

Effect of Cold, Warm or Contrast Therapy on Controlling Knee Osteoarthritis Associated Problems

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Abstract—Osteoarthritis (OA) is the most prevalent and far common debilitating form of arthritis which can be defined as a degenerative condition affecting synovial joint. Patients suffering from osteoarthritis often complain of dull ache pain on movement. Physical agents can fight the painful process when correctly indicated and used such as heat or cold therapy **Aim**. This study was carried out to: Compare the effect of cold, warm and contrast therapy on controlling knee osteoarthritis associated problems. **Setting**: The study was carried out in orthopedic outpatient clinics of Menoufia University and teaching Hospitals, Egypt. **Sample**: A convenient sample of 60 adult patients with unilateral knee osteoarthritis. **Tools**: three tools were utilized to collect the data. **Tool I**: An interviewing questionnaire. It comprised of three parts covering sociodemographic data, medical data and adverse effects of the treatment protocol. **Tool II**: Knee Injury and Osteoarthritis Outcome Score (KOOS). It consists of five main parts. **Tool III**: 0-10 Numeric pain rating scale. **Results**: revealed that the total knee symptoms score was decreased from moderate symptoms pre intervention to mild symptoms after warm and contrast method of therapy, but the contrast therapy had significant effect in reducing the knee symptoms and pain than the other symptoms. **Conclusions**: all of the three methods of therapy resulted in improvement in all knee symptoms and pain but the most appropriate protocol of treatment to relive symptoms and pain was contrast therapy.

Keywords—Knee Osteoarthritis, Cold, Warm and Contrast Therapy.

I. INTRODUCTION

OSTEOARTHRITIS (OA) is the far common debilitating form of arthritis which can be defined as a degenerative condition affecting synovial joint, being the most prevalent form of joint disease which does not lead to systemic involvement without associated mortality [1]. It affects the weight bearing joints in the knees, hips and hands. Osteoarthritis of knee is a common and progressive condition. It is reported that 6% of adults suffer from clinically significant knee osteoarthritis with the prevalence increasing with each decade of life [2].

It can be classified according to its causes or predisposing factors as either primary or secondary. The primary one (idiopathic) is the most common type and has no identifiable causes rather than genetic predisposition while several disorders are well recognized as causes for secondary OA. They can be grouped into four basic categories such as, metabolic as calcium crystal deposition and acromegaly;

anatomic as leg length inequality and congenital hip dislocation; traumatic as fractures and sprains and inflammatory as ankylosing spondylitis and septic arthritis [3].

Patients suffering from osteoarthritis often complain of dull ache pain on movement, typically occurring when movement is initiated. As osteoarthritis progresses, the pain becomes continuous, and the functionality of the joint is severely impaired [2]. However, among community residents, it has been found that articular pain is the most important problem affecting daily life. Patients have a tendency to avoid activity due to a fear that it will cause more pain. Moreover, knee OA sufferers often show joint stiffness, tenderness, crepitus, joint enlargement, deformity, muscle weakness, limitation of joint motion, impaired proprioception, and disability. Patients may experience a serious impact to daily activities due to difficulty in walking, moving, climbing stairs, getting in and out of a car and/or sitting in a chair that is caused by instability or buckling of the joints together with weakness of thigh muscles [4], [5].

It is not a curable disease, as the mechanism by which it arises and progress remains incompletely understood. Therefore, the goal of treatment is to alleviate the signs and symptoms of the disease and if possible to show its progression. Multiple treatment options are available for patients with OA of the knees including the use of superficial heat or cold, obesity management, exercises, oral pharmacological therapy, injection of corticosteroid or ultimately knee joint replacement surgery [6], [7].

There are risks and side effects associated with medications and surgery that are not associated with some remedies such as superficial heat or cold applications. Furthermore, not all treatment options meet the same results, supporting individualized patient management approaches; the benefits of others such as injections of corticosteroid don't last indefinitely and must be repeated. The periodic application of superficial heat or cold is relatively safe and low cost treatment that can be recommended in isolation or in combination with other treatment. Contrast therapy involving intervals of warm and cold application within a treatment session offers yet another option in the management of many different musculoskeletal conditions including knee OA [8], [9].

Warm may work by improving circulation and relaxing muscles so decreasing pain, while cold may numb the pain, decrease swelling, constrict blood vessels and block nerve impulses to the joint [10]. The usual sources of warm and/or

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cold therapy include either warm or cold compress, ultrasound for heat modalities, either warm or cold bath or shower and heating pads for heat remedies [11].

Few studies are available to demonstrate if either cold, warm or contrast therapies are of greater benefit and there are no clear answers or recommendations for patients to follow, hence this study was carried out to compare the effect of cold, warm or contrast therapy on controlling knee osteoarthritis associated problems.

II. SIGNIFICANCE OF THE STUDY

Osteoarthritis is the most common disease affecting 5.596869 from the total population in Egypt (Statistics by country for Osteoarthritis, 2011). Osteoarthritis of knees is a common and progressive condition. It is reported that 6% of adults suffer from clinically significant knee osteoarthritis with the prevalence increasing with each decade of life [2]. It has been observed that there are many patients admitted to orthopedic outpatient, clinics, orthopedic department and physiotherapy and rehabilitation department with knee osteoarthritis in Menoufiya university hospital complaining from joint pain, swelling and unable to perform activities of daily living. Physiotherapeutic conservative measures are often an adjunct to medical treatment or a follow up to surgical intervention such as heat or cold therapy. We hoped that one of the used therapy (warm, cold or contrast) may help in relieving patients' complain and provide them with easily used, harmless, time, effort and cost saving treatment modality for their complains.

III. AIM OF THE STUDY

The aim of the present study was to compare the effect of cold, warm or contrast therapy on controlling knee osteoarthritis associated problems.

Research Hypotheses

The following research hypothesis was formulated to achieve the aim of the study:

- Contrast therapy will be more effective in controlling knee osteoarthritis associated problems than warm or cold therapy.

IV. SUBJECTS AND METHOD

A. Subjects

Design: A quasi experimental research design was utilized to achieve the aim of this study.

Setting: The study was carried out in orthopedic outpatient clinics of Menoufia University and teaching Hospitals.

Subjects: A convenient sample consisted of 60 adult patients with unilateral knee osteoarthritis. They were selected according to the following criteria:

- Willing to participate in the study.
- Both sexes.
- No history of previous knee or hip arthroplasty or any other orthopedic surgical procedure on the affected knee.
- Have no kind of metal implants and/ or pacemaker.

- Have no cardiac disorders that affect local circulation.
- Have no history of receiving corticosteroid injection to the knee within the past 6 months.
- Free from diminished sensation to heat or cold in knee area.

Tools: In order to achieve the aim of the study, three tools were utilized to collect the data. These tools are as follows:

Tool I: An interviewing questionnaire: It was developed by the researchers to assess Patients' sociodemographic and medical data. It comprised of three parts:

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

Part two: Medical Data. It was comprised of questions about body mass index, reasons for visiting hospital, family history of osteoarthritis and vital signs.

Part three: Adverse effects of the treatment protocol such as localized inflammation, redness, hotness.....etc.

Tool II: Knee Injury and Osteoarthritis Outcome Score (KOOS): It was developed by the Roos et al. [12] to assess patients' opinion about their knee and associated problems. The English version was used. The scoring system was modified by researchers. It consists of five main parts as follow:

Part one (pain): It included questions about sensation of knee pain during the last week such as frequency and amount of experiencing knee pain during twisting, straightening, bending knee, walking on flat surface, going up and down stairs, being in bed at night, sitting or lying and standing upright.

Part two (other symptoms): It consisted of questions about the experienced other symptoms during the last week such as swelling of knee, hearing noise on moving knee, hanging up knee on moving and the ability to fully straight and bend knee. Also there were questions 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.

Part three (function in daily living): Questions about degree of experienced difficulty in function 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.

Part four (function in sport and recreation): Questions about degree of experienced difficulty in sports and recreational activities during the last week in squatting, running, jumping, twisting, and kneeling the injured knee.

Part five (knee related quality of life): Questions about frequency of awareness of knee problem, whether life style are modified to avoid potentially damaging activities, the amount of having difficulty with the knee during the last week.

Scoring system: The standardized answer options were given five likert boxes and each question had a score from zero to four in which zero indicate no problems, while four

indicates extreme problems. Each of the five scores was calculated as the sum of the items included. A total score 144-186 indicates extreme knee symptoms, while 100 to 143 score indicates moderate symptoms but 56 to 99 indicates mild symptoms and less than 56 represents no knee symptoms.

Tool II: 0-10 numeric pain rating scale: It was developed by the McCaffery and Beebe [13] to assess pain intensity. The scale consisted of 10 cm line that was numerated from zero to ten in which:

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)

B. Method

- 1- A written approval to carry out the study was obtained by the researchers from responsible authorities after explanation of the purpose of the study before initiating the study.
- 2- **Tools development:** the first tool was constructed by the researchers after reviewing the relevant literature and was tested for content validity by 5 experts in Nursing and Orthopedic fields. Modifications were done accordingly to ascertain relevance and completeness. While the second tool was developed by Roos et al. [12] and the third tool was developed by McCaffery and Beebe [13].
- 3- **Reliability of tool I:** tool one was tested using a test retest method and a Pearson correlation coefficient formula were used. It was 8.79.
- 4- Prior to the actual study, a pilot study was conducted on 10% of the study sample (6 patients) to test feasibility and applicability of the tools and then necessary modifications were carried out accordingly. Data obtained from the pilot study were not included in the current study.
- 5- The researchers introduced themselves to every participant, explain the purpose of the study and assured them that confidentiality would be maintained throughout the study then a verbal consent was obtained from each participant.
- 6- **Data collection:**-Data collection was extended over a period of 6 months from August 2012 to January 2013. Patients who agreed to participate in the study and fulfilling the inclusion criteria were included in the study.
 - The researcher initiated data collection by assessing sociodemographic and medical data through interviewing each participant individually using tool I.
 - The opinion of patients about knee and associated problems for each participant were assessed using knee Injury and Osteoarthritis Outcome Score (KOOS) (tool II).
 - Each participant was assessed for pain and its intensity using 0-10 numeric pain rating scale (tool III).
 - Each participant asked to complete the three treatment protocols including cold, warm and contrast

(alternating cold and warm) of one week (7 days) duration. The applications were applied through packs over layers of towel around the affected knee. Each treatment protocol consisted of twice a day (morning and evening) application of the treatment options for 5 consecutive days followed by 2 days of no treatment. Each of the twice daily treatment was applied for 20 minutes except for the contrast treatment which consisted of 4 minutes of warm followed by one minute with no treatment then two minutes of cold. This cycle was repeated three times in a total session of 21 minutes.

- Each participant was assessed for KOOS to assess the changes of knee problem changes from week to week induced by treatment protocol and 0 -10 numeric pain rating scale to assess responses of patients' pain to treatment protocol another three times (on the 7th day of each treatment protocol).
- After compilation of all three treatment protocol, each participant was asked about any adverse events for any of the treatment protocol.

V. STATISTICAL ANALYSIS

Data was collected, tabulated and statistically analyzed with SPSS statistical package version 11. Two types of statistics were done:

- 1- **Descriptive** such as number, percentage, mean and standard deviation.
- 2- **Analytical :**
 - a- Student T test for comparison between two groups with quantitative data.
 - b- Paired T test to study effectiveness of methods of treatment before and after for one group.
 - c- Chi square test for comparison of qualitative data between two or more groups.

P value was considered significant if less than 5%

Limitation: study sample did not prefer the cold therapy and a lot of them refused to apply it that foster the researchers to decrease number of studied sample and the data collection take long time in relation to the time of applications.

VI. RESULTS

Table I revealed that the mean age of studied sample was 55.2 ± 8.38 years. Three fourth of studied sample (75%) was female. As regard occupation, about two thirds of them (60%) were housewives. Regarding the medical data, the mean body mass index was 37.65 ± 5.6 . Only 10% of studied sample had positive family history of osteoarthritis.

Table II illustrated that the mean pretotal knee Injury and Osteoarthritis Outcome Score (KOOS) and the mean total KOOS after cold therapy of studied sample indicated that patients had moderate knee symptoms. While after warm and contrast therapy; the total score indicated mild knee symptoms. Also, it was showed that there were statistically significant differences between total KOOS score pre intervention and after the three methods of intervention.

Table III revealed that there were statistically significant differences between total pain score pre intervention and after the three methods of intervention.

Table IV and Fig. 1 showed that the contrast therapy had significant effect in reducing the total KOOS and pain scale than cold or warm therapy.

Table V presented that more than one third of studied sample (35%) had redness after applying warm therapy. While no one of them (0.0%) complained of side effects for cold or contrast therapy.

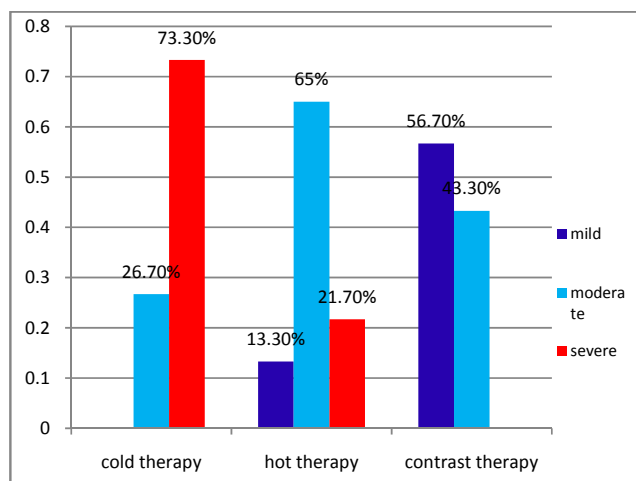


Fig. 1 Number and percentage distribution of studied sample regarding pain intensity after cold, warm, and contrast therapy

TABLE I
DISTRIBUTION OF BIOSOCIODEMOGRAPHIC CHARACTERISTICS OF STUDIED SAMPLE

Sociodemographic data	(No. =60)	%
Age :		
Mean \pm SD	55.20 \pm 8.38	
Sex :		
• Male	15	25.0
• Female	45	75.0
Education :		
• Illiterate	28	46.7
• Basic education	7	11.7
• Higher education	25	41.6
Occupation:		
• Manual	16	26.7
• Administrative	8	13.3
• House wife	36	60.0
Marital status:		
• Married	51	85.0
• Widowed	9	15.0
BMI :		
Mean \pm SD	37.65 \pm 5.6	
Reasons for visiting hospital		
• Swelling and hotness	48	80.0
• Difficult movement	12	20.0
Family history of Osteoarthritis		
• Yes	6	10.0
• No	54	90.0
Vital signs:		
• Normal	55	91.7
• Hypertension	5	8.3

Table VI revealed that there were no significant differences between male and female regarding total KOOS score. While there were significant differences between them regarding total pain score with warm and contrast therapy.

TABLE II
MEAN AND STANDARD DEVIATION OF EFFECTIVENESS OF COLD, WARM AND CONTRAST THERAPY ON TOTAL KOOS SCORE OF STUDIED SAMPLE

Total KOOS score	Mean \pm SD	T- test	P- Value
Pre total score	131.20 \pm 21.17	10.33*	<0.0001
Follow up1 (cold therapy) total score	108.16 \pm 27.18		
Pre total score	131.20 \pm 21.17	23.77*	<0.0001
Follow up2 (warm therapy) total score	76.28 \pm 24.32		
Pre total score	131.20 \pm 21.17	26.63*	<0.0001
Follow up3 (contrast therapy) total score	70.51 \pm 23.60		

*Indicate significance differences.

- The low total mean KOOS score, the mild knee symptoms

TABLE III
MEAN AND STANDARD DEVIATION OF EFFECTIVENESS OF COLD, WARM AND CONTRAST THERAPY ON TOTAL PAIN SCORE OF STUDIED SAMPLE

Total pain score	Mean \pm SD	T- test	P- Value
Pre total score	8.56 \pm 1.53	7.21*	<0.0001
Follow up1 (cold therapy) total score	7.56 \pm 1.95		
Pre total score	8.56 \pm 1.53	20.75*	<0.0001
Follow up2 (warm therapy) total score	5.30 \pm 1.95		
Pre total score	8.56 \pm 1.53	31.68*	<0.0001
Follow up3 (contrast therapy) total score	3.43 \pm 1.55		

- Indicate significance differences.

TABLE IV
COMPARISON BETWEEN EFFECTIVENESS OF COLD, WARM AND CONTRAST THERAPY FOR STUDIED SAMPLE ON TOTAL KOOS AND PAIN SCORE

Variables	Cold therapy Mean \pm SD	Warm therapy Mean \pm SD	Contrast therapy Mean \pm SD	Friedman test (X ²)	P- Value
Total KOOS score	108.16 \pm 27.18	76.28 \pm 24.32	70.51 \pm 23.60	91.96	<0.0001*
Total pain score	7.56 \pm 1.95	5.30 \pm 1.95	3.43 \pm 1.55	114.24	<0.0001*

- * Indicate significance differences.

TABLE V
COMPARISON BETWEEN COLD, WARM AND CONTRAST THERAPY REGARDING THEIR SIDE EFFECTS ON STUDIED SAMPLE

Quality of life domains	Warm therapy (No. =60)		Cold therapy (No. =60)		Contrast therapy (No. =60)		X ²	P value
	No.	%	No.	%	No.	%		
Redness	21	35.0	0.0	0.0	0.0	0.0		
Hotness	3	0.0	0.0	0.0	0.0	0.0		
No	36	60	60	60	60	100	27.3	<0.0001*

* Indicate significance differences.

TABLE VI
COMPARISON BETWEEN MALE AND FEMALE OF STUDIED SAMPLE REGARDING MEAN AND STANDARD DEVIATION OF TOTAL KOOS AND PAIN SCORE WITH COLD, WARM AND CONTRAST THERAPY

Variables	Male	Female	T- test	P- Value
Total KOOS score	Mean ± SD	Mean ± SD		
Pre total KOOS score	123.06±23.95	133.11±19.70	1058	>0.05
Follow up1 (cold) total KOOS score	105.73±21.79	108.97±28.92	0.45	>0.05
Follow up1(warm) total KOOS score	73.06±19.69	77.35±25.79	0.67	>0.05
Follow up1(contrast) total KOOS score	65.40±15.56	72.22±25.65	1.23	>0.05
Total pain score	Mean ± SD	Mean ± SD		
Pre total pain score	8.13±1.55	8.71±1.51	1.25	>0.05
Follow up1 (cold) total pain score	7±2.13	7.75±1.87	1.22	>0.05
Follow up1 (warm) total pain score	4.46±1.55	5.57±2.0	2.22	<0.05*
Follow up1 (contrast) total pain score	2.66±1.23	3.68±1.57	2.28	<0.01*

• Indicate significance differences.

VII. DISCUSSION

Osteoarthritis is the third leading cause of disease burden and the fourth most important cause of disability in the world. It was recently estimated that since 1990, the prevalence of arthritis has increased by 750000 cases per year [14]-[15].

The present study showed that, the mean age of studied sample was 55.20±8.38 years. This finding is consistent with [4], [16] who reported that the incidence of osteoarthritis rises with age and the prevalence increases substantially after the age 50 years in woman and 55 years in men.

Regarding sex, Puttini et al. [16] mentioned that knee osteoarthritis is common in woman than men. This is in line with the results of the present study which stated that, three quarters of studied sample were females. Also it was revealed that about two thirds of the sample of the present study was housewives. This coincides with the study of Lievense et al. [17] who stated that any work involve repetitive tasks and overloading the joints and corresponding muscles increase the risk of knee osteoarthritis.

It is summarized in a study [18] that, a higher body mass index significantly correlated with an increased risk of joint replacement due to osteoarthritis. This is in agreement with the findings of this study that showed that the mean body mass index of the studied sample was 37.65±5.6kg/m. Also Shaban [19] mentioned that the body mass index of the sample was 36.75± 5.16k/m.

Regarding family history of osteoarthritis, the majority of studied sample of the present study had no familial predisposition for osteoarthritis. This is in contrast to the results of Roberts and Lappe [20] who reported that the incidence of osteoarthritis is three times higher among sisters of osteoarthritis than in general population. This might be explained by the sample of the present study is small that is not amenable to study prevalence.

The cardinal and dominant symptoms of osteoarthritis is pain joint which may be deep, aching and localized. While with knee osteoarthritis, there are specific knee symptoms such knee pain and other symptoms as joint stiffness and knee swelling, alteration in activities of daily living, function and sports and quality of life. In the present study, the mean pre total knee osteoarthritis outcome score indicated moderate knee symptoms and pretotal pain score indicated sever pain [21].

Numerous studies had recommended that combination of pharmacological and non pharmacological treatment is frequently employed guidelines for **management** of hip and knee OA [22]. A variety of modalities have been investigated in the treatment as heat or cold therapy [23]. Regarding cold therapy, it was found that, the total KOOS and pain scores were decreased after applying the cold therapy but patients still had moderate KOOS and sever pain. This is in line with Zhang et al. and Brosseau et al. [20], [24] who reported that applications of ice packs for three weeks is followed by some improvement in pain.

In contrast to this study, Bleaky et al. [25] mentioned that twenty minutes cold applications can reduce the transmission of painful impulses by up to 29.4% and lasting about 30 minutes after its removal. This may be explained by our patients were not prefer applying cold that may affect the results.

In relation to warm therapy, it was found that warm therapy reduces the total KOOS score to mild knee symptoms. In this respect Garg [26] stated that application of heat produce vasodilatation which increases oxygen to tissues that reduce knee symptoms as stiffness of joints. Also the results of the current study revealed that warm therapy decrease pain intensity to moderate score. This is in agreement with Lofgree and Norrbrink [27] who stated that median pain intensity in

patients using warm therapy decreased than before the treatment. This may be occurring due to raise of nerve pain threshold.

In respect to the effect of contrast therapy, it was shown that the total KOOS score was decreased to mild knee symptoms and the total pain score decreased to moderate score. This may be illustrated by Bonhaman et al. [28] who concluded that there are a wide effect for contrast therapy for knee osteoarthritis symptoms such as reduction of inflammation, decreased edema, pain and stiffness, but the physiological basis of the therapy is not adequately understood.

Dengar et al. [29] confirmed that contrast therapy provided the greatest improvement in total KOOS and pain scores than cold or warm therapy. This finding supports the results and hypothesis of the present study.

In relation to side effects of the different treatment modalities, it was concluded that redness was occurred in more than one third of studied sample after applying warm therapy. This result coincides with Nadler et al. [30] who summarized that warm modalities provide significant pain relief with low side effects.

Dengar et al. [29] stated that the reasons for the effect of cold, heat or contrast require additional investigations but gender is likely to play some role. This is in agreement with the finding of the current study which showed that there was significant difference between total pain score for male and female after applying warm and contrast therapy.

VIII. CONCLUSION

The present study revealed that a distinct individual effect was observed for use of cold, warm and contrast therapy for knee osteoarthritis pain and problems, but the greater knee problems and pain relief were found when subjects used contrast therapy. Application of cold, warm and contrast are non invasive and generally safe.

IX. RECOMMENDATIONS

Based on the findings of the current study, the following recommendations can be suggested:

1. Superficial warm, cold or contrast therapy should be included in the early effort to manage patients with osteoarthritis.
2. Contrast therapy should be considered the most effective treatment options for relieving knee symptoms and pain.
3. Replication of the study with larger sample must be considered in the development of future research to allow greater generalization of the results. Also the patient preference of the treatment option should be considered that may affect the results.

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