: acupressure), Study 1 Mann–Whitney 34.93, $p < 0.001$, Study 2 Mann–Whitney 44.44, $p < 0.001$, Control Mann–Whitney 35.40, $p < 0.001$.

were the intervention program and the duration of illness (Table 4). It was evident that the duration of illness was a positive predictor of the score, whereas the intervention was a negative predictor. The effect of the intervention in the two groups was almost similar as noticed from the values of their beta coefficients, which were almost equal. Similarly, the models explain an almost equal proportion of the variation in the scores of the two interventions, 75% and 74%, respectively. As for the model comparing the two intervention groups, the same table showed no difference in the effect of the two different interventions on the WOMAC score. The predictors of the WOMAC score in both groups were the duration of illness and the BMI, and both were positive predictors. Both predictors explain about 67% of the variation in the WOMAC score.

Discussion

This study was carried out to test the hypothesis that the symptoms of pain, stiffness, and physical function in OA female

Table 4 Best fitting multiple linear regression models for total WOMAC scores.

	Unstandardized coefficients		Standardized coefficients	*t*-Test	*p*-Value	95% Confidence interval for B	
	B	Std. Error				Lower	Upper
Group 1 (isomeric) versus control							
Constant	37.974	2.070		18.342	< 0.001	33.829	42.120
Duration of illness	3.327	.339	.638	9.815	< 0.001	2.648	4.006
Intervention (reference: control)	−13.037	1.511	−.561	−8.625	< 0.001	−16.064	−10.010
R-square = 0.75							
Model ANOVA: $F = 90.04$, $p < 0.001$							
Variables entered and excluded: age, BMI, job status							
Group 2 (acupressure) versus control							
Constant	45.489	2.005		22.687	< 0.001	41.473	49.504
Duration of illness	1.891	.345	.366	5.488	< 0.001	1.201	2.582
Intervention (reference: control)	−13.778	1.252	−.734	−11.005	< 0.001	−16.285	−11.271
R-square = 0.74							
Model ANOVA: $F = 86.33$, $p < 0.001$							
Variables entered and excluded: BMI, age, job status							
Group 1 (isometric) versus Group 2 (acupressure)							
Constant	2.966	7.189		.413	0.681	−11.430	17.363
Duration of illness	2.247	.475	.529	4.727	< 0.001	1.295	3.199
BMI	.871	.278	.350	3.131	0.003	.314	1.428
R-square = 0.67							
Model ANOVA: $F = 59.87$, $p < 0.001$							
Variables entered and excluded: Group, age, job status, compliance							

patients will improve by either acupressure or isometric exercise interventions, with no difference between the two approaches. The findings lead to acceptance of the hypothesis, where patients in the two interventions groups demonstrated significant improvements in all symptoms, compared to the control group.

In order to assess the effect of an intervention, the groups under study, as well as the control group, should be similar in their basic characteristics, especially those related to the study outcomes. In the current study, patients in the three groups have similar age, mostly in the early fifties, which is typical of OA patients as shown by Brooks [30] in a study of OA in the United States. All our patients are females as per the inclusion criteria to avoid the possible confounding effect of gender since estrogen has been associated with OA risk [31]. A more recent study revealed that leptins increased the risk of OA in women but not in men [32].

Another important possible risk factor that was considered in the present study is obesity in terms of BMI. This is a well documented risk factor of OA [33]. Moreover, increased BMI has been shown to be a risk factor for more severe cartilage degeneration by MRI measurements in preclinical OA [34]. According to the present study finding, women in the three groups have almost equal BMI, which may preclude the role of BMI as a confounder. This is further confirmed by the multiple linear regression, which demonstrated that the effect of the intervention on WOMAC score in the two intervention groups was not predicted by their BMI.

Meanwhile, BMI turned to be an independent predictor of the score when comparing the two intervention groups, which further confirms its role in the symptoms of OA. The finding is in agreement with White et al. [35] whose study demonstrated that BMI is an important and significant predictor of walking independent of knee pain in OA patients. Its effect is even more important than the knee pain itself on walking.

The only factor that showed a significant difference among the three groups of the present study is the job status. The percentage of working women is lowest in the study group 2 (acupressure). This factor might be of importance since some occupations may increase the risk of OA [36]. Thus, exposures to more occupational tasks for long durations were reported to have an association with higher WOMAC pain scores [37]. However, multiple linear regression in the present study demonstrated that job is not a significant factor contributing to the changes in WOMAC score.

The present study finding revealed significant improvements in the total WOMAC scores in the two intervention groups, compared to the control group. On the same way, study done by Jansen et al. [38] entitled "Strength training alone, exercise therapy alone, and exercise therapy with passive manual mobilization each reduce pain and disability in people with knee osteoarthritis: a systematic review" revealed that all three intervention types were effective at relieving pain and improving physical function. The effect size of exercise with additional manual mobilization on pain (0.69) could be considered of moderate size, while the effect sizes of strength training (0.38) and exercise therapy alone (0.34) could be considered small. The effects on physical function tended to be smaller than those on pain and would be considered moderate or small.

Additionally, study conducted by the University in 3 Maryland School of Medicine, 570 patients received either acupuncture or sham acupuncture treatments for knee osteoarthritis. Those receiving real acupuncture reported improvement in function and pain relief in comparison with the sham treatments [39]. On the same way, patients with osteoarthritis of the knee who received acupuncture had significantly less pain and better function after 8 weeks than did patients who received minimal acupuncture or no acupuncture [40].

However, the isometric group demonstrated more improvement in the stiffness and functionality, whereas the acupressure group had improved pain scores. The effect of the isometric exercise on WOMAC score is in line with a number of previous studies [41–43].

On the other hand, the acupressure group of the present study showed more improvement in the pain component of the WOMAC scale. This is in congruence with previous studies that demonstrated the effectiveness of this treatment modality in the relief of various types of pain such as low back pain [44], dysmenorrhea [45], and pain in breast cancer [46]. The pain relief of acupressure has been attributed to its analgesic action, which has been considered by Litscher [21] as similar to general anesthesia. Nonetheless, limited studies examined its effectiveness in the relief of pain in knee OA [20].

The improvements witnessed in the two intervention groups of the present study must be considered as additive to the effects of the routine standard care provided in the study setting. It is to be noticed that patients in the control group, who have been receiving this routine care, showed improvements in their WOMAC score. However, this improvement is significantly less than that observed in the two intervention groups. Thus, the study interventions led to an additive improvement, which is attributed to the maneuvers applied, in addition to the educational component with follow-up at home that encouraged patient's adherence to the therapy. Such follow-up of home-based exercise therapy has been previously demonstrated [23].

Conclusions

The study results lead to the conclusion that isometric exercise and acupressure, along with patient education and follow-up may provide an improvement of pain, stiffness, and physical function of patients with knee OA. This improvement is additive to the effect of routine therapies. Since isometric exercise leads to more improvement of stiffness and physical function, while acupressure acts better on pain, a combination of both is recommended, with an expected synergistic effect. However, this needs further study. The study findings should be interpreted taking into consideration that it was carried out in a quasi experimental non-truly randomized design. Moreover, the fact that all the instruments were self-reported, especially the compliance reporting, could have been associated with some biases. Therefore, the findings need further confirmation through a randomized clinical trial.

Conflict of interest

The authors have declared no conflict of interest.

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