

## Effect Of Continuous Short Wave Diathermy and Infra Red Ray in Management of Symptomatic Knee Joint Osteoarthritis: A Comparative Study

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**Communication Date:** Feb. 1, 2015

**Acceptance Date:** Feb.. 10, 2015

**DOI:**

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**Key Words:** Osteoarthritis, Knee joint, Pain intensity, Joint range of motion. Goniometer, visual analogue scale

**To cite this article:**

Ojoawo, Adesola O; Adebowale Emmanuel, T.& and Olaogun Matthew O.B. Effect Of Continuous Short Wave Diathermy and Infra Red Ray in Management of Symptomatic Knee Joint Osteoarthritis: A Comparative Study. [online]. *Journal of Exercise Science and Physiotherapy*, Vol. 11, No. 2, Dec 2015: 98-107.

### Abstract

The study compared the effect of continuous short wave diathermy (CSWD) and Infrared radiation (IRR) in the management of symptomatic knee osteoarthritis (SKOA) patients. Fifty patients with SKOA receiving treatment at Obafemi Awolowo Teaching Hospital Complex, Ile-Ife, were randomly assigned equally into CSWD, Group A and IRR Group B. Subjects in the two groups had isometric strengthening exercises to the quadriceps muscles. Group A and B had for 15 minutes CSWD and IRR respectively twice in a week for 6 weeks. Present pain intensity and joint range of motion were measured before the treatment, 3 weeks and 6 weeks of treatment. Data were analysed using Descriptive and inferential statistics. There was a significant reduction in pain intensity of subjects in group A ( $f=11.05$ ,  $p=0.001$ ) and group B ( $f=3.843$ ,  $p=0.045$ ) between pre-treatment, and 6<sup>th</sup> week of treatment. Pain intensity of group A was less than that of Group B at 3<sup>rd</sup> week. CSWD and IRR are equally effective in alleviating pain intensity of patients with SKOA but CSWD may reduce it faster.

## Introduction

Worldwide, osteoarthritis (OA) which is associated with aging has been reported to be a significant public health problem due to its major impact on disability and associated morbidities in the elderly (Fransen, 2011). Symptomatic knee OA occurs in 10% men and 13% in women aged 60 years or older (Zhang *et al*, 2010). A study conducted by Akinpelu *et al* (2009) investigated the prevalence and pattern of knee OA in Igbo-Ora, a rural community in South-western Nigeria. It was found that the prevalence of knee OA among the people of Igbo-Ora was 21.4% among females and 17.5% among males, giving a female bias ratio of 1.2:1. They concluded that one out of every five adults aged 40 years and above in this Nigerian rural community may have symptomatic knee OA, with a female preponderance in the ratio of 1.2:1.

Primary knee osteoarthritis is a chronic degenerative disorder related to but not necessarily caused by aging. As a person ages, water content of the cartilage decreases as a result of a reduced proteoglycan content, thus causing the cartilage to be less resilient (Simon, 2005). The development of OA is correlated with a previous joint injury and obesity, especially with respect to knees (Coggon and Reading, 2001). Osteoarthritis commonly affects the large weight bearing joints especially the knees (Marks, 1999). A variety of causes such as hereditary,

developmental, metabolic and mechanical deficits may initiate processes leading to loss of cartilage with bone surfaces become less protected by cartilage, bone may be exposed and damaged (Conaghan, 2008). As a result of decreased movement secondary to pain, regional muscles may atrophy, and ligaments may become more lax (Conaghan, 2008). Osteoarthritis can cause a crackling noise (called crepitus) when the affected joint is moved or touched, and the patients may experience muscle spasm and contractions in tendons (McAlindon 2007). Pain which may be caused by accumulation of fluid, though occasionally, is aggravated by humid and cold weather (McAlindon, 2007).

Painful discomfort in osteoarthritis is often managed by pharmacological and non-pharmacological interventions. One of the non-pharmacological interventions in physiotherapy include thermotherapy. This can be in form Infrared radiation or electromagnetic radiation commonly referred to as short wave. Short wave diathermy (SWD) is the application of high-frequency electromagnetic energy that is primarily used to generate heat in tissues (Prentice, 2003). The body is placed within an electrical field and becomes part of an alternating current that is generated from the short wave diathermy unit (Denegar, 2000). This form of electrotherapy can be applied in either a continuous (CSWD) or a

pulsed (PSWD) setting. The depth of penetration of short wave diathermy is greater than any infra red modalities (Houghton, 2010). The main effects of SWD are to increase deep tissue temperature, provide vasodilation, and increase the amount of blood flow to the affected area (Goats, 1989). Short wave diathermy uses the radiofrequency wave bands of 27.12MHz and the wavelength is 11 meters (Guy et al, 1984). The short wave diathermy has adjustable arms to position the electrodes close to the body part requiring treatment. The short wave diathermy field is generated between the two plates and the configuration of the electrodes influences the distribution of the short wave diathermy field within the tissues (Guy et al 1984).

In contrast to short wave diathermy, Infrared radiation (IRR) is the part of the electromagnetic radiation spectrum comprised between 0.78 $\mu$ m and 1mm wavelength. It is usually divided into three segments. IR-A, from 0.78 to 1.4 $\mu$ m. IR-B, from 1.4 to 3 $\mu$ m. IR-C, from 3 $\mu$ m to 1mm. Heat from infrared radiation creates higher tissue temperatures, which produces vasodilation that increases the supply of oxygen, and nutrients and the elimination of carbon dioxide and metabolic waste (Nadler et al., 2004). In a Cochrane review by Brosseau et al (2010), thermotherapeutic treatment of knee OA was discussed with respect to knee ROM, pain, strength, oedema, and function. Thermotherapy produces localized thermal

effects on superficial target areas, depending on clinical indications and desired therapeutic outcomes. However, they do acknowledge a general heterogeneity in study parameters, citing variable methodology with respect to outcome results and test administration (Brosseau et al, 2003). Discrepancy in research standards is echoed in a systematic review by Jamtvedt and Dahm (2008), who concluded due to small sample sizes and low quality of studies, the efficacy of thermotherapeutic agents on pain and function in patients with knee OA as inconsistent and therefore unclear.

## Materials and Method

*Participants:* The sample for this study comprised of 50 subjects with SKOA attending out-patient Physiotherapy Clinic of Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC) Ile-Ife. They are individuals with radiographic evidence of osteoarthritis of the knee.

*Inclusion Criteria:* The subjects that participated in this study met the following criteria:

Chronic osteoarthritis (with duration of onset more than 3 months), patients had radiological report asserting knee osteoarthritis. Each of the patient reported pain, early morning stiffness, in one or both knee joints, reduced range of motion, muscle weakness, cracking when they were moving and pain when climbing stairs. The following tests were found painful at knee joint: passive movement of

the knee joint, patella compression, grinding test and genuflex.

*Exclusion criteria:* Patients with acute KOA, those that had surgery with metallic implant in the knee joint and patient with other pains apart from osteoarthritis of the knee.

*Sample size determination:* For a study comparing two means according to Rosner (2000), the equation for sample size is:

$$N = \frac{4\sigma^2 (Z_{crit} + Z_{pwr})^2}{D^2}$$

Where N is the total sample size (the sum of the sizes of both comparison groups),  $\sigma$  Is the assumed SD of each group (assumed to be equal for both groups) and this is assumed to be 6 Zcrit is the Standard Normal Deviate Corresponding to the Selected Significance Criterion (i.e 0.05 (95%=1.960).

Zpwr is the Standard Normal Deviate Corresponding to Selected Statistical Power (i.e 0.80=0.842).

D is the minimum expected difference between the two means and D=5

Therefore ;

$$N = 4 \times 6^2 (1.96 + 0.842)^2 \div 5^2$$

$$N = 45.22 \sim 45$$

This was increased to 50 because of attrition. Therefore a total number of 50 participants were enrolled for the study (25 participants for Group A and 25 participants for Group B).

Purposive sampling technique was used to select 50 patients with KOA and were randomly assigned in to 2 groups A and B. An opaque envelope with 50 rapped

pieces of paper was provided. In each rapped paper was written ‘‘S’’ and ‘‘I’’, patients that picked S were for shortwave and those that picked ‘‘I’’ were for Infra Red Ray.

*Procedures:* Ethical clearance was obtained from Health Research Ethics Committee, Institute of Public Health, Obafemi Awolowo University, Ile Ife, Nigeria. The purpose of the study was explained to each patient and the consent was obtained to participate in the study.

*Outcome measures:* Present pain intensity of subjects in both groups was rated using a 10 point visual analogue scale (VAS) where patient touched the level of his/her pain on the scale, the joint range of motions (active and passive knee flexion) were measured using universal goniometer. The body weight and height were measured using stadiometer.

*Intervention:* Subjects in each group was place on strengthening exercise using isometric muscle contraction with principle of overloading according to ACSM (2000). Participant on group A was placed on Short Wave Diathermy, Curaplus 967 with contraplanar method using rigid electrodes when patient was on sitting posture according to Kitchen and Bazin, (2007). Infrared lamp was applied to the knee of subjects in group B using Solarite overhead luminous lamp according to Kitchen and Bazin (2007). Each knee in the 2 groups was massage with neurogesic topical gel after the treatment. Each treatment section took an average of 30 minutes. Fifteen minutes of

infrared or short wave to the knee joint, 10 minutes of exercise for 5 minutes of massage then 5 minutes for patient to rest and dress up. These made a session. The treatment was carried out twice in a week for 6 weeks making 12 treatment sessions for each patients.

**Data Analysis:** The data was analysed using Statistical Package for Social Sciences (SPSS 16). Descriptive statistics and inferential statistics were used to summarize the data. Repeated measure Analysis of variance was used to compare the mean values of pre-treatment, 3<sup>rd</sup> week treatment and 6<sup>th</sup> week treatment of pain intensity, active range of motion and passive range of motion within the group. Repeated measure ANOVA was used to compare the pain intensity, active range of motion and passive range of motion of short wave diathermy and infrared radiation group between the group. An alpha level of  $p < 0.05$  was set as significant level.

## Results & Discussion

Table 1 shows the result of physical characteristics of participants. The mean age of the participants was  $64.33 \pm 8.04$  yrs, while the mean height, weight and BMI were  $1.63 \pm 0.07$  m,  $86.50 \pm 15.78$  kg and  $32.40 \pm 4.24$  kg/m<sup>2</sup> respectively. Also, the mean pre-treatment pain intensity of Group A and pre-treatment Group B were  $6.83 \pm 0.75$  and  $4.67 \pm 1.75$  respectively

**Table 1: Physical Characteristics of Subjects**

VARIABLES	Group A N= 25 Mean ±SD	Group B N= 25 Mean ±SD	t	P
Age/Yrs	64.33 ±8.04	63.23 ±7.56	0.26	0.87
Height/m	1.63 ±0.07	1.61 ±0.05	0.89	0.56
Weight/Kg	86.50 ±15.78	84.16 ±14.58	1.26	1.34
BMI/Kg/m <sup>2</sup>	32.40 ±4.24	33.56 ±4.14	0.67	0.78
PPI	6.83 ±0.75	6.67 ±1.75	0.98	0.76
ARM	88.33 ±19.15	89.17 ±18.82	1.34	0.54
PRM	94.17 ±18.00	94.17 ±18.82	1.54	0.75

**Key: BMI = Body Mass Index, PPI = Present Pain intensity, ARM = Active Rang of Motion PRM = Passive Range of Motion.**

*Comparison between pre-treatment, 3<sup>rd</sup> week treatment and 6<sup>th</sup> week treatment of pain intensity, active range of motion and passive range of motion of short wave group:*

**Table 2: Result of Repeated measure ANOVA comparing the mean values of pre-treatment, 3<sup>rd</sup> and 6<sup>th</sup> week of pain intensity, ARM and PRM of group A N = 23**

Variables	Means ± SD	F	p-value
PPI	6.83 ± 0.75		
P3W	5.83 ± 1.17	11.05	0.001
P6W	4.50 ± 0.55		
ARM	88.33 ± 19.15		
ARM3W	90.83 ± 17.15	0.284	0.757
ARM6W	95.83 ± 16.25		

PRM	94.17	±		
	18.00			
PRM3W	95.83	±	0.246	0.785
	17.15			
PRM6	100.83	±		
	16.25			

**KEY:** PPI = Present Pain intensity, P3W= Pain intensity, 3<sup>rd</sup> week, P6W = Pain intensity, 6 week  
 ARM = Active Rang of Motion ARM3W = Active range of motion 3rd week, ARM6W = Active range of motion 6 week. PRM = Passive Range of Motion, PRM3W = Passive range of motion 3rd week, PRM6W = Passive range of motion 6th week

Table 2 shows ANOVA comparing the mean values of pre-treatment 3<sup>rd</sup> week and 6<sup>th</sup> week of pain intensity, active range of motion and passive range of motion of group A. The results showed that there was significant difference in the pain intensity of pre-treatment, 3<sup>rd</sup> and 6<sup>th</sup> week ( $f=11.05$ ;  $p=0.001$ ). The results also showed that there was no significant difference in the active range of motion in pre-treatment, 3<sup>rd</sup> and 6<sup>th</sup> week ( $f=0.284$ ;  $p=0.757$ ) outcome measure. Moreover, the results also showed that there was no significant difference in the passive range of motion in pre-treatment, 3<sup>rd</sup> and 6<sup>th</sup> week ( $f=0.246$ ;  $p=0.785$ ) treatment.

#### Comparison between pre-treatment, 3<sup>rd</sup> week and 6<sup>th</sup> week pain intensity, active range of motion and passive range of motion of infrared radiation group

Table 3 presented ANOVA comparing the mean values of pre-treatment, 3<sup>rd</sup> week and 6<sup>th</sup> week of pain intensity, active range of motion and passive range of motion of group B. The

results showed that there was significant difference in the pain intensity of pre-treatment, 3<sup>rd</sup> and 6<sup>th</sup> week ( $f=3.843$ ;  $p=0.045$ ) outcome measure. The results also showed that there was no significant difference in the active range of motion in pre-treatment, 3<sup>rd</sup> and 6<sup>th</sup> week ( $f=0.74$ ;  $p=0.494$ ) treatment.

**Table 3: Result of Repeated measured ANOVA comparing the mean values of pre-treatment, 3<sup>rd</sup> and 6<sup>th</sup> week of pain intensity, ARM and PRM of group B. N = 22**

Variables	Means ± SD	F	p-value
PPI	4.67 ± 1.75		
P3W	4.00 ± 0.63	3.843	0.045
P6W	2.83 ± 0.75		
ARM	89.17±18.82		
ARM3W	90.00±17.61	0.74	0.494
ARM6W	100.00±14.83		
PRM	94.17 ± 18.82		
PRM3W	95.83 ± 16.25	0.731	0.498
PRM6W	105.00±14.83		

#### Comparison among pre-treatment, 3<sup>rd</sup> week and 6<sup>th</sup> week of group A and B

**Table 4: Comparison of PPI, ARM and PRM among pre-treatment, 3<sup>rd</sup> and 6<sup>th</sup> weeks of groups A and B**

VARIABLES	GROUP A	GROUP B	F	p-value
PPI	6.83±0.75 <sub>a</sub>	6.67±1.75 <sub>a</sub>		
P3W	5.83±1.17 <sub>b</sub>	6.00±0.63 <sub>a</sub>	11.2 77	0.0 00
P6W	4.50±0.55 <sub>b</sub>	4.83±0.75 <sub>b</sub>		
ARM	88.33±19.15 <sup>d</sup>	89.17±18.82 <sup>d</sup>		
ARM3W	90.83±17.15 <sup>d</sup>	90.00±17.61 <sup>d</sup>	0.41 7	0.8 33
ARM6W	95.83±16.25 <sup>d</sup>	100.00±14.83 <sup>d</sup>		
PRM	94.17±18.00 <sup>e</sup>	94.17±18.82 <sup>e</sup>		
PRM3W	95.83±17.15 <sup>e</sup>	95.83±16.25 <sup>e</sup>	0.39 8	0.8 47



PRM6W	100.83±16	105.00±14
	.25 <sup>e</sup>	.83 <sup>e</sup>

Table 4 shows comparison of pain intensity, active range of motion and passive range of motion among pre-treatment, 3<sup>rd</sup> week and 6<sup>th</sup> week of continuous short wave diathermy and infrared radiation group. Post hoc analysis was utilized to compare the difference among the means. There was significant difference between pre-treatment pain intensity of continuous short wave and pre-treatment pain intensity of infrared radiation. There was also significant difference between 6<sup>th</sup> week pain intensity of continuous short wave and 6<sup>th</sup> week pain intensity of infrared radiation.

The study was designed to compare the therapeutic effect of continuous short wave diathermy and infra red radiation on pain intensity and range of motion of patients with knee osteoarthritis. Considering the physical characteristics of the subjects, it was observed that the mean body mass index was at obese level according to *Lee and Neiman (1996)*. This is an indication that obesity might have input in development of knee osteoarthritis. *Ojoawo et al (2013)* reported that anthropometric measures such as weight, waist circumference, body mass index and frame size are contributory factors to development of knee osteoarthritis. *Messier et al (2005)* and *Abbate et al (2006)* also reported that increase in body mass index and weight are a predisposing factor for knee

osteoarthritis. A study of US African-American and Caucasian women identified higher risk of prevalent knee osteoarthritis with higher BMI levels (*Lachance et al 2001*). In a longitudinal study of men and women aged 40–64 years, *Manninen et al. (1996)* reported that for every standard deviation increase in BMI (3.8 kg/m<sup>2</sup>), there was a 40% increased risk [relative risk (RR) = 1.4; 95% confidence interval (CI) 1.2–1.5] for developing knee osteoarthritis. Adipose tissues has been observed to be an endocrine organ which secrete adipocytokines such leptine, resistine and adiponectine (*Sowers, & Karvonen-Gutierrez, 2010*). These hormones were found to influence development of osteoarthritis by direct joint degradation or through control of local inflammatory processes (*Dumond 2003, Chen, 2006*).

There was significant difference between the initial pain score and the final (sixth) week pain score in the continuous short wave diathermy. It has been documented that continuous form of short wave diathermy can be used to reduce pain and swelling, decelerate the inflammatory process, and promote healing in tissues with chronic inflammation (*Balogun & Okonofua, 1988*). The application of continuous form of short wave diathermy to the involved tissues may increase vascular circulation and change tissue temperature, which directly results in vascular dilatation, an increase in pain threshold and a decrease in pain and swelling (*Hecox, 1994*). Such vascular

improvement also decelerates the inflammatory process by increasing nutrition and oxygen supply and by removing metabolic and waste products (Rennie et al, 1996). In addition, Jan et al (2006) in their study reported that CSWD in patients with knee osteoarthritis can significantly reduce both synovial thickness and knee pain.

Our study also observed a significant difference between the pre-treatment pain intensity and the 6<sup>th</sup> week of subjects with infra red radiation. Infrared radiation is also a non-pharmacologic management approach whose heat creates higher tissue temperature and causes vasodilation that increases the supply of oxygen, and nutrients and the elimination of carbon dioxide and metabolic waste (Nadler et al, 2004) which eventually reduces pain intensity in knee osteoarthritis patient. Our study also observed a significant reduction in the 3<sup>rd</sup> week pain intensity of CSWD group than that of IRR indicating that CSWD reduces pain intensity faster than IRR. There was dearth of documentation that compared IRR and CSWD in SKOA, but based on the effect of CSWD on synovial thickness of patient with SKOA, it could be understood that effect of CSWD is more than that of IRR in amelioration of SKOA.

**Conclusion:** It can be concluded from the study that CSWD and IRR were proved to be effective in relieving pain intensity of patients with SKOA but CSWD reduces pain intensity faster.

**Acknowledgement:** This is to acknowledge the contributions of the following people during the data collection. Mr Odejide A.S, Mr Badru A.G and Mrs Arilewola T.O.; they are physiotherapists at Obafemi Awolowo University Teaching Hospitals Complex, Ile Ife, Nigeria where the study was conducted.

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Conflict of Interest: None Declared

