Effect of low level laser therapy on acupuncture points as adjunct management for osteoarthritis of the knees

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Abstract

A blinded randomized controlled study with ethical approval was done on 170 patients (85 Experimental and 85 Control) age 40 – 70 years old, 32 males and 138 females with mild to moderate osteoarthritis, either with unilateral (12.35%) or bilateral (87.65%) affliction of the knees. The experimental and control groups were comparable as to age and duration of osteoarthritis affliction as there was no significant differences in these two initial variables. Baseline data was acquired before the pre-treatment data was collected for five days on five variables: pain intensity as measured by the visual analogue scale (VAS), joint stiffness in minutes taken upon waking up in the morning, range of motion measured by a goniometer, mobility done through functional independent measurement and analgesic intake. Mental capacity examination was also conducted on subjects who were $\geq$ 65 years old to make sure that they understood and could follow instructions. Informed consent was taken before any data were collected. A 200mW low level laser with a wavelength of infrared 808nm (KLO5, Matrix Laser Therapeutic Apparatus) was applied for 30 seconds on each of 10 identified acupuncture points on the knees once a day for five consecutive days. Continuous mode of delivery was utilized. The ten acupuncture points were the following: ST35, ST36, GB34, SP9; BL23, REN4, LR7, LR8, BL40, MN-LE16. Subjects did not take any drugs nor did they seek other alternative modalities such as massage or topical application of ointments and liniments during the course of the study.

Data was subjected to SPSS Version 22 using dependent and independent *t*-tests with α at .01. Cohen's *d* was also determined. Significant differences on a daily basis were noted between the experimental and control group of subjects on the pain intensity (VAS scores), joint stiffness and mobility particularly at the treatment and post-treatment phases of the study, but not on the range of motion. Comparing the 5-day averages between groups, however, significant differences between the experimental and control groups could be noted mainly at the pre-treatment versus post-treatment in the variables studied except in the range of motion of the right knee. Line graphs showed a decreasing trend in the VAS and joint stiffness while an increasing trend could be seen in the range of motion and mobility in the experimental group. In comparison, the control group showed a consistently horizontal trend in all variables. Regular intake of Paracetamol 500 mg was not noted.

This study showed that low level laser therapy (LLLT) on acupoints can be used as management for mild to moderate osteoarthritis of the knees without any adverse reactions and easy to administer.

Key Words: Knee Osteoarthritis; Low level laser therapy (LLLT); Acupuncture

Introduction

As people age, they usually suffer from various disorders foremost of which is osteoarthritis. The management of osteoarthritis remains palliative, dealing with the alleviation of symptoms: primarily pain, swelling and joint stiffness as these are the most disabling manifestations of this condition.

Unfortunately, patients who experience pain become less functional and dependent on analgesics. They usually resort to polypharmacy because of other existing disease conditions. The additional intake of organ-damaging drugs may aggravate further their already compromised condition. The use of some nonsteroidal anti-inflammatory drugs (NSAIDs) for this condition is foremost in the pharmacologic intervention modality [1]. Side effects, however, have been attributed to these drugs which may manifest as unacceptable gastrointestinal, cardiovascular, renal and hematologic disorders [2,3]. When side effects become severe complications, they become a major health care problem and a health economic burden. There is then the need to decrease or entirely eliminate the intake of organ-damaging drugs in managing chronic conditions such as osteoarthritis.

Low Level Laser Therapy (LLLT) has been used in various inflammatory disorders. Its effect on osteoarthritis has been mentioned, but data among Filipinos are scarce. It is an entirely non-invasive procedure [4], and is generally safe for all kinds of populations. It may be able to reduce the actual analgesic use of patients with osteoarthritis.

Systematic reviews have shown LLLT to have a significant effect in reducing pain among patients with chronic joint disorders and particularly, lateral elbow tendinopathy [5,6]. It has already been suggested that LLLT modulated the inflammatory response in tendinopathy and arthritis [7]. In an experiment on male rats, the application of 50 mW LLLT and 100 mW LLLT at 808 nm on the joints of rats subjected to injury has resulted in *"modulating inflammatory mediators (IL-1, IL-6) and inflammatory cells (macrophages and neutrophils)"* resulting in a "*reduction of the inflammatory process"* [8].

The application of LLLT has been varied. Researchers have used different wavelengths and laser conductors such as Helium-Neon (He-Ne) or Gallium Aluminum Arsenide (GaAlAs) [9,10,11]. Some practitioners apply LLLT locally in a circular manner while others target nerve pathways [10,12]. Other authors suggest that the use of a higher power or duration [9] will bring about better pain alleviation. Many use continuous mode of delivery for osteoarthritis rather than a pulsed mode.

LLLT can easily be administered by health care providers, family members and the patients themselves. It has been proven safe, without side effects with low cost [9,13,14,15]; and, easy to administer with adequate training.

Another alternative, Traditional Chinese Medicine (TCM), particularly acupuncture, has also been found to be effective in alleviating the symptoms of osteoarthritis usually diagnosed as *Bi* syndrome specifically cold/pain or damp/fixed *bi* [16,17]. The use of needles, however, can be taken negatively as many people are afraid of being punctured. While acupuncture has also been practiced, authors have not come to a consensus on what acupuncture regimen to follow in the treatment of osteoarthritis. Disposal of sharps can also be a problem. Besides, this modality of treatment cannot be done by just anyone.

Many Filipino patients complain that their pains usually occur in the early morning especially during the rainy and cold months. These are the periods when they take more analgesics on a per need basis. Many of them also resort to massage and apply

liniments on their knees. From the Traditional Chinese Medicine point of view, osteoarthritis is a "*painful impediment"* or "*cold impediment*" (*Bi* syndrome specifically pain/cold and damp/fixed *bi*) as characterized by "severe joint pains exaggerated by cold" [17,18,19]. Acupuncture has been used for centuries (3000 years) to address imbalance in the body. Its use for pain relief has been attributed "*through the gate-control mechanism or through the release of neurochemicals… such as endorphins*" that relieved pain [20].

Traditional Chinese Medicine (TCM) where classical acupuncture is the mainstream modality of treatment places emphasis on a vital energy, *qi* flowing in the body along pathways called meridians where acupuncture can be applied [20].

TCM diagnoses arthritis in many different ways. One of these is aggravated by cold as "cold bi" [16,17]. This condition is described as *"pain with severe soreness of the joints and muscles, fixed in location, with limited range of motion. The pain is stimulated by cold and relieved by heat*" [16,17]. From this TCM diagnosis, many researchers utilize acupuncture along related meridian points for the relief of pain, stiffness and loss of joint mobility for osteoarthritis. In a review of randomized controlled trials covering literature for the period 1966 to April 2006 on MEDLINE and 1982 - 2005 on CINAHL, researchers note that several meridian points have been used by different researches but four: ST 35, ST 36, SP9 and GB 34 appear in half of the ten studies cited in their research [20].

In spite of the studies showing the effect of acupuncture on alleviating pain and other symptoms of arthritis, certain disadvantages in the utilization of this modality in the community have been recognized as follows: first, health care practitioners have to undergo training for acupuncture skills; second, acupuncture needles may not always be available; and, third, some patients are afraid of needles. Low level lasers (LLL), on the other hand, can easily be administered by caregivers or by patients themselves. The application of LLLT on specific acupuncture points for osteoarthritis will deliver a more acceptable approach in administering LLLT to patients with osteoarthritis in terms of (1) pain alleviation; 2) stiffness alleviation; (3) improvement of range of motion of affected body parts; (4) improvement in mobility; and, (5) decrease in the number and duration of standard treatments such as analgesic intake.

Laser acupuncture can bring about a synergistic positive effect for osteoarthritis by using a combination of wavelength, power, duration, mode of laser deliver without the negative emotional implications of acupuncture [21]. The use of infrared on acupuncture points has also been suggested for pain as this wavelength has a deeper skin penetration compared to red laser [21].

Method

A double-blind, randomized control design was used in this study. A pre-trial phase was done on four subjects (two experimental and two control) to familiarize the team on the use of the LLLT on the ten acupuncture points. Study proper was then done on 170 subjects, 32 males and 138 females, age 40-70 years old, diagnosed with mild to moderate osteoarthritis of the knees as per American Rheumatology Association criteria, equivalent to *Bi Zheng* Syndrome specifically Cold/Pain & Damp/Fixed *Bi* Syndromes, bilateral or unilateral with a duration of at least six months. Other inclusion criteria included: cognitive ability to follow instructions; mental alertness; with osteoarthritic symptoms felt mainly on the knees. Exclusion criteria included patients with: extreme deformity of the knees; osteoarthritis manifesting in different parts of the body; lesions over the acupuncture meridian points; cancer and any malignant tumor; varicosities of the lower extremities; other co-morbidities such as epilepsy, renal

disease, heart disease, and uncontrolled diabetes; and, undergoing uninterrupted physical rehabilitation measures. Ethical approval was acquired before this research was done. Consent to participate in the study was also signed by all subjects

Variables tested were: pain intensity as measured by the Visual Analog Scale (VAS), joint stiffness in minutes as experienced when waking up in the morning, range of motion as measured by a goniometer, mobility through functional independent measurement as described by the Osteoarthritis Research Society International (OARSI), developed by the University of Melbourne; and, regularity and dose of analgesic intake. Subjects were provided with 500 mg Paracetamol for break through pain.

Baseline data on the five variables were taken during the initial physical examination and inclusion into the study. The main data subjected to statistical analysis were the five days before the onset of the treatment, five days during the treatment or no treatment and five days post treatment or no treatment.

KLO5, Matrix Laser Therapeutic Apparatus with wavelength of 808 nm (infrared) was utilized in this study [22]. The program of treatment followed was: once a day for five consecutive days, mean power at 200 mW, continuous mode of delivery, and 30 seconds on each of ten acupoints: ST35 *(Dubi),* ST36 *(Zusanli),* GB34 *(Yanglingquan)*, SP9 *(Yinglingquan)*, BL23 *(Shenshu),* REN4 *(Guanyuan)*, LR7 *(Xiguan)*, LR8 *(Ququan),* BL40 *(Weizhong)*; and, MN-LE16 *(Xiyan)* [16,17,19,20].

Results and Analysis

Of the 170 subjects, 71 females and 14 males were randomly assigned to the experimental group while 67 females and 18 males were randomly assigned to the control group. Data were subjected to SPSS software version 22 program using independent and dependent *t*-tests at α=.01. Cohen's *d* was also computed.

Age & Duration of Osteoarthritis

The experimental and control groups were comparable as no significant mean differences were noted between the groups as to their average age and duration of osteoarthritis (Table I).

Table I
Mean, Standard Deviation of Differences Between the Experimental Group With LLLT) and the Control Group (No LLLT)

Variable (in years)	Group with LLLT (Experimental) N= 85		Group without LLLT (Control) N= 85		*t*-value	*df*	*p* value 2-tailed
	Mean	SD	Mean	SD			
Age	56.282	9.170	55.588	9.220	0.492	168	.623
Duration of Osteoarthritis	4.235	2.552	3.917	2.150	0.877	168	.382

Independent *t*-tests (between experimental and control groups) were done on a daily basis. Paired *t*- tests were also done on the same group: pre-treatment versus during treatment, during treatment versus post-treatment and pre-treatment versus post treatment for each of the experimental (with LLLT) and control groups (without LLLT). Independent *t*-tests were also done between the 5-day averages of the experimental versus the control group on the pre-treatment versus the during treatment; the during

versus the post-treatment; and, the pre-treatment versus the post-treatment phases of the study. Descriptive data were also recorded. Clinical response of the subjects was also observed during the treatment phase and post-treatment phases.

Pain Intensity by Visual Analog Scale (VAS)

Pain intensity was measured by VAS on a scale of 0 to 10, with 0, no pain and 10 severe pain. This subjective score was taken upon waking up in the morning for the baseline, pre-treatment, during and post-treatment phases. The VAS showed an apparent significant mean difference between the experimental and control groups on D4 when no LLLT was yet applied, and D6, the first day of treatment or no treatment. This might be due to the increase in the average VAS score in the control group and a decrease in the experimental group due to factors that this study cannot explain. The magnitude of the effect, however, was moderate to medium (Cohen's *d* = 0.386 & 0.602 respectively). After the initial LLLT treatment (D6), significant mean differences were noted between the experimental and control groups with Cohen's *d* ranging from 1.099 on D7 and increasing to 3.415 (high effects) on D15 at α<.01 (Table II). Clinical improvement on the VAS of the experimental group were appreciated on the third day (D8) of treatment.

Table II
Mean, Standard Deviation and Differences of VAS Between Groups Who Did & Did Not Receive LLLT Per Day

VAS	Group with LLLT (Experimental)		Group without LLLT (Control)		*t* -value	*df*	*p* value 1-tailed	Cohen's *d*
	Mean	SD	Mean	SD				
D1	3.835	1.550	4.282	1.666	-1.811	168	.036	0.277
D2	3.788	1.574	3.718	1.351	.314	168	.377	0.048
D3	3.394	1.516	3.624	1.447	-1.009	168	.157	0.155
D4	3.212	1.431	3.835	1.779	-2.518	168	.006	0.386
D5	3.153	1.332	3.624	1.431	-2.220	168	.014	0.340
D6	2.859	1.552	3.800	1.572	-3.928	168	.000	0.602
D7	2.041	1.389	3.753	1.711	-7.162	168	.000	1.099
D8	1.288	1.199	3.565	1.393	-11.423	168	.000	1.752
D9	0.800	0.998	3.894	1.504	-15.805	168	.000	2.424
D10	0.635	0.829	3.741	1.347	-18.110	168	.000	2.778
D11	0.459	0.712	3.659	1.394	-18.853	168	.000	2.892
D12	0.306	0.530	3.835	1.503	-20.423	168	.000	3.133
D13	0.218	0.466	3.776	1.546	-20.322	168	.000	3.117
D14	0.176	0.406	3.812	1.476	-21.894	168	.000	3.358
D15	0.065	0.241	3.706	1.487	-22.260	168	.000	3.415

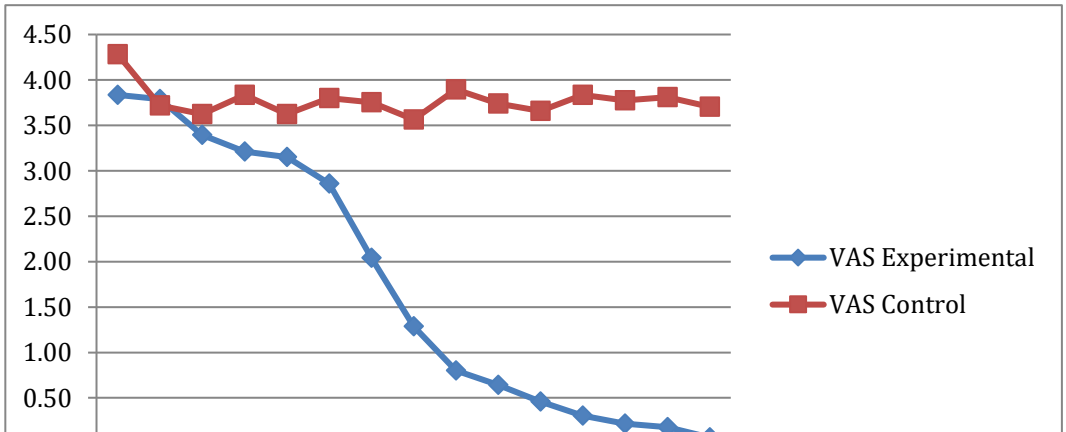

Figure 1.
Line graph showing the differences in the VAS scores between the experimental group (received LLLT) and control (did not receive LLLT)

Drastic decrease in the VAS score can be seen on D7 (2^{nd} day of treatment) among the subjects in the experimental group while that of the control group showed a horizontal pattern.

Averaging the five days of the VAS data, significant mean differences were noted between the pre-treatment versus during treatment, during treatment versus post treatment; and, pre-treatment versus post-treatment data of the experimental group (α<.01). Magnitude of effect (Cohen's *d*) was also high. For the Control Group, no significant mean differences were seen between the groups (Table III & IV).

By comparing the averages of the 5-day pre-treatment, during treatment and post-treatment phases between the experimental and control groups, significant mean differences could be seen between the experimental group and the control group during the treatment and post treatment phases (α<.01) with high effect sizes but not during the pre-treatment phase (Table V).

Table III
Paired Differences of VAS Averages (5 days) Between Phases of the Experimental Group

Paired Comparison (VAS)	Mean	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment	3.476	1.234	1.759	2.138	20.426	84	.000	3.133
During Treatment	1.528	0.814						
During Treatment	1.528	0.814	1.127	1.440	16.288	84	.000	2.498
Post-treatment	0.245	0.271						
Pre-treatment	3.476	1.234	2.982	3.482	25.686	84	.000	3.940
Post-treatment	0.245	0.271						

Table IV
Paired Differences of VAS Averages (5 days) Between Phases of the Control Group

Paired Comparison (VAS)	Mean	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment	3.816	1.285	-0.017	0.150	1.564	84	.061	0.240
During no Treatment	3.751	1.227						
During no Treatment	3.751	1.227	-0.096	0.082	-0.157	84	.437	0.024
Post-no treatment	3.758	1.189						
Pre-treatment	3.816	1.285	-0.034	0.152	1.257	84	.106	0.193
Post-no treatment	3.758	1.189						

Table V
Comparisons between the Experimental and Control Groups, Before, During and Post-treatment with or without LLLT on VAS Averages (5 days)

Independent Comparison (VAS)	Mean	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment								
Experimental	3.476	1.234	-.722	.042	-1.759	168	.040	0.270
Control	3.816	1.275						
During Treatment								
Experimental	1.528	0.814	-2.538	-1.907	-13.918	168	.000	2.135
Control	3.751	1.227						
Post-treatment								
Experimental	0.245	0.271	-3.774	-3.252	-26.567	168	.000	4.075
Control	3.758	1.189						

Joint Stiffness

Joint stiffness was measured by asking subjects if this occurred in the morning when they woke up. The number of minutes until resolved were recorded. Significant mean difference was noted between the experimental and control groups on D2, D4 D5 even before the procedure was done. The experimental group showed higher mean values than the control during these days that elicited the statistical significance. This showed, however, that even before the treatment, the experimental group was suffering more of joint stiffness than the control group. On D6 and D7 (1st and 2nd days of treatment or non-treatment with LLLT), however, there was no significant mean differences between the two groups (α>.01) as the experimental group was then showing decreasing mean scores but not the control group. From D8 (3rd day of treatment or no treatment with LLLT) onwards, significant changes were then seen (Table VI) between the experimental and control groups (α<.01), with the former showing decreasing joint stiffness. Effect sizes were also high from D9 onwards (Cohen's *d*>0.8). Clinically, on D8 onwards, the experimental group recorded decreasing joint stiffness almost approaching 0, upon waking up in the morning. Some subjects in this group also related that before they joined the study, they literally crawled from their beds upon waking up in the morning because of joint stiffness. After the procedure, they could stand up immediately as soon as they got out of bed. No such pattern was related by the control group.

Averaging the five days of the Joint Stiffness data, significant mean differences were noted between the pre-treatment versus during treatment, during treatment versus post treatment; and, pre-treatment versus post-treatment data of the experimental group (α<.01) with high effect sizes (Table VII). This was also seen in the control group where Cohen's *d* increased from moderate to high (Table VIII). While significant mean differences were noted in both groups, the pattern of joint stiffness was not the same. For the experimental group the mean averages decreased while in the control group these average means increased. Joint stiffness improved in the experimental group but became worse in the control group.

Table VI
Mean, Standard Deviation and Differences of Joint Stiffness Between Groups Who Did & Did Not Receive LLLT Per Day

Joint Stiffness	Group with LLLT (Experimental)		Group without LLLT (Control)		*t value*	*df*	*p* value 1-tail	Cohen's *d*
	Mean	SD	M	SD				
D1	7.847	7.243	6.247	5.368	1.636	168	.052	0.251
D2	7.129	6.727	5.059	4.032	2.434	168	.008	0.373
D3	5.829	4.951	4.712	3.434	1.710	168	.045	0.262
D4	6.253	6.087	4.359	2.804	2.606	168	.005	0.399
D5	6.659	6.532	4.253	3.124	3.064	168	.001	0.470
D6	5.694	6.063	5.400	4.239	0.367	168	.357	0.056
D7	4.100	4.568	5.435	4.503	-1.919	168	.028	0.294
D8	2.588	3.652	5.624	4.362	-4.919	168	.000	0.755
D9	1.224	2.909	5.024	3.219	-8.075	168	.000	1.239
D10	0.482	1.702	5.265	3.906	-10.350	168	.000	1.588
D11	0.400	1.197	6.606	5.242	-10.641	168	.000	1.632
D12	0.176	0.848	5.782	4.139	-12.232	168	.000	1.876
D13	0.059	0.542	6.288	4.473	-12.746	168	.000	1.955
D14	0.012	0.109	6.006	5.000	-11.049	168	.000	1.695
D15	0.000	0.000	4.976	3.502	-13.100	168	.000	2.009

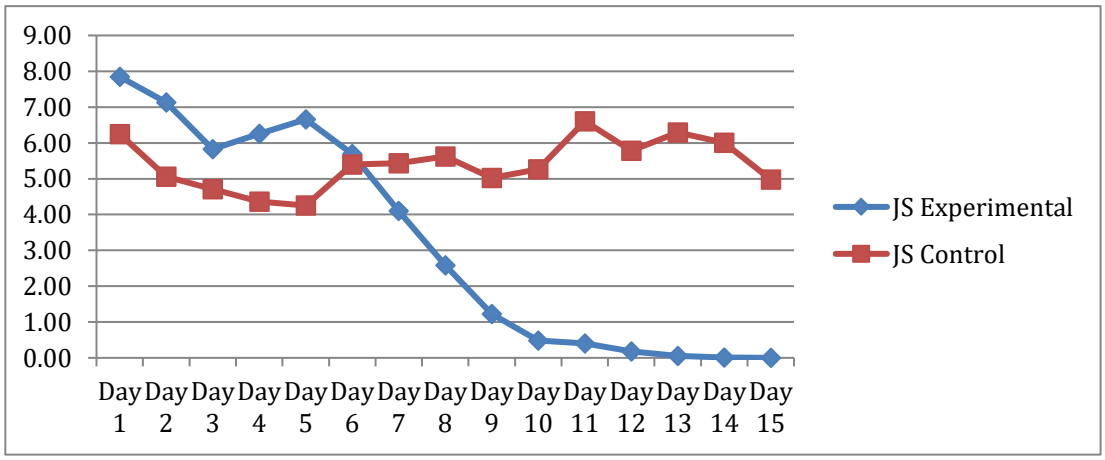

Figure 2.
Line graph showing the differences in the Joint Stiffness scores between the experimental group (received LLLT) and control (did not receive LLLT)

As can be seen from the line graph, joint stiffness decreased dramatically from D8 (3rd day of treatment with LLLT) in the experimental group. The control group showed a horizontal pattern.

Table VII
Paired Differences of Joint Stiffness Averages (5 days) Between Phases of the Experimental Group

Paired Comparison (Joint Stiffness)	Mean	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment	6.744	5.855	3.123	4.729	9.726	84	.000	1.492
During Treatment	2.818	3.311						
During Treatment	2.818	3.311	1.997	3.263	8.258	84	.000	1.266
Post-treatment	0.188	0.571						
Pre-treatment	6.744	5.855	5.359	7.752	10.898	84	.000	1.672
Post-treatment	0.188	0.571						

Table VIII
Paired Differences of Joint Stiffness Averages (5 days) Between Phases of the Control Group

Paired Comparison (Joint Stiffness)	Mean	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment	4.926	3.273	-0.620	-0.227	-4.277	84	.000	0.656
During no Treatment	5.349	3.340						
During no Treatment	5.349	3.340	-0.712	-0.231	-3.903	84	.000	0.599
Post-no treatment	5.821	3.758						
Pre-treatment	4.926	3.273	-1.190	-0.599	-6.030	84	.000	0.925
Post-no treatment	5.821	3.758						

By comparing the averages of the 5-day pre-treatment, during treatment and post-treatment phases between the experimental and control groups, significant mean differences could be seen between the experimental group and the control group during the pre-treatment, treatment and post treatment phases (α<.01) ranging from moderate during the pre-treatment phase to high effect size during the post treatment phase (Table IX). This might be due to the higher values in the experimental group before the start of LLLT treatment. While these significant differences exist, the mean averages of the

experimental group were seen to be decreasing while the mean averages for the control group were increasing.

Table IX.
Comparisons between the Experimental Group and Control Group, Before, During and Post-treatment with or without LLLT on Joint Stiffness Averages (5days)

Independent Comparison (Joint Stiffness)	Mean	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment								
Experimental	6.744	5.855	0.381	3.254	2.498	168	.007	0.383
Control	4.926	3.273						
During Treatment								
Experimental	2.818	3.311	-3.539	-1.525	-4.964	168	.000	0.761
Control	5.349	3.340						
Post-treatment								
Experimental	0.188	0.571	-6.447	-4.819	-13.664	168	.000	2.096
Control	5.821	3.758						

Range of Motion

The range of motion of the knees was measured using a goniometer. Not all subjects were treated on both knees (Table X).

Table X
Frequency Distribution of Location of Osteoarthritis of the Knees

Gender	Male		Female		TOTAL
Location of Knees	Experimental	Control	Experimental	Control	
Unilateral Left knee	(3)	(5)	(2)	(1)	(11)
Right knee	(2)	(0)	(3)	(5)	(10)
TOTAL	5	5	5	6	21
Bilateral	9	13	66	61	149
TOTAL	14	18	71	67	170

Left Knee

No significant mean differences were noted on the range of motion of the left knee on all days of the study. However, the means of the experimental group seem to increase as the days went by. No such pattern could be seen in the control group.

Table XI
Mean, Standard Deviation and Differences of Left Knee Range of Motion Between Groups Who Did & Did Not Receive LLLT Per Day

Range of Motion Left Knee	Group with LLLT (Experimental)		Group without LLLT (Control)		*t value*	*df*	*p* value 1-tailed	Cohen's *d*
	Mean	SD	M	SD				
D1	117.150	6.343	118.975	6.090	-1.856	158	.032	0.294
D2	117.450	6.125	118.663	5.989	-1.266	158	.103	0.200
D3	117.350	5.998	118.750	6.243	-1.446	158	.075	0.228
D4	117.688	6.284	118.925	6.168	-1.257	158	.105	0.199
D5	117.775	6.418	118.775	6.034	-1.015	158	.155	0.161
D6	117.700	6.204	118.563	6.324	-0.871	158	.192	0.138
D7	118.418	6.603	118.613	6.328	-0.190	157	.425	0.030
D8	118.463	6.121	118.525	6.004	-0.065	158	.474	0.010
D9	118.975	6.384	118.538	6.102	0.443	158	.329	0.070
D10	118.938	6.151	118.538	6.084	0.414	158	.340	0.065
D11	119.038	6.194	118.150	6.144	0.910	158	.182	0.144
D12	119.038	6.371	118.438	6.156	0.606	158	.273	0.096
D13	119.313	6.247	118.500	6.224	0.824	158	.205	0.130
D14	119.300	6.108	118.475	6.329	0.839	158	.201	0.133
D15	119.388	5.908	118.463	6.125	0.972	158	.166	0.154

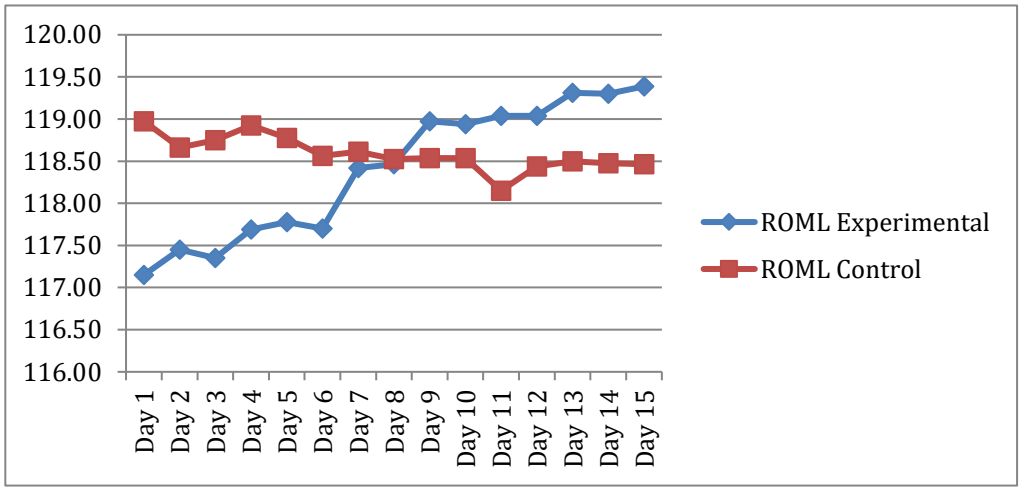

Figure 3.
Line graph showing the differences in the Joint Range of Motion of the Left Knee as measured by a goniometer between the experimental group (received LLLT) and control (did not receive LLLT)

Line graph shows the increasing trend of range of motion of the left knee in the experimental group. A horizontal pattern can be seen in the control group.

Averaging the five days of the range of motion of the left knee data, significant mean differences were noted between the pre-treatment versus during treatment, during treatment versus post treatment; and, pre-treatment versus post-treatment data of the experimental group (α<.01) with high effect sizes. The control group showed significant mean difference during the pre-treatment versus the during treatment and the pre-

treatment versus the post-treatment, but Cohen's *d* was moderate to medium (Tables XII & XIII). It can be noted that the average means of range of motion of the left knee in the experimental group increased by 1.732 mm from pre-treatment to post-treatment, while the control group showed a decrease in mean values (0.413).

Table XII
Paired Differences of Left Knee Range of Motion Averages (5 days) Between Phases of the Experimental Group

Paired Comparison Range of Motion Left Knee	Mean N=80	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment	117.483	6.156	-1.285	-0.735	-7.318	79	.000	1.157
During Treatment	118.493	6.190						
During Treatment	118.493	6.190	-0.895	-0.550	-8.343	79	.000	1.319
Post-treatment	119.215	6.103						
Pre-treatment	117.483	6.156	-2.000	-1.465	-12.886	79	.000	2.038
Post-treatment	119.215	6.103						

By comparing the averages of the 5-day pre-treatment, during treatment and post-treatment phases between the experimental and control groups on range of motion of the left knee, no significant mean differences could be seen between these groups (Table XIV). However, there seems to be an improvement in the experimental group compared to the control group as evidenced by the line graphs and the means.

Table XIII

Paired Differences of Left Knee Range of Motion Averages (5 days) Between Phases of the Control Group

Paired Comparison Range of Motion (Left Knee)	Mean N=80	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment	118.818	6.023	0.135	0.390	4.095	79	.000	0.648
During no Treatment	118.555	6.072						
During no Treatment	118.555	6.072	0.016	0.284	2.227	79	.014	0.352
Post-no treatment	118.405	6.079						
Pre-treatment	118.818	6.023	0.246	0.579	4.924	79	.000	0.779
Post-no treatment	118.405	6.079						

Table XIV.
Comparisons between the Experimental Group and Control Group, Before, During and Post-treatment with or without LLLT on Averages (5 days) of the Left Knee Range of Motion

Independent Comparison (Range of Motion Left Knee)	Mean N=160	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment								
Experimental	117.483	6.156	-3.237	0.567	-1.759	158	.084	0.270
Control	118.818	6.023						
During Treatment								
Experimental	118.493	6.190	-1.977	1.852	-13.918	158	.474	2.135
Control	118.555	6.072						
Post-treatment								
Experimental	119.215	6.103	-1.092	2.712	-26.567	158	.201	4.075
Control	118.405	6.079						

Right Knee

No significant mean differences were noted on the range of motion of the right knee on all days of the study. However, the means of the experimental group seem to gradually increase as the days went by (Table XV).

Table XV

Mean, Standard Deviation and Differences of Right Knee Range of Motion Between Groups Who Did & Did Not Receive LLLT Per Day

Range of Motion Right Knee	Group with LLLT (Experimental)		Group without LLLT (Control)		*t value*	*df*	*p* value 1-tailed	Cohen's *d*
	Mean	SD	M	SD				
D1	118.338	5.985	120.190	5.339	-2.058	157	.020	0.326
D2	118.650	5.628	120.481	5.303	-2.111	157	.018	0.335
D3	118.588	5.899	120.152	5.241	-1.768	157	.040	0.280
D4	118.525	5.833	120.177	5.397	-1.853	157	.033	0.294
D5	118.513	5.891	119.937	5.388	-1.590	157	.057	0.252
D6	118.975	5.964	119.861	5.389	-0.982	157	.164	0.156
D7	119.363	6.095	119.861	5.375	-0.546	157	.293	0.087
D8	119.538	6.344	119.886	5.325	-0.375	157	.354	0.059
D9	119.975	6.514	120.089	5.142	-0.122	157	.451	0.019
D10	120.025	6.193	120.076	5.293	-0.056	157	.478	0.009
D11	119.963	6.225	119.684	5.441	.301	157	.382	0.048
D12	120.063	6.196	120.025	5.043	.041	157	.484	0.007
D13	120.138	5.765	119.949	5.252	.215	157	.415	0.034
D14	120.225	5.779	119.772	5.208	.519	157	.302	0.082
D15	120.263	5.454	119.785	5.505	.550	157	.292	0.087

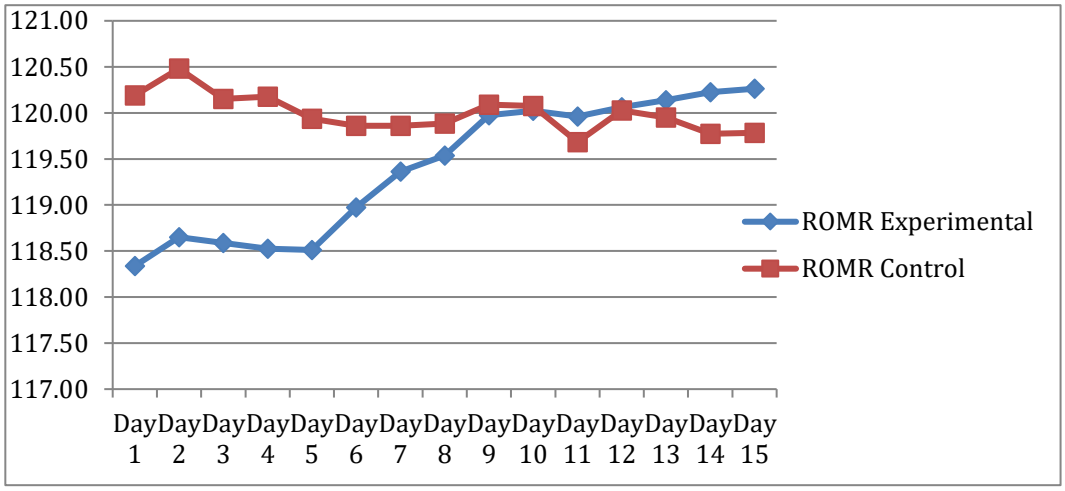

Figure 4.
Line graph shows the differences in the range of motion of the right knee as measured by a goniometer between the experimental group (received LLLT) and control (did not receive LLLLT).

The line graph showed an upward trend in the experimental group compared to the control group in the range of motion of the right knee, where almost a horizontal pattern could be seen.

Averaging the five days of the range of motion of the right knee data, significant mean differences were noted between the pre-treatment versus during treatment, during treatment versus post treatment; and, pre-treatment versus post-treatment data of the

experimental group (α<.01) with high effect sizes. An increasing trend in the range of motion of the right knee could be seen (Table XVI).

The control group showed a significant mean difference between the pre-treatment versus the during treatment; and, the pre-treatment versus the post-treatment but Cohen's *d* was moderate to medium (Table XVII). There was no significant mean difference between the during treatment and the post-treatment phase of the range of motion of the right knee in this group. In contrast to the experimental group, the average means for the control group showed a decreasing trend in the range of motion of the right knee.

Table XVI
Paired Differences of Right Knee Range of Motion Averages (5 days) Between Phases of the Experimental Group

Paired Comparison (Range of Motion Right Knee)	Mean N=80	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment	118.523	5.774	-1.340	-0.765	-7.285	79	.000	1.152
During Treatment	119.575	6.102						
During Treatment	119.575	6.102	-0.739	-0.335	-5.295	79	.000	0.837
Post-treatment	120.112	5.848						
Pre-treatment	118.523	5.774	-1.849	-1.331	-12.227	79	.000	1.933
Post-treatment	120.112	5.848						

By comparing the averages of the 5-day pre-treatment, during treatment and post-treatment phases between the experimental and control groups, no significant mean differences could be seen between the experimental group and the control group during the pre-treatment, during treatment and post treatment phases (α>.01). At the start of the study, the means of the range of motion of the right knee in the experimental group was even lower than that of the control (Table XVIII). As the days went by, however, the experimental group's average means of the range of motion of the right knee increased (upward trend) while that of the control group even decreased (downward trend, Figure 4)

Table XVII
Paired Differences of Right Knee Range of Motion Averages (5 days) Between Phases of the Control Group

Paired Comparison (Range of Motion Right Knee)	Mean N=79	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment	120.187	5.250	0.095	0.370	3.372	78	.000	0.537
During no Treatment	119.954	5.191						
During no Treatment	119.954	5.191	-0.034	0.179	1.361	78	.089	0.217
Post-no treatment	119.882	5.165						
Pre-treatment	120.187	5.250	0.143	0.469	3.732	78	.000	0.594
Post-no treatment	119.882	5.165						

Table XVIII.
Comparisons between the Experimental Group and Control Group, Before, During and Post-treatment with of without LLLT on Right Knee Range of Motion Averages (5 days)

Independent Comparison (Range of Motion Right Knee)	Mean N=159	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment								
Experimental	118.523	5.774	-3.394	0.065	-1.902	157	.030	0.301
Control	120.187	5.250						
During Treatment								
Experimental	119.575	6.102	-2.155	1.396	-0.422	157	.337	0.067
Control	119.954	5.191						
Post-treatment								
Experimental	120.112	5.848	-1.499	1.960	0.264	157	.396	0.042
Control	119.882	5.165						

Mobility

Mobility was measured by the functional independent measurement described by the Osteoarthritis Research Society International (OARSI) as developed by the University of Melbourne. This involved counting the number of times the subjects sat and stood from a chair within one minute.

Significant mean differences (α<.01) could be seen between the experimental and control groups from D10 onwards but effect size was moderate to medium.

Table XIX
Mean, Standard Deviation and Differences on Mobility Between Groups Who Did & Did Not Receive LLLT Per Day

Mobility	Group with LLLT (Experimental)		Group without LLLT (Control)		*t value*	*df*	*p* value 1-tailed	Cohen's *d*
	Mean	SD	M	SD				
D1	11.741	2.416	12.353	2.729	-1.548	168	.062	0.237
D2	11.988	2.383	12.435	2.813	-1.118	168	.133	0.171
D3	12.012	2.462	12.588	2.842	-1.413	168	.079	0.217
D4	12.012	2.625	12.471	2.860	-1.090	168	.139	0.167
D5	11.976	2.577	12.579	2.958	-1.299	168	.098	0.199
D6	12.200	2.645	12.176	2.770	0.057	168	.478	0.009
D7	12.859	2.883	12.306	2.739	1.282	168	.101	0.197
D8	13.188	3.126	12.388	2.829	1.749	168	.041	0.268
D9	13.424	2.892	12.424	2.847	2.272	168	.012	0.348
D10	13.635	2.853	12.447	2.831	2.726	168	.003	0.418
D11	13.506	2.644	12.224	2.598	3.190	168	.001	0.489
D12	13.576	2.638	12.318	2.969	2.922	168	.002	0.448
D13	13.729	2.736	12.647	2.975	2.469	168	.007	0.379
D14	13.882	2.826	12.341	2.688	3.643	168	.000	0.559
D15	14.047	2.777	12.435	3.126	3.554	168	.000	0.545

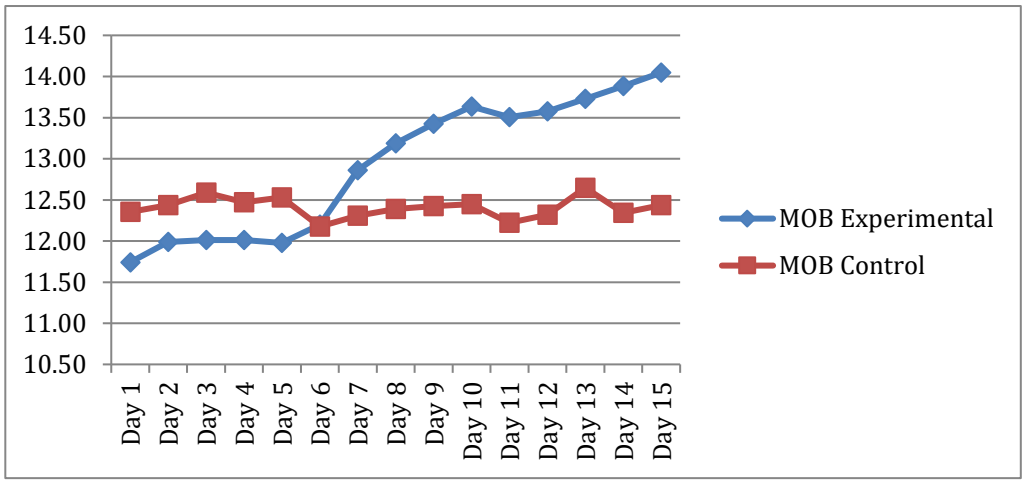

Figure 5.
Line graph shows the differences in mobility between the experimental group (received LLLT) and control (did not receive LLLT)

The line graph shows the upward trend in the mobility among the subjects in the experimental group compared to the subjects in the control group that shows a horizontal pattern.

Averaging the five days of the mobility data, significant mean differences were noted between the pre-treatment versus during treatment, during treatment versus post treatment; and, pre-treatment versus post-treatment data of the experimental group (α<.01) with high effect sizes. The average means of joint mobility in the experimental group also increased with time (Table XX).

As for the control group, there were no significant mean differences between the pre-treatment versus during treatment; during treatment versus post treatment phases; and, pre-treatment versus post-treatment phases at α<.01 (Table XXI).

Table XX
Paired Differences of Mobility Averages (5 days) Between Phases of the Experimental Group

Paired Comparison (Mobility)	Mean	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment	11.946	2.385	-1.433	-0.798	-6.991	84	.000	1.072
During Treatment	13.061	2.725						
During Treatment	13.061	2.725	-0.821	-0.553	-10.194	84	.000	1.564
Post-treatment	13.748	2.628						
Pre-treatment	11.946	2.385	-2.133	-1.472	-10.842	84	.000	1.663
Post-treatment	13.748	2.628						

By comparing the averages of the 5-day pre-treatment, during treatment and post-treatment phases between the experimental and control groups, significant mean differences could be seen between the experimental group and the control group at the post-treatment phase (α<.01) with medium effect size, Cohen's *d* = 0.505 (Table XXII).

Table XXI
Paired Differences of Mobility Averages (5 days) Between Phases of the Control Group

Paired Comparison (Mobility)	Mean	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment	12.475	2.719	0.020	0.234	2.355	84	.011	0.361
During no Treatment	12.348	2.673						
During no Treatment	12.348	2.673	-0.165	0.076	-0.739	84	.231	0.113
Post-no treatment	12.393	2.734						
Pre-treatment	12.475	2.719	-0.045	0.210	1.284	84	.102	0.197
Post-no treatment	12.393	2.734						

Table XXII.
Comparisons between the Experimental Group and Control Group, Before, During and Post-treatment with or without LLLT on Mobility Averages (5 days)

Independent Comparison (Mobility)	Mean	SD	95%Confidence Interval of the Difference		*t*-value	*df*	*p*-value 1-tailed	Cohen's *d*
			Lower	Upper				
Pre-treatment								
Experimental	11.946	2.385	-1.304	0.245	-1.350	168	.089	0.207
Control	12.475	2.719						
During Treatment								
Experimental	13.061	2.725	-0.105	1.5304	1.722	168	.049	0.264
Control	12.348	2.673						
Post-treatment								
Experimental	13.748	2.628	0.543	2.167	3.295	168	.000	0.505
Control	12.393	2.734						

Analgesic Intake

Rescue dose with Paracetamol 500 mg was generally low among the subjects but a downward trend could be seen among subjects in the experimental group than in the control group.

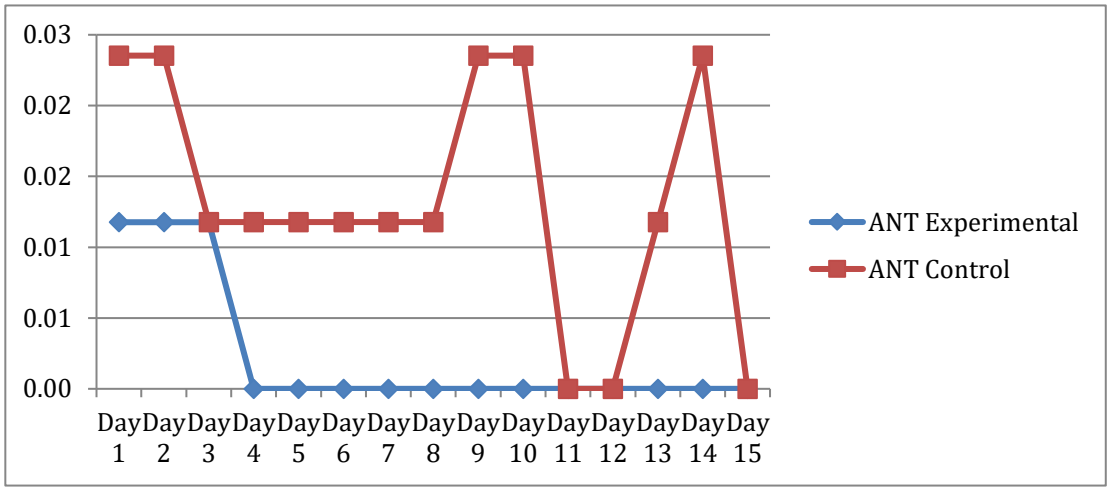

Figure 5.
Line graph shows the differences in analgesic intake between the experimental group (received LLLT) and control (did not receive LLLT)

Discussion

Osteoarthritis of the knees have plagued many Filipinos particularly the elderly. As a debilitating disease, the consequence of suffering from this condition especially during cold months cannot be ignored. Many take pharmaceutical drugs for pain relief, but they become susceptible to unacceptable side effects [9]. As a substitute for drugs, this study embarked on laser acupuncture as an adjunct to the management of mild to moderate osteoarthritis of the knees. Both acupuncture and low level laser therapy have been known to show improvement in osteoarthritis separately, but certain limitations hinder their widespread use.

One hundred seventy subjects (170) randomly distributed to two groups: experimental and control participated in this study. Low level laser therapy (LLLT) was applied on acupuncture points. Ten acupoints were chosen in the regimen: ST35, ST36, GB34, SP9, BL23, REN4, LR7, LR8, BL40, MN-LE16 differing in some researches where five [22] or eight [23] acupoints were used. This was a combination of all possible points as suggested by various sources [15,16,18,19]. To reduce the duration of treatment to five days, a higher power of 200mW, infrared (808nm) and 30 second per point was utilized in this research in contrast to Rayegani et al.'s research where the duration was two weeks using a wavelength of 880nm with a lower power of 50 mW [24]. Continuous mode of laser operational delivery was used.

After five days of observation post-treatment, improvement in the pain score, joint stiffness and mobility is observed as evidenced by statistical analyses and clinical observation. This is not observed in the range of motion, both on the left and right knees. There is, however, a consistent improvement in the experimental group, but not in the control group as evidenced in the line graphs of all the variables. Majority of the subjects preferred not to take Paracetamol during the course of the study.

This study established a regimen for the management of mild to moderate osteoarthritis of the knees. The combined use of low level laser therapy (LLLT) and acupuncture, can indeed be applied for this condition without the disadvantages when only one modality is used.

Recommendation

It is recommended that the study be extended more than 5-day post-treatment to find out how long the laser treatment on the ten acupuncture points will be in effect. This extension on the observation time might also capture significant changes between the experimental and control groups on the range of motion considering that improvement in the mean scores of this variable can be seen in the former, 5-day post treatment despite the apparent non-statistical difference.

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