

Effect of Local Heat Application on Complaints of Patients with Moderate Knee Osteoarthritis

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Received December 10, 2018; Revised January 13, 2019; Accepted January 21, 2019

Abstract Background: Osteoarthritis (OA) brings discomfort and disability for around 10% of the total human population due to chronic joint pain. Heat therapy is a common pain management device and easy way to alleviate joints stiffness. **This study aimed** to evaluate the effect of local heat application on joint pain, stiffness, and physical function of patients with moderate knee OA. A quasi-experimental design was utilized. **Setting:** This study was conducted at the Outpatient Clinics related to the Orthopedic and Traumatology Hospital (El Hadara), Alexandria University, Egypt. **Subject:** a total of 52 patients with moderate knee OA were recruited as a convenience sample. They were enrolled into control and intervention groups (26 patients, each). **Tools:** four tools were utilized, **Tool 1:** to assess the severity of disease. **Tool 2:** Self reporting rating scales, to assess pain and tenderness pre and post heat applications. **Tool 3:** Western Ontario and McMaster (WOMAC) OA Index, which aims to determine the change(s) in daily function difficulties with pain, stiffness and physical function and **Tool 4:** Clinical physical assessment. **Results:** The results of the study showed high statistical significant differences in pain intensity and tenderness scores before and after applying hot compresses in the intervention group and also, between the control and intervention subjects regarding pain intensity and tenderness 4 weeks post heat applications. Statistical significant differences were found in control and intervention subjects post 4 weeks of intervention regarding scores of pain, joint stiffness, physical function disabilities, and all overall WOMAC. All studied subjects had body mass index score of $> 27\text{kg/m}^2$. There were positive statistical significant correlations between pain intensity, tenderness, physical function, and Overall WOMAC scores and BMI in both control and intervention subjects ($P \leq 0.05$). **Conclusion:** local heat applications with moderately knee OA patients every other day decreased pain, stiffness and physical functional disability. **Recommendations:** additional randomized controlled trials are needed to evaluate long term heat application effects and follow up of patients with mild moderate and severe knee OA, are to be continued.

Keywords: moderate knee osteoarthritis, heat application, pain, stiffness, physical function

Cite This Article: Hanan Gaber Mohamed, and Mervat Abdel Fattah Mohamed, "Effect of Local Heat Application on Complaints of Patients with Moderate Knee Osteoarthritis." *American Journal of Nursing Research*, vol. 7, no. 2 (2019): 148-159. doi: 10.12691/ajnr-7-2-6.

1. Introduction

Knee osteoarthritis (OA) is a chronic and degenerative condition affecting synovial joints, characterized by the loss of articular cartilage tissue. It is one of the leading causes of morbidity and disability [1]. It has been reported that 6% of adults suffer from clinically significant knee OA with the prevalence increasing with each decade of life [2]. Osteoarthritis is non-inflammatory arthritis that affects more than 27 million Americans," and occurs when the cartilage that cushions the bones wears away, typically with age or use of weight [3].

While the prevalence of OA increases with age, there is a growing recognition that OA affects people at younger ages [5,6]. The disease is classified as primary (idiopathic) or secondary. Primary osteoarthritis sometimes is referred

to as "menopausal OA." Although no single clear cause has been established for OA, a genetic component has been found. Obesity is a potential modifiable factor contributing not only to OA risk, but also to pain symptoms probably due to mechanical loading. Heavy physical activity and occupational load may increase the risk of knee OA especially among obese individuals [7]. Secondary osteoarthritis can be caused by trauma, such as undue stress to a particular joint. It also may develop as a result of an inflammatory condition, such as rheumatoid arthritis, or be caused by a metabolic condition like acromegaly [8].

Plain radiography remains a mainstay in the diagnosis of OA. The first formalized attempts at establishing a radiographic classification scheme for OA were described by Kellgren and Lawrence (KL) [9]. The KL classification was originally described using anteroposterior knee radiographs. Each radiograph was assigned a grade from

0 to 4, which they correlated to increasing severity of OA [9].

The most evident symptoms of knee OA are localized pain in a joint at rest, morning stiffness usually lasting fewer than 30 minutes, bony tenderness and bony enlargement in the joint line, deformities, physical function limitation, and incapacity [10,11]. Clinical results show increased joint volume due to synovitis caused by synovial effusion or thickening. Pain intensity may vary from no pain to individuals' immobilization and physical incapacity [10,12].

The pain experience in knee OA in particular, is well-recognized as typically transitioning from intermittent weight-bearing pain to a more persistent, chronic pain. Consequences of pain related to OA contribute to a substantial socioeconomic burden [13]. As there are no cures for OA, treatments currently focused on maintaining the functions of the patient by controlling the pain, joint stiffness, and improved joint function [14].

Moreover, decreased strength in the muscle groups involving the joints is significant in OA because it causes progressive loss of function. These symptoms significantly restrict the individual's ability to get up from a chair, walk, or climb stairs [15]. Walking with a limp, poor alignment of the limb, and instabilities can also be observed in individuals with OA. During movements, crepitating can be heard because of arthritis of the irregular joint surfaces [5].

The guidelines for the treatment of thigh and knee OA have been published by the American College of Rheumatology, (ACR Subcommittee 2000) and the European League against Rheumatism (EULAR) (Jordan et al. 2003). These guidelines suggest pharmacological, non-pharmacological and operational methods for the treatment of knee OA [16,17]. Many conventional medications such as opioid and non-steroidal anti-inflammatory drugs (NSAIDs) of further concern involve the potentially lethal side effects of NSAIDs, including gastric ulcers and renal insufficiency. Local injection of the knee by corticosteroids usually is limited to a maximum of four per year because of the cumulative effects of cortisone [18]. Although some report notes its short-term benefits, the side effects of any drug taken over extended periods mandate cautious and carefully monitored use [19].

Different non-pharmacological methods like patient education, protection of the joint, losing weight, exercise, heat-cold application, ultrasound and transcutaneous electrical nerve stimulation can be applied for the treatment of knee OA [16,17]. Using heat and/or cold therapies on knee OA is a simple, inexpensive alternative treatment that can help to alleviate pain, stiffness and swelling [20].

In general, the physiological effects of heat therapy can encourage the healing of damaged tissues and causes the blood vessels of the muscles to dilate, which increases the flow of oxygen and nutrients to the muscles [21]. In addition to, warmth with gentle bending and flexing, can spur joint fluid (synovial fluid) production, which can relax muscles and help lubricate joints, relieve muscle and joint stiffness, help warm up joints before activity, or ease a muscle spasm. Warmth also, can stimulate sensory receptors in the skin and decrease the transmissions of pain signals to the brain [22].

Common ways of superficial heat application are thermoforms. It may be applied in the form of hot water, heat packs, or wax therapy, and may serve as an adjunct during painful episodes [23]. Most patients find that 20 to 30 minutes of heat application on knee provides maximum relief. In addition to, starting the day with a hot bath or shower is a quick and easy way to alleviate morning stiffness [22]. Care should be taken against burns; patients with diabetes are particularly vulnerable because of reduced skin sensation. Also; applying heat to a large area of the body, may low blood pressure due to the excessive peripheral vasodilation. This reduction in blood pressure can cause fainting if it is serious. This effect of heat application in individuals with heart, lung or circulatory system diseases, such as arteriosclerosis, develops more frequently than healthy individuals [21].

Because of osteoarthritis' prevalence and chronicity, nursing emphasis is placed on managing and controlling symptoms to minimize disability and maximize independence. Individualized care is a key component for successful management therefore nursing interventions, for pain management, should include heat therapy, exercise, diet control, and joint protection, attention to psychosocial parameters, and patient education [24]. Nursing contribution is a vital part of successful long term osteoarthritis management that requires a holistic approach to the client with reliance on the client's wants, needs, and lifestyle [25].

Rakel & Barr (2003) emphasized that nurses traditionally apply heat and cold applications and some forms of massages; thus, they should be informed on the strength of the evidence for the efficiency of these applications [26]. Wright and Sluka (2001) postulated that information on the effect of superficial heat application in depressing the pain or improving the physical function is, contradictory [27]. So far studies on clinical evidence of local heat application on OA pain level are few and need to be more articulated. This current study aimed to evaluate the effect of local heat application on management of patients with OA.

1.1. Significance of the Study

The lifetime risk of developing symptomatic knee OA is estimated to be 45% (40% in men and 47% in women) based upon Johnston County OA Project data, with risks increasing to 60.5% among the obese, which are approximately double the risk of those who are of normal or underweight. With aging of the population and increasing obesity, the prevalence of OA is expected to rise [28]. It is reported that 6% of adults suffer from clinically significant knee OA with the prevalence increasing with each decade of life [1].

Osteoarthritis brings discomfort and disability for around 10% of the total human population due to chronic joint pain. Although knee OA is not a fatal disease, if left untreated, most of the patients will have to tolerate chronic joint pain and joint diseases until the end of their life [29].

1.2. Operational Definition

Patients' complaints: Joint pain, morning joint stiffness, tenderness and physical function limitations, suffered by patients with focal knee cartilage defect.

Moderate Knee osteoarthritis: A series of radiological features that are considered evidence of moderate (Grade 3) knee OA characterized by multiple osteophytes, definite joint stiffness narrowing (JSN), some sclerosis, possible deformity of bone ends [9].

1.3. Aim of the Study

This study aimed to evaluate the effect of local heat application on joint pain, stiffness, and physical function disability of patients with moderate knee osteoarthritis (OA).

1.4. Research Hypothesis

Patients with moderate knee OA who have received local heat application would have less pain, stiffness, and physical function than those who have not received local heat application.

2. Methodology

2.1. Research Design

A quasi experimental, research design was utilized to fulfill the aim of the study.

2.2. Setting

This study was conducted at the Outpatient's Clinics related to the Orthopedic and Traumatology Hospital (El Hadara), Alexandria University, Egypt.

2.3. Subjects

Throughout six months 80 OA, patients were showing up at the above mentioned settings. Among whom 52 consecutive patients fulfilling the inclusion criteria of being with moderate OA; randomly were divided into two equal groups of 26 patients, each as follows:

- Control group who followed the routine prescribed medication only.
- Intervention group to whom the frequent heat applications were used in addition to their routine prescribed medication.

2.4. Subjects Inclusion Criteria

Patients, who participated in this study, were recruited according to the following criteria:

- Age ranging 45- 60 years old.
- Both sexes (male and female).
- Have been diagnosed of moderate knee OA (Kellgren- Lawrence III).
- They had pain recently lasting for at least three weeks
- Able to give consent and willing to participate in the study.
- Free from psychological and emotional problems.
- Free from all the following associating illness:
 - Peripheral vascular diseases, spinal cord injury, rheumatoid arthritis

- Intra-articular knee depo-corticosteroids and hyaluronate in the past 3 months.
- Open wounds.
- Previous surgery or arthroscopy on the affected knee.
- Acute trauma or inflammation around the leg.
- Cardiac pacemaker, tendency to hemorrhage oedema on the affected knee.
- Malignancy, sensitivity or allergy for heat.
- Diseases that can lead to secondary OA such as diabetes, gout and hypothyroidism.

3. Tools

Four tools were used in this study for data collection.

Tool 1: Basic data interview schedule: This tool was developed based on a thorough review of related literature [1,2,5,7,9,12] It comprised three parts:

Part 1: Sociodemographic Data: This part included information about patient's age, sex, marital status, level of education and occupation.

Part 2: Medical history information: This part included two questions namely: duration of disease and family history regarding knee OA.

Part 3: Kellgren and Lawrence, (1954) (KL) grading for determining knee degenerative changes. This grading was assessed by reviewing the patients' plain x-ray film of the knee. The system uses four grades (0-4) to assess the severity of disease with **grade 0** = none, **grade 1** indicates doubtful joint space narrowing (JSN), **grade 2** indicates definite osteophytes of minimal severity characterized by presence of osteophytes and possible JSN, **grade 3** moderate OA characterized by multiple osteophytes, definite JSN, some sclerosis, possible deformity of bone ends and **grade 4** indicates sever OA characterized by large osteophytes, marked JSN, severe sclerosis and definite bone deformity [9]. It was done by doctors' order in the outpatient's clinics to confirm the subjects in the study who was diagnosed with moderate Knee OA.

Tool 2: Self reporting rating scales: This tool included two parts:

Part I: Pain Visual Analogue Rating Scale: This part was developed by **McCaffery and Beebe, (1993)** to assess pain intensity for both groups as baseline data and after heat application for the intervention group. The linear scale is a visual representation of the range of pain that a patient believes he or she might experience. The range is represented by a line, usually 10 cm in length with or without marks at each centimeter [30]. The patient selects the number from (0-10) that best reflects the intensity of pain. It is classified as follow:

0 = no pain

1-3 = mild pain (little interfering with activities of daily living)

4-6 = moderate pain (interfering significantly with activities of daily living)

7-10 = sever pain (disabling, unable to perform activities of daily living)

Part II: Tenderness index scale score pre and post heat application: This scale was developed by **Ritchie (1986) and Cook (2001)**. It was used to assess knee tenderness for both group subjects before and one month

later after heat application therapy. Tenderness was tested by applying firm pressure to the knee and it was recorded according to the following score; from 0 to 3 where 0 represents no pain and 1, 2, 3 represent mild, moderate and severe tenderness respectively. Pressure was applied to each of the following sites: suprapatellar, infrapatellar, medial collateral ligament, lateral collateral ligament and popliteal fossa, then the mean tenderness score of these areas were calculated [31,32].

Tool 3: Western Ontario and McMaster (WOMAC) Osteoarthritis Index:

This index was developed and adopted by Bellamy, (2005). It is a self-reporting measure of physical disabilities questionnaire that aims to determine the change(s) in daily function difficulties and consequences experienced by OA patients who receive medication and other treatment using Likert scale version of the **Western Ontario McMaster universities OA Index (WOMAC)**. It comprises 24 questions in three subscales [33].

Subscale one concerned with WOMAC pain: This subscale includes five questions related to amount of experiencing knee pain during walking, with ascending stairs, being in bed at night, on rest or with weight bearing sitting or lying and standing upright.

Subscale two concerned with stiffness: This subscale includes two questions related to about amount and severity of experienced knee joint stiffness during the last week after awaking in the morning, after sitting, lying or rest later in the day.

Subscale three concerned with physical functions disability in daily living: This subscale includes 17 questions about degree of experienced difficulty in functions of daily living in the last week during descending and ascending stairs, rising from sitting, standing, bending to pick up an object from the floor, walking on flat surface, getting in and out of car, going shopping, putting on and off socks, lying in and raising from bed, getting in and out of bath and toilet and having light and heavy domestic duties.

There are five alternatives on the Likert scale for each question. They are 0= no constraints or difficulties, 1 = slight, 2=moderate, 3=severe, 4= very severe constraints. The highest score for each subscale on WOMAC on the Likert scale was: 20 for pain, eight for stiffness and 68 for physical function. The total score ranges from 24 to 96. The highest total score (96) denotes worse or more symptoms and the strongest physical constraints.

Tool 4: Clinical physical assessment: This tool was developed based on a review of related literatures and aimed to assess the anthropometric studies and vital signs parameters. It consisted of two main parts:

Part I: Anthropometric studies: This part included assessing body height (cm) and weight (kg.). The body mass index (BMI) was calculated with weight divided by the height squared ((kg)/ (m²). It was categorized into four levels: underweight (BMI < 18.5), ideal weight (18.5 ≤ BMI < 24.0), overweight (24.0 ≤ BMI < 27.0) and obese (BMI ≥ 27.0 Guidelines for Taiwan, (2011) [34].

Part II: Vital signs assessment: Body temperature (BT), Heart rate (HR) and systolic and diastolic blood pressure (BP) were measured before heating application technique on knee joint.

4. Method

1. Administrative Approval:

- An official permission to carry out the study was obtained from the directors and the responsible authorities of the study setting after explaining the aim of the study.
- Informed consents were obtained from eligible study subjects after explanation of the study purpose.

2. Ethical considerations:

- The participants were given the opportunity to refuse participation and or withdraw at any stage of the data collection without giving any reason.
- The studied sample also assured that any information collected would be confidential and used only for the research purpose.

3. Developing study tools

Tools were developed based on review of relevant literature.

Validity and reliability:

- Tools were revised by 5 experts in the fields of Rheumatology and Medical Surgical Nursing for content and construct validity. The necessary modifications were introduced accordingly.
- Reliability of the tool was measured by Cronbach's alpha coefficient ($r=0.7$).

Pilot study:

- A pilot study was carried on 10% of the studied patients after the final tools were developed to test the clarity, and applicability of the tools and to estimate the time to fill the tools. Pilot study patients were excluded from the study subjects.

5. Data Collection

The data were collected over a period of 6 months, starting from January to June 2018. It was carried out in three phases:

- Assessment phase (pre – intervention and treatment)

Study participants' diagnosis of moderate KOA, was established through X-ray studies. Study aim was introduced to each patient individually and informed consents were taken from both group subjects. The interview questionnaire (Tool 1) was filled in (part I) and (part II). Each patients' pain and tenderness, were assessed using the standardized scale questionnaire (**Tool 2 part I, II**), as well as, Western Ontario and McMaster (WOMAC) OA Index as baseline data for both group subjects before applying heat therapy (**Tool 3**). Weight and height were measured and Body mass index (BMI) calculated (**Tool 4 part I**). In addition, body temperature, heart rate and systolic and diastolic BP were measured using **tool 4 part II** for every subject, before heat application.

Implementation phase

Once the assessment phase was completed, heat application was applied for the intervention group participants along with their prescribed routine medical care. They were informed and prescribed by their doctors that they could apply heat as a non-pharmacological treatment. The control subjects were instructed to receive the prescribed routine medical care only. Subjects in the intervention group received a total of 16 intervention sessions, 30

minutes every other day (i.e. four sessions a week for four weeks). Heat applications were carried out by the investigators at the outpatients' clinics. Otherwise, those subjects were instructed and followed to continue the heat session schedule at home. After completion of heat maneuvers, every participant was asked about his comfort or adverse events, if any.

Heat application intervention:

This technique included:

1. Explaining the purpose and effects of heat application and its benefit upon knee joints for the intervention subjects.
2. Assisting the patient to relax.
3. Measuring vital signs using **tool 4 part II**.
4. Helping the subject assume supine position during heat application.
5. A hot moist bottle bag with cover (40-42°C) was applied on the OA knee for 20-30 minutes every other day [6,35]. Heat application to the patients in the intervention group was carried out by the investigators at the outpatient clinics.

Evaluation Phase (post – intervention and treatment)

The effectiveness of heat application on knee OA patients' health outcomes was evaluated, on the 4th week post heat application. This effectiveness was based on finding of differences or no differences between pre (baseline assessment) and post intervention ascertaining changes of pain intensity and tenderness index scores (**Tool 2 part I, II**), and health status outcomes including pain, stiffness and physical function (WOMAC) using **tool 3**.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. (Armonk, NY: IBM Corp). Qualitative data were described using number and

percent mean standard deviation. Significance of the obtained results was judged at the 5% level. **The used tests were**

1 - Chi-square test

For categorical variables, to compare between different groups

2 - Monte Carlo correction

Correction for chi-square when more than 20% of the cells have expected count less than 5.

For normally distributed quantitative variables, to compare between two studied.

3 - Paired t-test

For normally distributed quantitative variables, to compare between two periods

4 - Pearson coefficient

To correlate between two normally distributed quantitative variables.

6. Results

Table 1 shows comparisons between the intervention and control knee OA subjects according to their socio-demographic characteristics. The mean age of intervention and control subjects was (51.77 ± 5.45 and 51.58 ± 4.91) years respectively. More than half of the subjects in intervention and control groups (i.e. 53.8% and 50% respectively) were males. More than three quarters of subjects in the intervention and control groups were married. Fifty and 53.8% of the intervention and control subjects had full time work, whether mentally or technical. Table also shows that; no statistical significant differences were found between the two groups regarding patients' socio-demographic characteristics.

Table 1. Comparisons between intervention and control Knee OA subjects according to their socio- demographic data (n = 52)

Socio-demographic characteristics	Intervention group (n=26)		Control group (n=26)		Test of sig.	P
	No.	%	No.	%		
Age (years)					$\chi^2=0.517$	
45 – < 50	11	42.3	13	50.00		
50 – < 55	7	26.9	6	23.1		
55 – 60 years	8	30.8	7	26.9		
Min. – Max.	44.0 – 60.0		45.0 – 60.0		t=0.134	0.894
Mean ± SD.	51.77 ± 5.45		51.58 ± 4.91			
Sex					$\chi^2=0.077$	0.781
Male	14	53.8	13	50.0		
Female	12	46.2	13	50.0		
Marital status					$\chi^2= 0.464$	^{MC} p=1.000
Single	4	15.4	3	11.5		
Married	20	76.9	20	76.9		
Widow	2	7.7	3	11.5		
Education					$\chi^2= 2.218$	^{MC} p=0.567
Illiterate	1	3.8	3	11.5		
Read and Write	9	34.6	5	19.2		
Secondary	6	23.1	7	26.9		
High	10	38.5	11	42.3		
Occupation					$\chi^2= 0.988$	^{MC} p=0.857
Technical work	11	42.3	9	34.6		
Office /clerical	9	34.6	11	42.3		
House wife	6	23.1	6	23.00		
Length of time of work					$\chi^2= 0.077$	0.781
Full time	13	50.0	14	53.8		
Part time	13	50.0	12	46.2		
Socio-economic status					$\chi^2= 0.250$	^{MC} p=1.000
Adequate	4	15.4	5	19.2		
Moderate / enough	18	69.2	17	65.4		
Inadequate	4	15.4	4	15.4		

χ^2 : Chi square test *MC: Monte Carlo - t: Student t-testp: p value for comparing between the two studied groups.

Table 2. Comparisons between the intervention and control knee OA subjects according to their medical history information (n=52)

Medical history information	Intervention group (n=26)		Control group (n=26)		χ^2	P
	No.	%	No.	%		
Duration of disease					1.659	^{MC} p=0.656
6 months – < 1 year	4	15.4	4	15.4		
1 – < 3 year	10	38.5	14	53.8		
3 – < 5 year	10	38.5	7	26.9		
> 5 years	2	7.7	1	3.8		
Family history					0.310	0.578
No	13	50.0	15	57.7		
Yes	13	50.0	11	42.3		

χ^2 : Chi square test p: p value for comparing between the two studied groups.

Table 3. Comparisons between the intervention and control knee OA subjects according to their clinical physical assessment parameters (N= 52)

Clinical physical assessment parameters	Intervention group (n=26)		Control group (n=26)		T	P
	No.	%	No.	%		
BMI (kg/m²)					-	-
Obese (≥ 27.0)	26	100.0	26	100.0		
Min. – Max.	31.89 – 39.56		31.51 – 39.92		0.522	0.604
Mean \pm SD.	35.97 \pm 2.34		35.62 \pm 2.53			
Vital signs					1.078	0.286
Temperature						
Min. – Max.	36.80 – 37.50		36.50 – 37.30		0.225	0.823
Mean \pm SD.	37.03 \pm 0.15		36.98 \pm 0.15			
Pulse					0.225	0.823
Min. – Max.	68.0 – 110.0		64.0 – 107.0			
Mean \pm SD.	86.62 \pm 12.03		85.88 \pm 11.41			
Blood pressure					0.213	0.832
Systolic						
Min. – Max.	110.0 – 130.0		110.0 – 130.0		1.020	0.313
Mean \pm SD.	120.0 \pm 7.48		120.42 \pm 6.80			
Diastolic						
Min. – Max.	70.0 – 90.0		70.0 – 90.0			
Mean \pm SD.	81.65 \pm 6.19		80.0 \pm 5.48			

t: Student t-test p: p value for comparing between the two studied groups

Table 4. Comparisons between the intervention and control knee OA subjects in relation to their pain intensity pre and post 4th week of intervention and routine treatment (N= 52)

VAS of pain	Intervention group (n=26)		Control group (n=26)		Test of sig.	P
	No.	%	No.	%		
Pre intervention					$\chi^2=$ 0.433	0.510
Moderate	5	19.2	7	26.9		
Severe	21	80.8	19	73.1		
Mean \pm SD.	7.35 \pm 0.94		7.23 \pm 0.99		t=0.431	0.668
Post intervention and treatment					$\chi^2=$ 5.438*	0.020*
Moderate	21	80.8	13	50.0		
Severe	5	19.2	13	50.0		
Mean \pm SD.	5.69 \pm 0.84		6.58 \pm 1.06		t=3.329*	0.002*
p₁	<0.001*		<0.001*			
% change	↓22.4 \pm 7.5		↓9.1 \pm 8.4		t= 6.060*	<0.001*

χ^2 : Chi square test t: Student t-test

p: p value for comparing between the two studied groups

p₁: p value for paired t test for comparing between Pre- test and Post test

*: Statistically significant at p \leq 0.05.

Table 2 displays comparisons between the intervention and control knee OA subjects in relation to their medical history. No statistical significance differences were found between both intervention and control subjects regarding medical history information, since $P \geq 0.05$. The findings revealed that; half of the intervention subjects (50%) and less than half of the control subjects (42.3%) had family history of knee OA.

Table 3 Demonstrates comparisons between the intervention and control knee OA subjects in relation to clinical physical assessment parameters. No statistical significant differences were elicited between the intervention and control subjects regarding BMI, temperature, pulse, and blood pressure $P= (0.604, 0.286,$

0.823, 0.832, and 0.313 respectively). All the studied subjects (100 %) in both groups were obese (≥ 27.0).

Table 4 shows comparisons between the intervention and control knee OA subjects according to their levels of pain intensity score pre and post 4th week of post intervention and routine treatments (n = 52). The table shows that 80.8% and 73.1% of subjects in the intervention and control group had severe knee pain pretreatment respectively and the difference was insignificant (p =0.510). However, statistical significance differences were found between both group subjects after application of intervention and treatment in relation to their pain intensity where (p= 0.020).

Table 5 shows comparisons between the intervention and control knee OA subjects according to their levels of tenderness pre and post 4th week of intervention and routine treatments (n = 52). The table shows that 42.3% and 57.7% of patients in the intervention and control group had moderate tenderness pre intervention respectively, and the difference was insignificant where (p=0.500). However, statistical significant differences emerged between the intervention and control subjects after treatments in

relation to their means score of tenderness (p =0.040*). Although there was significant decrease and improvement in tenderness score post treatments in the control subjects (1.58±0.86). The score was still higher than those in intervention group subjects (1.12±0.71) (P<0.001*). Percent change and improvement i.e. decline of tenderness score, was also found to be higher changes among the intervention group subject than control group subjects where t= 3.076* and p= 0.003*.

Table 5. Comparison between the intervention and control knee OA subjects according to tenderness score pre and post 4th week of intervention and routine treatment (N= 52)

Tenderness score	Intervention group (n=26)		Control group (n=26)		Test of sig.	P
	No.	%	No.	%		
Pre intervention						
Mild	7	26.9	6	23.1	$\chi^2=1.385$	0.500
Moderate	11	42.3	15	57.7		
Severe	8	30.8	5	19.2		
Mean ± SD	2.04±0.77		1.96±0.66		t= 0.385	0.702
Post intervention and routine treatment						
None	5	19.2	3	11.5	$\chi^2=5.068$	MCp=0.167
Mild	13	50.0	8	30.8		
Moderate	8	30.8	12	46.2		
Severe	0	0.0	3	11.5		
Mean ± SD	1.12±0.71		1.58±0.86		t= 2.113*	0.040*
p_i	<0.001*		<0.001*			
% change	↓50.6±28.1		↓23.7±34.7		t= 3.076*	0.003*

χ^2 : Chi square test MC: Monte Carlo

p: p value for comparing between the two studied groups p_i: p value for paired t test for comparing between Pre- test and Post-test *: Statistically significant at p ≤ 0.05.

Table 6. Comparisons between the intervention and control knee OA subjects in relation to their pain, stiffness and physical function disabilities (WOMAC) pre and post 4th week of intervention and routine treatments. N= 52

	WOMAC	Intervention group (n=26)	Control group (n=26)	T	P
Pain	Pre intervention				
	Total score	15.12 ± 1.11	15.38 ± 0.80	1.003	0.321
	*M % Score	75.58 ± 5.54	76.92 ± 4.02		
	Post intervention and treatment				
	Total score	12.04 ± 0.77	13.77 ± 1.03	6.843*	<0.001*
*M % Score	60.19 ± 3.87	68.85 ± 5.16			
p_i	<0.001*	<0.001*			
% change	↓20.0±6.7	↓10.5±5.5	5.654*	<0.001*	
Joint Stiffness	Pre intervention				
	Total score	5.42 ± 0.86	5.62 ± 0.50	0.991	0.328
	*M% Score	67.79 ± 10.71	70.19 ± 6.20		
	Post intervention and treatment				
	Total score	4.42 ± 0.64	4.92 ± 0.56	2.989*	0.004*
*M% Score	55.29 ± 8.04	61.54 ± 7.0			
p_i	<0.001*	<0.001*			
% change	↓19.6±10.9	↓12.2±8.4	2.746*	0.008*	
Physical function Disability	Before intervention				
	Total score	51.12 ± 2.89	51.50 ± 2.90	0.479	0.634
	*M% Score	75.17 ± 4.25	75.74 ± 4.27		
	Post intervention and treatment				
	Total score	42.08 ± 2.68	46.88 ± 3.01	6.079*	<0.001*
*M % Score	61.88 ± 3.94	68.95 ± 4.43			
p_i	<0.001*	<0.001*			
% change	↓17.6±4.9	↓8.9±4.1	6.960*	<0.001*	
Total Scores	Pre intervention				
	Total score	71.65 ± 4.12	72.50 ± 3.58	0.791	0.433
	*M % Score	74.64 ± 4.29	75.52 ± 3.73		
	Post intervention and treatment				
	Total score	58.54 ± 3.28	65.58 ± 4.12	6.818*	<0.001*
*M % Score	60.98 ± 3.41	68.31 ± 4.29			
p_i	<0.001*	<0.001*			
% change	↓18.2±4.2	↓9.5±4.0	7.621*	<0.001*	

t: Student t-test p: p value for comparing between the two studied groups p_i: p value for paired t test for comparing between Pre- test and Post test *: Statistically significant at p ≤ 0.05 * Mean Percent Score.

Table 6 illustrates the comparisons between the intervention and control knee OA subjects in relation to their pain, stiffness and physical function disabilities (WOMAC) pre and post 4th week of intervention and routine treatments. N= 52. No statistical significant differences were elicited between the intervention and control subjects in all the pretreatment scores regarding pain, stiffness, physical function disability, and total score of WOMAC (all P were more than 0.05). Statistical significant differences were noticed between the intervention and control subjects in all post- intervention scores regarding pain, stiffness, physical function disability, and total score of WOMAC ($P \leq 0.05$). Although there were significant improvements in pain, stiffness, and physical function disability mean score post 4th week of routine treatment in the control subjects, where all $p = 0.001^*$, those of the intervention group were still significantly higher since all p were less than 0.001^* .

Table 7 shows the correlations between BMI of the studied patients and pain intensity, tenderness and Overall WOMAC scores. Statistically positive significant correlations were elicited between each of the VAS of

pain, tenderness, physical function disability, and overall WOMAC scores and BMI in both the intervention and control subjects since $P \leq 0.05$. However, negative statistical significant correlations were noticed between pain item of WOMAC and BMI in both studied groups since P were more than 0.05.

Table 8 depicts the correlations between pain intensity, tenderness and WOMAC scores with subjects' socio-demographic data post intervention and routine treatments. Regarding the age, there were positive statistical significant correlations between each of VAS of pain, tenderness, physical function disability and the overall WOMAC scores with participants' age in both the intervention and control subjects since $P = \leq 0.05$. Also, there were statistical positive significant correlations between each of physical function disability and overall WOMAC item scores and education in the control subjects ($P \leq 0.05$). Nevertheless, negative statistical significant correlations were noticed between each of VAS of pain, tenderness, physical function disability and the overall WOMAC scores—with sex, length of time of participants' work as well as family history ($P > 0.05$).

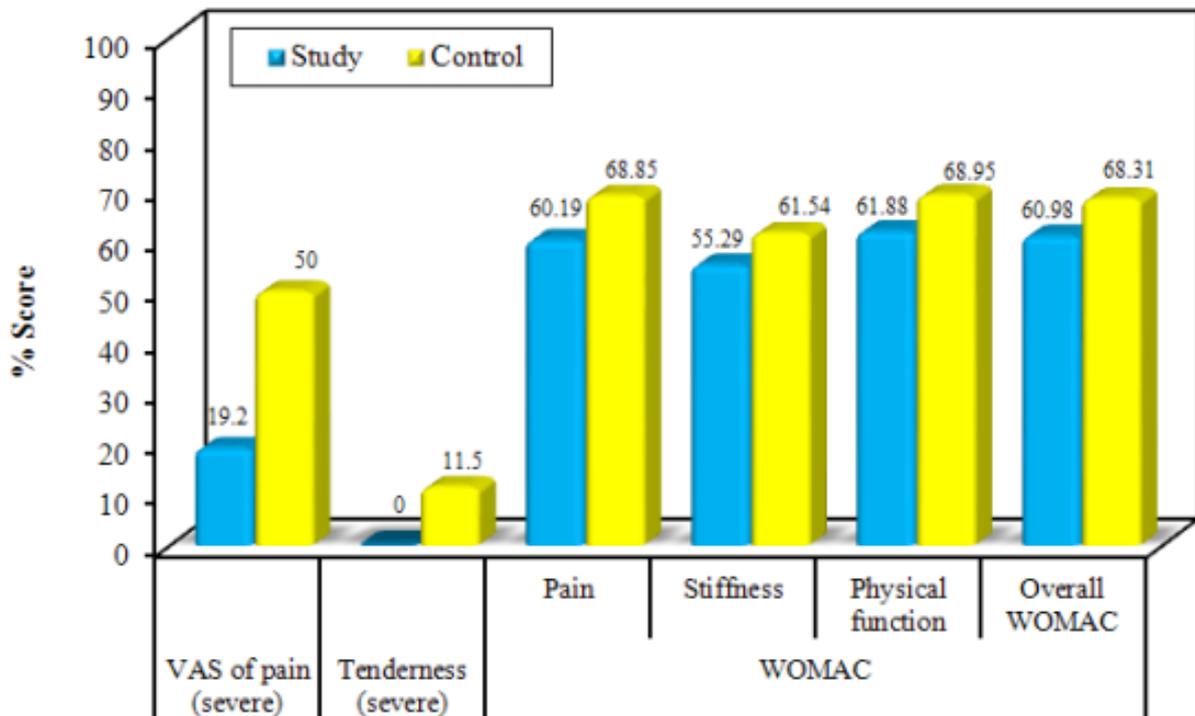


Figure 1. This figure displays comparisons between the intervention and control knee OA subjects in relation to percent mean scores of their pain intensity, tenderness and WOMAC including pain, stiffness and physical function disabilities post intervention and routine treatments (N= 52)

Table 7. Correlations between BMI of the studied patients and pain intensity, tenderness and overall WOMAC scores (N=52)

Post intervention and routine treatments	BMI (kg/m ²)			
	Study (n=26)		Control (n=26)	
	R	p	r	P
VAS of pain	0.589*	0.002*	0.625*	0.001*
Tenderness score	0.620*	0.001*	0.526*	0.006*
Overall WOMAC:	0.451*	0.021*	0.409*	0.038*
Pain	0.029	0.890	0.180	0.379
Stiffness	0.138	0.502	0.400*	0.043*
Physical function disability	0.509*	0.008*	0.423*	0.031*

r: Pearson coefficient * Statistically significant at $p \leq 0.05$.

Table 8. Correlations between pain intensity, tenderness and WOMAC scores with subjects' socio demographic data post intervention and routine treatments (N=52)

	Post treatments		VAS of pain	Tenderness score	WOMAC			
					Pain	Stiffness	Physical function Disability	Overall
Intervention group (n=26)	Age (years)	R	0.790*	0.729*	0.249	0.314	0.606*	0.616*
		P	<0.001*	<0.001*	0.220	0.118	0.001*	0.001*
	Sex	R	0.065	-0.153	0.258	0.113	0.002	0.085
		P	0.752	0.455	0.203	0.583	0.991	0.680
	Education	R	0.333	0.183	-0.160	-0.232	-0.077	-0.146
		p	0.096	0.372	0.436	0.254	0.710	0.477
Length of time of technical work	r	0.187	0.055	0.051	0.183	-0.029	0.024	
	p	0.360	0.789	0.806	0.371	0.887	0.908	
Family history	r	0.00	-0.276	-0.355	-0.061	-0.029	-0.120	
	p	1.000	0.173	0.075	0.767	0.887	0.560	
Control group (n=26)	Age (years)	r	0.668*	0.565*	0.217	0.337	0.424*	0.410*
		p	<0.001*	0.003*	0.287	0.092	0.031*	0.037*
	Sex	r	0.258	0.046	0.076	0.000	0.274	0.219
		p	0.203	0.824	0.712	1.000	0.176	0.282
	Education	r	0.355	0.221	0.220	0.270	0.414*	0.394*
		p	0.075	0.279	0.281	0.182	0.035*	0.046*
Length time of technical work	r	0.301	0.283	0.211	0.270	0.088	0.154	
	p	0.135	0.162	0.300	0.182	0.667	0.452	
Family history	r	-0.100	-0.310	0.041	-0.022	0.033	0.032	
	p	0.626	0.123	0.841	0.916	0.871	0.877	

r: Pearson coefficient *: Statistically significant at $p \leq 0.05$.

7. Discussion

The most evident complaints of knee OA are localized knee joints pain, stiffness and loss of physical function. The current study aimed to evaluate the effects of local heat application on pain, stiffness, and physical function in patients with knee OA.

Concerning the age, Felson (2004) stated that aging is the most significant risk factor for knee OA [37]. The present study showed that, the majority of patients' age in the studied groups ranged from 45 – 55 years old. The present findings are in accordance with Zhang et al. (2018), and Salehi-Abari (2016), who found that, the majority of the cases were more than 40 years old [18,38]. Losina et.al (2013) and Aminian and Baghaei (2014) stated that while the prevalence of OA increases with age, there is a growing recognition that OA affects people at younger ages [6,39]. The current study findings not in line with Cunha-Miranda, et.al (2015) and Henrotin, et.al (2010) who stated that OA is one of the most common types of arthritis and is most prevalent after age 80 [40,41].

Concerning the sex, the current study showed that half of the subject's patients in both groups were females. This is inconsistent with Katz (2015) and Shehata and Fareed (2013) who found that three fourth of their studied sample (75%) were females [42,43]. Lawrence, et al (2008) and Zang, Jordan (2008) found that both genders can be affected but women are affected more than men [44,45]. Nevertheless, Marley et.al (2014) and Cho et.al found (2011) that the gender differences in prevalence has recently been emphasized in meta-analyses, which provides evidence for a greater risk in females for prevalent and incident knee OA [46,47].

With respect of the obesity, women with body mass index (BMI) of 30- 35kg/m² had a four times higher risk

for knee OA than non-obese women [48]. Jones et al (2000) and Coggon et al. (2001) found that knee OA has been strongly associated with several environmental factors including obesity [49,50]. This finding supports the present study results since all studied subjects had BMI score of > 27kg/m². Furthermore, Ahmed (2014) and Losina et al. (2011) stated that due to progressive aging of the population and the escalating prevalence of obesity, it is estimated that the number of people affected by knee OA will dramatically rise in the next decades [51,52]. No doubt, the effect of obesity on OA has been mediated through the increased mechanical loading of the knee and hip, which would lead in cartilage damage in weight bearing joints.

In relation to family history of OA, fifty percent of the intervention subjects and more than half of the control subjects had family history regarding knee OA. Roberts and Lappe (2001) reported that the incidence of OA were among sisters of their studied sample [53]. Interestingly, Mohamed (2014) and Zhai et al. (2004) indicated a modest but significant genetic effect of knee radiographic osteoarthritis (ROA) has been reported in most studies [54,55]. Nevertheless, Shehata and Fareed (2013) found that the majority of their studied sample of the present study had had no familial predisposition for OA [43].

Nuki, and Salter (2007) found that increased risk for knee OA was associated with those involved in heavy occupational loads that entail prolonged or repeated knee bending. The risk may be even higher in those activities containing both knee bending and mechanical loading of the knee and hip [56]. McAlindon et.al (1999) added that heavy physical effort may increase the risk, especially among the obese [57]. However, Lievens et al. stated that any work load involving repetitive tasks and overloading the joints and corresponding muscles increase the risk of knee OA [58].

Heavy work may activate the biochemical cascade that leads to joint degeneration and pain. More than one third of the current studied participants had been involved in full time in technical work.

The results of the present study showed high statistical significant differences between pain intensity and tenderness scores before and after heat application for the intervention group subjects and also, in pain intensity and tenderness scores of the control subjects and intervention subjects one month after treatments. This finding is in accordance with Dinçer et al, (2006) Lofgren and Norrbrink (2009) who mentioned that significant reduction of pain measurements namely VAS, was observed as a result of applying hot compresses [59,60]. Archanah et.al (2018), Giombini et.al (2007) contended that hyperthermia act by increasing local blood flow, which accelerates metabolic processes and toxin removal, thereby facilitating tissue repair and promoting pain relief [61,62].

Also, Steen and Cooper (1998) and Smeltzer and Bare (2014) stated that during the application of local heat, there will be a dilution of intravascular prostaglandins, bradykinin, and histamine. These substances are among the most potent pain inducing molecules [63,64]. Local heat although a minor pain control method may also increase the threshold of cutaneous sensory receptors, through enkephalin production [65].

Regarding the WOMAC sub score items, according to Brandt (1998), approximately 60% of patients diagnosed with rheumatoid arthritis (RA) and OA preferred heat application on their aching joints although the effect of heat application was not well investigated [66]. Davis and Atwood (1996) stated that current knowledge on the therapeutic benefits of heat application is insufficient; and the expected benefit from the heat application is low, whereas 70% of the studied patients expressed that they applied heat application to alleviate morning joint stiffness from 20 to 30 minutes [67]. Mazzuca et al. (2004) found no statistical significant differences between the scores for WOMAC pain, WOMAC stiffness and WOMAC disability after heat application [68].

This result is not in congruence with the present study findings that revealed statistical significant difference between intervention and control groups in all post 4th week of intervention regard scores of pain, joint stiffness, and physical function disabilities as well as the overall WOMAC after heat application. Yıldırım et al., (2010) and Dinçer et al, (2006) argued that the differences between the initial WOMAC pain and WOMAC disability scores and those obtained after heat application in their study, were statistical significant, while the difference between the scores for WOMAC stiffness after the intervention was not statistically significant [59,69].

Also, Güngen et al. (2012) had recently shown that the application of hot packs improves pain both at rest and during activities as well as physical performance in patients with knee OA [70]. Kaplan et al. (2003) added that delivery of nutrients and oxygen is enhanced following deep heating, thus facilitating tissue repair. The increased capillary permeability induced by heat therapy allows macrophages and granulocytes to reach the affected area, therefore promoting the removal of toxins and necrotic debris. Noteworthy, the activity of cartilage

degrading enzymes is blunted following joint heating. In addition, hyperthermia can interfere with the activity of collagenase, oxygenate and other enzymes involved in the inflammatory process [71].

There were positive statistical significant correlations between each of (VAS of pain, tenderness, physical function disability and overall WOMAC scores) and age in both the intervention and control group subjects post 4th weeks heat application. Many studies are consistent with our findings [43,61,71,72].

For the education, there were statistical significant correlations between each of the physical function disability and overall WOMAC scores with education and age of the control subjects. In spite of the homogeneity of both intervention and control subject noticed as regards their level of education, significant correlations between the level of education and overall physical disabilities of the control subjects were be detected. This may be attributed to the fact that control subjects were not following their intervention protocol.

Local heat application has been widely used as an adjoining non-pharmacological treatment modality for the management of knee OA. The findings of the current study have demonstrated the efficiency of heat application for the managing the pain, as well as overcoming disability in daily physical activities. Since local heat application has been found to be initially reducing the pain and increasing the physical activity, it may be a choice of preference for the managing patients with knee OA, to whom NSAIDs and analgesics are contra indicated. Nevertheless, research on this issue has remained limited.

8. Conclusions

It was found that, local heat applications with moderately knee OA patients every other day decreased pain, stiffness and physical functional disability.

9. Recommendations

- The efficiency of heat application on pain, stiffness, physical function for patients with knee osteoarthritis may offer an insight into decision - making process for appropriate intervention.
- Prospective, more long lasting studies are advocated to evaluate long term heat application effects and follow up of patients with mild moderate and severe knee OA, are to be continued
- Continued clinical evidence with x ray study changes is required with the above mentioned advocated studies, to confirm the clinical findings.
- Study the effect of contrast therapy on controlling knee OA associated problems.

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