Effect of physical Exercise and Heat Application on Pain and Morning Stiffness in Osteoarthritis Patients

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Abstract

Background: Osteoarthritis (OA) is a mutual advanced joint disease which is characterized by chronic pain, stiffness, and functional disability. **Aim of the study:** Evaluate effect of physical exercises and heat application on pain and morning stiffness in osteoarthritis patients. **Study design:** Quasi-Experimental design was employed to implement this study. **Setting:** This study was implemented at the Suez- Canal University Hospitals' orthopedic outpatient clinics. **Subjects:** 120 patients were included in the study as a purposive sample, while 40 patients assigned randomly into each group (control, heat and physical exercise). **Data collection tools:** Structured interview questionnaire to assess demographic data of patients and awareness about the disease and its management in addition to, the self- administered Knee Injury and Osteoarthritis Outcome Score (KOOS) to assess short and long-term patient-relevant outcomes following knee osteoarthritis. **Results:** This study revealed that (80%, 100% and 97.5%) and, (32.5%, 15%, 57.5%) of the heat, exercise, and control group had joint pain and stiffness respectively. Regarding post intervention; there was statistically significant difference between the heat, exercise and control group with 45 % of the heat group and 95% of the exercise group had moderate level of signs and symptoms. **Conclusion:** Heat application and physical exercises had positive effect on relieve pain, stiffness, and improvement of physical function, with heat applications had have the higher effect on symptoms. **Recommendations:** Using a combination of physical exercise and heat application together for patient with osteoarthritis to control pain, morning stiffness, and activity level.

Keywords: Heat Application, Osteoarthritis, Morning Stiffness, Pain, Physical Exercises.

Introduction:

Osteoarthritis (OA) is a long -term chronic disease characterized by deterioration of cartilage in joints which results in bones rubbing together and creating stiffness, pain, and impaired movement **(Vos et al., 2016)**. Three main biological processes responsible about OA are including enetic alterations, sex hormone deficit, and aging; as they proposed to induce crucial changes in joint tissues originating preliminary osteoarthritic changes **(Cucchiarini et al., 2016)**.

The primary symptoms of OA are joint pain, stiffness, and locomotors restriction. Other manifestations in patients with OA include squeal such as muscle weakness and poor balance **(Glyn-Jones et al., 2015).** OA is diagnosed through examination, imaging, and synovial fluid aspiration **(Hussain et al., 2016)**, and lead to different comorbidities like fibromyalgia **(Hawker, 2019)**.

Most patients find osteoarthritis to be a nuisance that ultimately becomes significant enough to affect daily activities. And sometimes there are more serious complications include: rapid, complete breakdown of cartilage lead to condorolysis, osteonecrosis, stress fracture in response to repeated injury, bleeding inside the joint, infection, deterioration or rupture of the tendons and ligaments around the joint, leading to loss stability and pinched nerve **(*O'Neill* et al., 2018).**

Evidence-based approaches to treat knee OA include non-pharmacologic, pharmacologic, and surgical modalities. Treatments to modify the course of the disease have not reached a threshold of efficacy to gain regulatory approval despite numerous efforts. The clinical decision-making of treatment is often influenced by specific patient and disease characteristics ***(McAlindon et al., 2014)***.

Patients with OA may fall into different categories that must be considered when making treatment decisions. This categories include: **Mild knee osteoarthritis** could be

treated by non-pharmacologic therapies alone or in combination with topical therapies or analgesics on an as-needed basis as they are likely to provide adequate control of symptoms ***(Bhatia et al., 2013)***. **Moderate to severe knee osteoarthritis** may be treated initially by non-pharmacologic interventions with aquatic exercises as they are usually better tolerated than land-based exercises in patients with severe pain ***(McAlindon and Bannuru, 2018)***.

Nurses assist in diagnosing and assessing the disease's functional and psychosocial impacts, provide medication, pain management, monitor disease progress, educate patients, and coordinate care with other providers such as physical, occupational, and psychosocial therapists. Understanding the clinical manifestations of and the diagnostic criteria for OA provide the foundation for these activities ***(*Hunter et al., 2018*)***. Patient education is an ongoing, integral part of management. The nurse should address aspects of the disease process, benefits and risks of treatment options. Empowering the patient by involving them in shared decision making and providing them with positive skills directed at lifestyle changes goes a long way to ensure treatment adherence **(Hafez et al., 2015).**

The American College of Rheumatology (ACR) has approved regular exercise as a therapeutic approach for the management of knee OA. Evidence suggests that stretching, strengthening and aerobic exercise decrease pain and improve muscular strength, functional ability and psychological well-being **(Abbasi, 2017)**. The potential benefits of physical activity and exercise on OA include: Minimizing the pathological process that takes place in the OA joint, increasing cartilage nutrition and remodeling, increasing the synovial blood flow, decreasing swelling, and improving muscle strength **(Gay et al., 2016*)***.

The periodic application of superficial heat or cold is a relatively safe and low cost treatment that can be recommended in isolation or in combination with other treatments for patient with knee OA. Ice is essential during the acute phase of pain and is also useful after exercising, as it causes capillary vasoconstriction with decreased blood flow and decreased metabolic activity, resulting in decreased inflammatory edema leading to prevention of further damage **(*İnan, & Kıyak*, 2014).**

Heat application increase blood flow and local metabolic activity with relaxation of muscle spasm, it should be used after the initial swelling and edema phases have stabilized. The application area should be checked for the tolerance of application, skin integrity of the patient, bleeding, and circulatory disorder **(Karadağ et al., 2019)**.

Significance of the Study

Osteoarthritis (OA) most commonly affects the different joints of the body, but it is relatively common in the knees especially with aging. It affects the general wellbeing as it lea to different clinical manifestations and complications making the patient more vulnerable to not good life nature ***(Haq & Davatchi, 2015).***

Knee OA accounts for four- fifths of the burden of OA worldwide that increases with obesity and age ***(Vos et al., 2016)***. Exploring the differences of prevalence, incidence, and risk factors of knee OA in age, gender, region, and others can help better understanding of the potential etiology of knee OA and providing preventive strategies ***(James et al., 2018).***

The application of heat compresses and implementation of physical exercises relieve the pain and morning stiffness of patients with knee osteoarthritis, which in turn improve physical functioning and enhance practicing activities of daily living. Therefore, the present study was conducted to provide evidence for this hypothesis. Also, it will relieve patients' complaints and reduce hospitalizations for these patients, as well as reducing treatment burden on the hospital.

Aim:

The current study aimed to evaluate effect of physical exercise and heat application on pain and morning stiffness in osteoarthritis patients.

This aim was achieved through the following objectives:

- Evaluate effect of heat application on relieving pain and morning stiffness in osteoarthritis patients.

- Evaluate effect of physical exercises on relieving pain and morning stiffness in osteoarthritis patients.
- Compare between effect of physical exercises and heat application on relieving pain and morning stiffness in osteoarthritis patients

Research Hypothesis:

H_0: Osteoarthritis patients who will intervene with heat application and physical exercises will have no change in levels of pain and morning stiffness.

H1: Osteoarthritis patients who will intervene with heat application and physical exercises will have reduced levels of pain and morning stiffness.

Subject and Methods

Design:

A Quasi-Experimental design was exploited to apply this study.

Setting:

The present study was implemented in Suez Canal University Hospitals, especially at the orthopedic outpatient clinics. The orthopedic clinic consists of three rooms; two rooms for observation of patients and the third for follow-up after orthopedic surgery and hall for waiting, in addition to tickets' room.

Sample and sampling technique:

A purposive sample was selected based on retrospective statistical data. The number of patients with osteoarthritis at the orthopedic outpatient clinic in Suez Canal University Hospitals, were (1300) patients by the year of 2020. The sample consisted of (120) adult patient was involved in the current study at confidence level 95%, and randomly classified into three equal groups using Steven **Thompson equation, (2012).**

$$n = \frac{N \times p(1-p)}{\left[\left[N-1 \times \left(d^2 \div z^2\right)\right] + p(1-p)\right]}$$

As: n= sample size, N=Total population, Z=1.96, D=error level 5%, P=0.5.

The sample selected based on some inclusion criteria as patients aged 20-60 years old, having no comorbid diseases to avoid effect of cofactors on results of the study, and no history of joint surgeries. But; the exclusion criteria included patients who have verbal disability, and with body mass index above 35.

Tools for Data Collection: Two tools were used to collect data pertinent to the current study.

Tool 1: **Structured Interview Questionnaire,** that was developed by the researchers and reviewed by a panel of five experts in medical surgical nursing aimed to identify patient demographic data and assess patient's awareness about the disease and its management, it takes about (15) minuets to be completed. It is divided to two parts:

Part I: Demographic Data: It included six items about patients' age, gender, marital status, educational level, job, type of work and residence.

Part II: Patient Health Status: it was adapted and developed by the researchers from **(Mohamed & Mohamed, 2019)**. It included items about past history and present history as duration of osteoarthritis, the affected joint, family members suffering from OA, other chronic diseases, body mass index (BMI), and doing exercises.

Tool 2: Joint Injury and Osteoarthritis Outcome Score (KOOS) Joint Survey. It is a self-administrated questionnaire adapted from ***Roos & Lohmander, (2003),*** with reliability by Cronbach alpha of this tool equal 0.89. The KOOS is a questionnaire designed to assess short and long-term patient-relevant outcomes following knee injury, by assessing five outcomes including pain, symptoms, activities of daily living, sport and recreation function, and knee- related quality of life. The researchers excluded the part of quality of life because it is not suitable for the study aim. The tool included 38 items, and needed about 15 minutes to fill out.

Scoring system

The KOOS four dimensions are scored separately: Pain (nine items); symptoms (seven items); ADL function (17 items); sport and recreation function (five items). A Likert scale was used as all items have five possible answer options scored from 0 (No problems) to 4 (Extreme problems), and each of the four scores was calculated as the sum of the items included. Each item gets score from 0 to 4. Normalized score (100 indicated no symptoms and 0 indicated extreme symptoms) was calculated for each subscale, as 100 indicates no problem and 0 indicates extreme problems.

The normalized score is transformed to meet this standard using formulas provided for each. Total score for each subscale was categorized as: < 100 – 66 Mild, < 66- 33 Moderate, and < 33- 0 Extreme.

Validity:

The revision of the tools was done after translated into Arabic through back –to-back translation by a panel of five experts in Medical-Surgical nursing and biostatistics as a jury to measure the content validity, comprehensiveness, probability, simplicity, thoughtfulness and applicability of the tools. The necessary modifications were done accordingly.

Reliability:

The reliability was tested statistically to assure that the tools are reliable before data collection. Reliability of study tools based on standardized items was set at 0.917 for tool I, which means high reliability of the used tool. The validity of tool II was predetermined at 0.89, means high reliability.

Preparatory Phase:

After extensive review for the current national and international literatures related to the research title using books, articles, web sites, periodicals and journals which composed a guide to develop tool of data collection. Moreover, made the researcher acquainted with the actual and clear dimension of the problem.

Ethical Considerations:

An official permission was obtained from the Faculty of Nursing, Suez Canal University, Research Ethics Committee with number (90/2020) to conduct the study. Theresearchers clarified that participation is volunteer, after clarification of aim, method, and mother nature of the study. The researchers also, told the patients as they can withdraw from the study at any time if they want. A verbal consent was obtained from patients, after explaining that obtained data will not use for other purposes than research. Confidentiality and anonymity of patients were assured through coding of all data and protection of all information.

Administrative Design:

Approval to carry out this study was obtained from the vice dean of post graduate student affairs of the faculty of nursing SCU, and an official permission was obtained from the hospital manager and outpatients' manager to collect data from patients to complete the study and facilitate data collection.

Pilot Study:

The pilot study was conducted on 10 % of total number of the included (120) patients, that equaled 12 patients. The pilot study was done to evaluate tools used for data collection, and determine their simplicity, fairness, and applicability, in addition to estimate the time needed to fill the questionnaire with each patient. Pilot study was excluded from the results as some modifications were done.

Work Field:

1. Preparatory Phase:

After yielding approvals to carry on the study; the researchers interviewed the patients who met sampling criteria, and obtain patients' agreement to participate in the study. The researchers implemented the pilot study to complete validation of data collection tools.

2. Assessment Phase.

The patients who met the inclusion criteria were interviewed individually for ten minutes to explain the nature and purpose of the study. Patients were asked to fill out the study tools to obtain baseline data through assessing level of pain and morning stiffness.

3. Planning Phase.

After the first interview with patients, in addition to literature, the researcher planned how to explain every intervention (heat

application and exercises) effectively by preparing simple booklet for every method in a simple and clear Arabic language that supported with figures for more clarification.

4. Implementation Phase.

The researchers met patients twice every week (Sunday-Tuesday) at the morning shift, through six months started from January 2020 to June 2020. The researchers assessed the patients' level of pain and morning stiffness by using the previous tools. The researcher divided the patients into equal groups each group composed of 40 patients; the first group is called heat group were exposed to heat application, the second group is called exercise were followed physical exercises of osteoarthritis and the third group is called control group who received the hospital routine care only, which included medications only with follow-up at the orthopedic outpatient. The interview and implementation of educational sessions were implemented at the waiting hall.

The Intervention was conducted through five sessions; (1 theoretical and 4 practical). Each session either for theoretical or practical took around 50 minutes. Session (1), concentrated on increasing patients' awareness about knee osteoarthritis and the effective management methods. It contained a brief description about OA causes, clinical manifestation, complications and management. Session (2), focused on educating patients how to practice physical exercises effectively referenced from **(Songül et al., 2019)** under supervision of the orthopedic specialist. The researchers explained types of exercises, and how to do these types by showing different picture for every type, duration and frequency of these exercises as well as explaining contraindication of some types of exercises.

Session (3), focused on educating patients about the techniques of using heat application to do effective heat application compresses under supervision of the orthopedic specialist, and referenced from (**Shereif & Hassanin, 2011)**. The researchers explained different ways of heat application and clarifying the duration and frequency of compressors by showing the patients some pictures and videos about heat application. Session (4, and 5), evaluated the effect of exercises heat application Using KOOS tool to evaluate the effect of physical exercises on OA symptoms (on pain and morning stiffness).

5. Evaluation Phase:

The researchers evaluated the patients' level of pain and morning stiffness and compare between effect of heat application and exercise on level of pain and morning stiffness before implementing the intervention and after one month, using tool I and II. During the time from first assessment until time of evaluation, the researchers contacted with the participants through telephone twice a week to check that patients follow implementation of the heat applications and physical exercises regularly.

Statistical analysis

Data was analyzed using Statistical Package for Social Sciences version 21. descriptive data was offered as number and percentages. Chi-Square test and Student t-test were used for comparison between groups. $P < 0.05$ was considered to be statistically significant.

Limitations of the study:

The current study has several limitations. First, the study's small sample size (120 cases) limits its generalizability even though the results were highly significant with excellent discriminatory power. Hence, a definite conclusion cannot be made based on this study alone. Second, the relatively short-term follow-up, one-month post-intervention. The study did not investigate the long-term effects of the exercise and heat application, or both. Therefore, the researcher could not manage to observe the durability of treatments.

Results

Table 1: revealed that 30%, 32.5% of heat group and control group aged between 40 <45 years respectively and 55% of the exercise group located in the same age group with statistically significant difference between age groups with P value=.008. Also, 70%,72.5% and 75% of heat group, exercise group and control group respectively were female.

Regarding marital status; 92.5%, 97.5% and 80% of the exercise, heat and control groups respectively were married.70% of the exercise group and 45% of the heat group was moderate educate, and 50% of the control group was

illiterate, with statistically significant difference between studied groups with P value<.008. As regards job; 70% of the exercise group was working with 68% of them their work needs moderate effort, 62.5% of the heat group was working with 68% of them their work needs moderate effort, 55% of the control group was working with 42.5% of them their work needs moderate effort. 72%, 65%, 70% of studied groups resided at rural areas.

Table 2, revealed that 57.5%, 70% and 60% of the heat, the exercise and the control group respectively had less than five years of osteoarthritis with both knees affected in 35%, 37.5% and 50% respectively. 47.5%, 17.5 and 40% of the heat group, the exercise group and the control group respectively had hypertension as a chronic comorbid disease, with 50%, 47.5% and 35% respectively had family history of osteoarthritis with the mother was the dominant person have the disease in the family by 35%, 32.5% and 27.5% respectively in the same groups. 85% of the heat and the control groups and 92.5% of the exercise group didn't do exercises. Regarding BMI; the mean score of the heat group, the exercise group and the control group was 35.12±5.90, 36.13±3.11, 34.39±4.79 respectively without significant difference.

Table 3, revealed that 80%, 100% and 97.5% of the heat group, the exercise group and the control group respectively had joint pain as dominant symptom followed with 77.5%, 95% and 80% respectively had joint crepitus, 65%, 90% and 60% respectively had limitation of movement; then stiffness in 32.5%, 15%, 57.5% of the heat group, the exercise group and the control group.

Regarding time of stiffness; the same table shows that 40%, 70 % and 55% of the heat group, the exercise group and the control group had morning stiffness that sometimes affected them in 45%, 45% and 42.5% respectively. Also, 55%, 65% and 57.5% of the heat group, the exercise group and the control group respectively used tab as a method for relieving stiffness and 42.5 %, 87.5% and 77.5 % used physiotherapy for relieving stiffness. Furthermore, 45%, 60% and 50% of them respectively used hot compresses for relieving stiffness.

Table 4, revealed that 72.5%,75% and 72.5% of the heat group, the exercise group and the control group respectively had duration of pain for less than 30 minutes with 17.5%, 50% and 52% respectively had piercing character of pain. Regarding pain onset, 92.5%, 95 % and 95.5% of the heat group, the exercise group and the control group had intermittent onset that occurred with movement in 62.5%, 40% in the heat group and the exercise group respectively and 35% all the time in the control group.

Table 5, revealed that there was no significant difference between the heat group, the exercise group and the control group with regard to pre-intervention in total mean scores. Regarding post intervention, there was significant difference between the heat group, the exercise group and the control group with regard to total mean scores with total mean scores in the heat group, the exercise group and the control group is (65.71%, 52.59 % and 49.82%) respectively with P value <.001.

The same table shows high significant difference between the heat group versus the control group and the exercise group versus the control group and the heat group versus the exercise group in total mean scores items with P value <.001, except the exercise group versus the control group comparison which revealed no significant difference with P value 0.151. There was high significant difference in the heat group and the exercise group with P value <.001 with effect size 1.9 and 0.66 respectively. Also, there was no significant difference in the control group in the two measurements.

Table 5, revealed no statistically significant difference in percentages between all the studied groups at the pre-intervention. Regarding post intervention; there was statistically significant difference in percentages with P value <.001 between the heat group, the exercise group and the control group with 90 % of the heat group had moderate signs and symptoms level pre-intervention to be changed to 55 % in extreme level and 45% in moderate level. Also, 85% of the exercise group had moderate level of signs and symptoms to be changed to 95% in moderate post intervention. Furthermore, 90% of the control group had moderate level of signs and symptoms to be decreased to 85% in moderate level post intervention. With heat applications are more effective than physical exercises.

Table (1): Distribution of the studied groups regarding their demographic data (n=40)

Demographic data	Heat (G1) n=40		Exercise (G2) n=40		Control(G3) n=40		X^2 test	P-value
	N	%	N	%	N	%		
Age								
20:<25	1	2.5	0	0	0	0	20.86	**.008***
25:<30	0	0	1	2.5	0	0		
30:<35	3	7.5	8	20.0	6	15.0		
35:<40	7	17.5	7	17.5	6	15.0		
40:<45	12	30.0	22	55.0	13	32.5		
45-49	18	45.0	2	5.0	15	37.5		
Gender								
Male	12	30.0	11	27.5	10	25.0	.251	.882
Female	28	70.0	29	72.5	30	75.0		
Marital status								
Married	37	92.5	39	97.5	32	80.0	10.51	.105
Single	0	0	1	2.5	0	0		
Divorced	1	2.5	0	0	1	2.5		
Widowed	2	5.0	0	0	7	17.5		
Educational level								
Illiterate	8	20.0	0	0	20	50.0	41.50	**<.001***
Read and write	2	5.0	0	0	5	12.5		
Primary	2	5.0	4	10.0	0	0		
Moderate	18	45.0	28	70.0	12	30.0		
High	10	25.0	8	20.0	3	7.5		
Job								
Working	25	62.5	28	70	22	55.0	2.60	.271
Not working	15	37.5	12	30	18	45.0		
Type of work	**n=25**		**n=28**		**n=22**			
Official	5	20	5	20	4	10.0	.251	.254
Moderate effort	17	68	17	68	17	42.5		
With lifting load	3	12	3	12	1	2.5		
Residence								
Rural	29	72.5	26	65.0	28	70.0	.714	.700
Urban	11	27.5	14	35.0	12	30.0		

X2 is chi-square test; p value is significant <.05

Table (2): Distribution of the studied groups regarding their health status (n=40)

Health Status	Heat (G1) n=40		Exercise(G2) n=40		Control(G3) n=40		X^2- test	p-value
	N	%	N	%	N	%		
Duration of osteoarthritis								
<5y	23	57.5	28	70.0	24	60.0	5.02	.285
5:10 y	15	37.5	12	30.0	12	30.0		
>10y	2	5.0	1	2.5	4	10.0		
Knee affected								
Right	11	27.5	16	40.0	16	40.0	7.27	.122
Left	15	37.5	9	22.5	4	10.0		
Both	14	35.0	15	37.5	20	50.0		
Other chronic diseases								
Hypertension	19	47.5	7	17.5	16	40.0	3.80	0.703
DM	2	5.0	4	10.0	6	15.0		
Liver	1	2.5	1	2.5	0	0		
Others	3	7.5	1	2.5	1	2.5		
No	15	37.5	28	70.0	17	42.5		
Family members suffering from OA								
Yes	20	50.0	19	47.5	14	35.0	1.87	.392
No	20	50.0	21	52.5	26	65.0		
If yes mention	**n=23**		**n=19**		**n=14**			
Father	4	10.0	4	10.0	1	2.5	2.09	.251
Mother	14	35.0	13	32.5	11	27.5		
Brother	1	2.5	2	5.0	1	2.5		
Sister	1	2.5	0	0	1	2.5		
Do exercises								
Yes	6	15.0	3	7.5	6	15.0	3.16	.788
No	34	85.0	37	92.5	34	85.0		
BMI								
Weight (Mean±sd)	92.28±13.62		98.05±8.95		89.78±16.59		F(3.99)	**.021***
Length (Mean±sd)	162.43±5.69		164.75±4.45		161.08±6.77		F(4.22)	**.018***
BMI(Mean±sd)	35.12±5.90		36.13±3.11		34.39±4.79		F(1.35)	.263

X2 is chi-square test; F is one-way anova test; P value is significant <.05

Table (3): Distribution of the studied groups regarding criteria of signs and symptoms of osteoarthritis (n=40).

Criteria of signs and symptoms	Heat(G1) n=40		Exercise(G2) n=40		Control(G3) n=40		X^2 test	P-value
	N	%	N	%	N	%		
Signs and symptoms								
Joint pain	32	80	40	100	39	97.5	1443	04104
Stiffness	13	32.5	6	15	23	57.5		
Limitation	26	65	36	90	24	60		
Crepitus	31	77.5	38	95	32	80		
Edema	7	17.5	2	5	8	20		
Insomnia	16	40	8	20	31	77.5		
Redness	0	0	0	0	0	0		
Squeeze	6	15	2	5	8	20		
Time of stiffness								
Morning	16	40.0	28	70.0	22	55.0	66422	**.012***
Afternoon	2	5.0	2	5.0	8	20.0		
After activity	15	37.5	8	20.0	3	7.5		
After rest	4	10.0	2	5.0	5	12.5		
Morning and after rest	1	2.5	0	0	2	5.0		
Afternoon and after activity	1	2.5	0	0	22	55.0		
Duration								
Continuous	6	15.0	6	15.0	13	32.5	2436	.229
Sometimes	18	45.0	18	45.0	17	42.5		
For fifteen minutes	10	25.0	7	17.5	9	22.5		
For thirteen minutes	5	12.5	9	22.5	1	2.5		
Methods for relieving stiffness*								
Tab	66	55	26	65	23	57.5	30422	04254
Injection	1	2.5	0	0	0	0		
Hot compresses	32	45	24	60	20	50		
Physiotherapy	31	42.5	15	87.5	13	77.5		
Diet therapy	1	17.5	31	32.5	31	42.5		
Exercise	1	2.5	0	0	0	0		
Local	7	17.5	1	7.5	0	0		

*** is multiple response question, X2 is chi-square test; P- value is significant <.05**

Table (4): Distribution of the studied groups regarding pain characteristics of osteoarthritis (n=40)

Pain characteristics	Heat (G1) n=40		Exercise(G2) n=40		Control(G3) n=40		X^2 test	P-value
	N	%	N	%	N	%		
Pain duration								
35≥ 10 mins	29	72.5	30	75.0	29	72.5	9.39	.138
10 mins >1 hour	9	22.5	9	22.5	5	12.5		
1 hour ≥ 2hours	2	5.0	1	2.5	6	15.0		
Pain characteristics*								
Burning	6	35	8	60	6	35	17.84	0.715
Piercing	7	3145	20	50	21	5645		
Pulsatile	4	30	8	60	8	60		
Acute stabbing	2	5	1	645	0	0		
Squeezing	16	40	0	0	0	0		
Constant	3	145	10	65	3	145		
Scattered	6	35	7	3145	8	60		
Severe	2	5	0	0	5	3645		
Pain onset								
Continuous	3	7.5	2	5.0	2	5.0	.303	.859
Intermittent	37	92.5	38	95.0	38	95.0		
Pain time								
Morning	5	12.5	2	5.0	6	15.0	15.11	.128
Evening	3	7.5	6	15.0	5	12.5		
Before sleeping	1	2.5	3	7.5	2	5.0		
During sleeping	2	5.0	1	2.5	1	2.5		
All the time	4	10.0	12	30.0	14	35.0		
With movement	25	62.5	16	40.0	12	30.0		

***is multiple response question, X2 is chi-square test; p-value is significant <.05**

Table (5): Comparison of the studied groups regarding total mean scores of signs and symptoms pre and post intervention (n=40)

Total signs and symptoms	Heat G1. (n=40)	Exercise G2. (n= 40)	Control G3. (n=40)	F (P.value) (η2)	P1	P2	P3
	Mean±SD	Mean±SD	Mean±SD				
Pre	48.75±9.03	46.07±9.99	47.05±9.59	NS			
Post	65.71±6.81	52.59±6.86	49.82±11.23	39.38**(<.001*)** **(.40)**	**(<.001*)**	**(<.001*)**	**(.151)**
t, P value, d^2	10.76**(<.001*)** (1.9)	3.51**(.001*)** (.66)	NS				

F is one-way anova test; t is paired sample t- test; d^2 is Cohen's d effect sizeP value is significant <.05*; P1 is heat versus exercise group, P2 is heat versus control group, p3 is exercise versus control group; Adjustment for multiple comparisons: Least Significant Difference (equivalent to noadjustments).

Table (5): Comparison of the studied groups regarding total levels of signs and symptoms pre and post intervention (n=40)

Total levels of signs and symptoms	Heat G1. (n=40)				Exercise G2. (n= 40)				Control G3. (n=40)				Pre	Post
	Pre		Post		Pre		Post		Pre		Post			
	N	%	N	%	N	%	N	%	N	%	N	%		
Extreme	2	5.0	0	0	4	10.0	0	0	2	5.0	2	5.0	(.965)	**(<.001*)**
Moderate	36	90.0	18	45.0	34	85.0	38	95.0	36	90.0	34	85.0	**mc**	**mc**
Mild	2	5.0	22	55.0	2	5.0	2	5.0	2	5.0	4	10.0		

[mc] is Mont Carlo chi-square test chi-square test; P value is significant <.05

Discussion

Knee osteoarthritis is a widespread, progressive condition known as joint degenerative disease, usually induced by wear, tear, and progressive articular cartilage loss **(Elsiwy et al., 2019 & Springer, 2019).** Osteoarthritis is the most frequently identified issue among older people. Its prevalence increases with age, and more often influences women than men, it is strongly associated with aging and heavy physical occupational activity. Many risk factors such as trauma, overuse, and genetic disorders also lead to the occurrence of the disease **(Abd Allah et al., 2017).** Numerous none-pharmacological methods such as educating patients, joint protection, weight loss, exercise performing, and heat compresses (alternating heat application), can be applied for the treatment of KOA **(Jordan et al., 2015).** Therefore, the current study aimed to evaluate the effect of physical exercise and heat application on pain and morning stiffness in knee osteoarthritis patients.

Concerning the age of the studied patients, the current study showed that, less than half of heat group and control group aged between 45 and 49 years. More than half of the exercise group located between 40 and 45 years with statistically significant difference between the studied groups. This may be due to the fact that, along with the rise in age, the related risk factor of obesity is increasingly rising due to progressive sedentary behavior, improvements in lifestyle habits, dietary routine, and working conditions in the adult population. These findings in agreement with **(Mohamed, 2018; Murphy et al., 2018),** who mentioned that the majority of patients in the studied groups were between 45 and 55 years old and **Saffari et al., (2018)** added that the prevalence of osteoarthritis increases incredibly in the near future due to the aging of the population.

Regarding gender**,** the current results showed that around three- quarters of heat group, exercise group and control group were female. This can be due to hormonal changes, especially after menopause and osteoporosis, which can increase the risk of knee osteoarthritis due to estrogen withdrawal, and exacerbate degenerative changes in multiple joints, as well as less muscle tone and more fat cluster loading on joints especially knees. This finding agrees with a study in Egypt by **(Elstaar et al., 2016; Shin, 2017; Shehata & Fareed, 2018),** who recorded that nearly three-quarters of the patients were female.

With regard to marital status**,** the current research showed that the majority of studied patients throughout the study were married. This

result correlates with **(Groessl et al., 2015; Atamaz et al., 2018; Ulusoy & Yıldırım, 2018),** who found that majority of the studied patients were married. This is related to the fact that that the large percentage of the studied patients were lie in the bearing age so it is apparent that they are married.

As regards educational level**,** the current study, found that the highest number of patients were moderate education among heat and exercise groups, while half of control group were illiterate. This can be attributed to the fact that people with high educational level care for themselves and their wellbeing more than those with low educational level. This finding is in contrast with (**Abd Elfatah, Weheida & Mekkawy, 2019; Uludağ & Kaşikçi (2019),** who found that half of patients were illiterate. Furthermore, current results are supported by **Alkan et al., (2017)** who mentioned that on the other side higher education patients had better functional ability compared to patients educated in primary school.

Regarding patients' occupation**,** it was seen that around two-thirds of the patients were working with their work requires moderate effort. This result is in the same line with **Shehata & Fareed, (2018),** who found that about two-thirds of the sample were working as housewives. But results disagree with **Uludağ & Kaşikçi, (2019),** who noticed that most KOA patients didn't work anywhere. Furthermore, **Lievense et al. (2017)** reported that every work requires repetitive activities, and overloading of joints and associated muscles raises the risk of osteoarthritis in the knees.

Regarding place of residence**,** the current findings showed that around two-thirds of studied patients live in rural areas. This finding agrees with a systematic review conducted by **Usenbo et al. (2015)** who mentioned that the highest prevalence for knee osteoarthritis in rural South Africa. Moreover, the current study consistent with **Fransen et al. (2015$_b$)** who documented that rural patient exhibited about twice of the symptomatic knee osteoarthritis prevalence relative to their urban counterparts.

Regarding the length of the illness duration, it was found that nearly two-thirds of the patients examined suffered from knee OA for less than 5 years, with nearly one-third of the studied patients were obese among the studied groups This in agreement with **Acıkgöz et al., 2017; Mohamed & Mohamed, 2019; Uludağ &Kaşikçi, 2019),** who estimated that more than half of studied patient had OA from for less than five years. Also**, (Abd Elfatah et al., 2019; Uludağ & Kaşikçi, 2019),** was found that more than half of the patients were obese.

The current study found that more than half of patients had systemic diseases as hypertension. The mechanism may include ischemia below the cartilage of patients with knee OA due to hypertension; this form of ischemia may inhibit articular cartilage metabolism and bone remodeling. This finding is consistent with **(Singh et al., 2015; Uludağ & Kaşikçi, 2019)** who found that most of knee OA patients had another disease apart from osteoarthritis such as diabetes mellitus, high blood pressure, renal impairment conditions, and high total cholesterol level compared to the non-affected population.

Concerning family history of osteoarthritis**,** the present study found that over nearly half of the patients had a previous family history of osteoarthritis. This result confirmed by the fact the risk factors of the disease include having family history. The finding is in agreement with **Silverwood et al. (2015),** who stated that environmental factors, genetic factors, fand their interactions are associated with OA susceptibility.

Concerning signs and symptoms, the present study showed that most of the patients in the studied groups were admitted to the hospital due to knee problems such as joint pain, stiffness, limitation of physical activities, and crepitus. This may be related to increased stiffness following long periods of inactivity. All of this may be linked to pain, which is the most prominent symptom in OA patients that are always interrupting patients' sleep. In the same line, **(Jakobsson & Hallberg, 2015; Uludağ & Kaşikçi, 2019)** found that majority of patients reported complaining of knee joint pain range from mild to severe.

Concerning the quality and type of pain among the studied patients, the present study discovered that less than half of the heat group patients had a squeezing pain, and half of exercise and control groups had a piercing sensation of pain, with lowest percent of the studied patients apply compresses on the knee. This result

consistent with **Abd Elfatah et al. (2019)** who indicated that more than one- quarter of knee osteoarthritis patients was suffering from the worst pain, and **Davis & Atwood, (2015),** found that three-quarters of patients used heat application for temporary pain relief. Also, **Ghaleb, (2015)** revealed that pain management methods carried out by a minority of the sample.

As regard knee joint stiffness, the study findings showed that the majority of patients suffering from knee-stiffness in the morning. This could be attributed to the connective tissues or cartilage degeneration is caused the bones to rub painfully against each other, and this process results in stiffness and chronic pain after a period of inactivity. This result is in the same line with **Ibrahim, (2017),** who found that all the studied subjects had pain and morning stiffness.

Regarding the total knee injury and osteoarthritis outcome score pre and post intervention**,** the present study results clarified that there was a statistically significant reduction with improving in total KOOS mean score of pain, other related symptoms, difficulty in performing activities of daily living, the difficulty of performing sports and recreational activities post the intervention of physical exercise and heat application. In addition to a highly statistically significant difference in total KOOS scores post intervention compared to pre intervention.

The study results agreed with **(Archanah et al., 2018; Basuny et al., 2020; Ariana et al., 2021),** whose results displayed that heat compresses had significant effect in reducing the total mean KOOS dimensions score post intervention and improves pain and the range of motion exercises (ROM) in patients with knee OA. Also, **Abd Elfatah et al. (2019),** who reported that there was a decreased mean of pain among the contrast hydrotherapy group than the heat group with highly statistically significant differences. **Raj & Mol, (2017)**, found statistically significant difference between total score of pain, post implementation of physical exercise and heat application. From the researchers' field experience these results could ensure that physical exercise and heat applications are preferred by patients because they are simple and reliable non pharmacological method for the relief of pain as well no side effects on patients' health.

Conclusion

The current study reported statistically significant improvements in pain, physical function, and clinical signs and symptoms between heat and exercise groups compared to control group. Comparing between heat application and physical exercises, the current study found that heat application has strong positive effect on relieve pain, stiffness and improvement in physical functions than physical exercises.

Recommendations

Based upon the findings of the current study; the following recommendations are suggested: Use a combination of physical exercise and heat application together as methods of treatment to relieve pain, stiffness and improve physical function for patient with osteoarthritis. Studies comparing the efficiency of other non - pharmacological methods apart from heat application and exercises (such as cold application, acupressure, etc.) could be considered in managing OA patients.

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