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 > 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 \( \alpha \) 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 $\alpha=.01$. 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>
<thead>
<tr>
<th>Variable</th>
<th>Group with LLLT (Experimental) N=85</th>
<th>Group without LLLT (Control) N=85</th>
<th>t-value</th>
<th>df</th>
<th>p value 2-tailed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Age</td>
<td>56.282 9.170</td>
<td>55.588 9.220</td>
<td>0.492</td>
<td>168</td>
<td>.623</td>
</tr>
<tr>
<td>Duration of Osteoarthritis</td>
<td>4.235 2.552</td>
<td>3.917 2.150</td>
<td>0.877</td>
<td>168</td>
<td>.382</td>
</tr>
</tbody>
</table>

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 $\alpha < .01$ (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

<table>
<thead>
<tr>
<th>VAS</th>
<th>Group with LLLT (Experimental)</th>
<th>Group without LLLT (Control)</th>
<th>t-value</th>
<th>df</th>
<th>p value 1-tailed</th>
<th>Cohen's $d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>D1</td>
<td>3.835 (1.550)</td>
<td>4.282 (1.666)</td>
<td>-1.811</td>
<td>168</td>
<td>.036</td>
<td>0.277</td>
</tr>
<tr>
<td>D2</td>
<td>3.788 (1.574)</td>
<td>3.718 (1.351)</td>
<td>.314</td>
<td>168</td>
<td>.377</td>
<td>0.048</td>
</tr>
<tr>
<td>D3</td>
<td>3.394 (1.516)</td>
<td>3.624 (1.447)</td>
<td>-1.009</td>
<td>168</td>
<td>.157</td>
<td>0.155</td>
</tr>
<tr>
<td>D4</td>
<td>3.212 (1.431)</td>
<td>3.835 (1.779)</td>
<td>-2.518</td>
<td>168</td>
<td>.006</td>
<td>0.386</td>
</tr>
<tr>
<td>D5</td>
<td>3.153 (1.332)</td>
<td>3.624 (1.431)</td>
<td>-2.220</td>
<td>168</td>
<td>.014</td>
<td>0.340</td>
</tr>
<tr>
<td>D6</td>
<td>2.859 (1.552)</td>
<td>3.800 (1.572)</td>
<td>-3.928</td>
<td>168</td>
<td>.000</td>
<td>0.602</td>
</tr>
<tr>
<td>D7</td>
<td>2.041 (1.389)</td>
<td>3.753 (1.711)</td>
<td>-7.162</td>
<td>168</td>
<td>.000</td>
<td>1.099</td>
</tr>
<tr>
<td>D8</td>
<td>1.288 (1.199)</td>
<td>3.565 (1.393)</td>
<td>-11.423</td>
<td>168</td>
<td>.000</td>
<td>1.752</td>
</tr>
<tr>
<td>D9</td>
<td>0.800 (0.998)</td>
<td>3.894 (1.504)</td>
<td>-15.805</td>
<td>168</td>
<td>.000</td>
<td>2.424</td>
</tr>
<tr>
<td>D10</td>
<td>0.635 (0.829)</td>
<td>3.741 (1.347)</td>
<td>-18.110</td>
<td>168</td>
<td>.000</td>
<td>2.778</td>
</tr>
<tr>
<td>D11</td>
<td>0.459 (0.712)</td>
<td>3.659 (1.394)</td>
<td>-18.853</td>
<td>168</td>
<td>.000</td>
<td>2.892</td>
</tr>
<tr>
<td>D12</td>
<td>0.306 (0.530)</td>
<td>3.835 (1.503)</td>
<td>-20.423</td>
<td>168</td>
<td>.000</td>
<td>3.133</td>
</tr>
<tr>
<td>D13</td>
<td>0.218 (0.466)</td>
<td>3.776 (1.546)</td>
<td>-20.322</td>
<td>168</td>
<td>.000</td>
<td>3.117</td>
</tr>
<tr>
<td>D14</td>
<td>0.176 (0.406)</td>
<td>3.812 (1.476)</td>
<td>-21.894</td>
<td>168</td>
<td>.000</td>
<td>3.358</td>
</tr>
<tr>
<td>D15</td>
<td>0.065 (0.241)</td>
<td>3.706 (1.487)</td>
<td>-22.260</td>
<td>168</td>
<td>.000</td>
<td>3.415</td>
</tr>
</tbody>
</table>
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\textsuperscript{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 ($\alpha<.01$). 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 ($\alpha<.01$) 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
Table IV
Paired Differences of VAS Averages (5 days) Between Phases of the Control Group

<table>
<thead>
<tr>
<th>Paired Comparison (VAS)</th>
<th>Mean</th>
<th>SD</th>
<th>95% Confidence Interval of the Difference</th>
<th>t-value</th>
<th>df</th>
<th>p-value 1-tailed</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-treatment</td>
<td>3.476</td>
<td>1.234</td>
<td>1.759 - 2.138</td>
<td>20.426</td>
<td>84</td>
<td>.000</td>
<td>3.133</td>
</tr>
<tr>
<td>During Treatment</td>
<td>1.528</td>
<td>0.814</td>
<td>1.127 - 1.440</td>
<td>16.288</td>
<td>84</td>
<td>.000</td>
<td>2.498</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>0.245</td>
<td>0.271</td>
<td>0.127 - 0.365</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table V
Comparisons between the Experimental and Control Groups, Before, During and Post-treatment with or without LLLT on VAS Averages (5 days)
### 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 (\( \alpha > .01 \)) 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 (\( \alpha < .01 \)), 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 (\( \alpha < .01 \)) 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
### Table V
**Paired Differences of Joint Stiffness Averages (5 days) Between Phases of the Experimental Group**

<table>
<thead>
<tr>
<th>Joint Stiffness</th>
<th>Group with LLLT (Experimental)</th>
<th>Group without LLLT (Control)</th>
<th>t value</th>
<th>df</th>
<th>p value 1-tail</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>7.847</td>
<td>7.243</td>
<td>6.247</td>
<td>5.368</td>
<td>1.636</td>
<td>168</td>
</tr>
<tr>
<td>D2</td>
<td>7.129</td>
<td>6.727</td>
<td>5.059</td>
<td>4.032</td>
<td>2.434</td>
<td>168</td>
</tr>
<tr>
<td>D3</td>
<td>5.829</td>
<td>4.951</td>
<td>4.712</td>
<td>3.434</td>
<td>1.710</td>
<td>168</td>
</tr>
<tr>
<td>D4</td>
<td>6.253</td>
<td>6.087</td>
<td>4.359</td>
<td>2.804</td>
<td>2.606</td>
<td>168</td>
</tr>
<tr>
<td>D5</td>
<td>6.659</td>
<td>6.532</td>
<td>4.253</td>
<td>3.124</td>
<td>3.064</td>
<td>168</td>
</tr>
<tr>
<td>D6</td>
<td>5.694</td>
<td>6.063</td>
<td>5.400</td>
<td>4.239</td>
<td>0.367</td>
<td>168</td>
</tr>
<tr>
<td>D7</td>
<td>4.100</td>
<td>4.568</td>
<td>5.435</td>
<td>4.503</td>
<td>-1.919</td>
<td>168</td>
</tr>
<tr>
<td>D8</td>
<td>2.588</td>
<td>3.652</td>
<td>5.624</td>
<td>4.362</td>
<td>-4.919</td>
<td>168</td>
</tr>
<tr>
<td>D9</td>
<td>1.224</td>
<td>2.909</td>
<td>5.024</td>
<td>3.219</td>
<td>-8.075</td>
<td>168</td>
</tr>
<tr>
<td>D10</td>
<td>0.482</td>
<td>1.702</td>
<td>5.265</td>
<td>3.906</td>
<td>-10.350</td>
<td>168</td>
</tr>
<tr>
<td>D11</td>
<td>0.400</td>
<td>1.197</td>
<td>6.606</td>
<td>5.242</td>
<td>-10.641</td>
<td>168</td>
</tr>
<tr>
<td>D12</td>
<td>0.176</td>
<td>0.848</td>
<td>5.782</td>
<td>4.139</td>
<td>-12.232</td>
<td>168</td>
</tr>
<tr>
<td>D13</td>
<td>0.059</td>
<td>0.542</td>
<td>6.288</td>
<td>4.473</td>
<td>-12.746</td>
<td>168</td>
</tr>
<tr>
<td>D14</td>
<td>0.012</td>
<td>0.109</td>
<td>6.006</td>
<td>5.000</td>
<td>-11.049</td>
<td>168</td>
</tr>
<tr>
<td>D15</td>
<td>0.000</td>
<td>0.000</td>
<td>4.976</td>
<td>3.502</td>
<td>-13.100</td>
<td>168</td>
</tr>
</tbody>
</table>

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**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.

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

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

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 ($\alpha<.01$) 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)

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

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

<table>
<thead>
<tr>
<th>Gender</th>
<th>Male</th>
<th>Female</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location of Knees</td>
<td>Experimental</td>
<td>Control</td>
<td>Experimental</td>
</tr>
<tr>
<td>Unilateral</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Left knee</td>
<td>(3)</td>
<td>(5)</td>
<td>(2)</td>
</tr>
<tr>
<td>Right knee</td>
<td>(2)</td>
<td>(0)</td>
<td>(3)</td>
</tr>
<tr>
<td>TOTAL</td>
<td>5</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Bilateral</td>
<td>9</td>
<td>13</td>
<td>66</td>
</tr>
<tr>
<td>TOTAL</td>
<td>14</td>
<td>18</td>
<td>71</td>
</tr>
</tbody>
</table>

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

Page 11
<table>
<thead>
<tr>
<th>Range of Motion Left Knee</th>
<th>Group with LLLT (Experimental)</th>
<th>Group without LLLT (Control)</th>
<th>t value</th>
<th>df</th>
<th>p value 1-tailed</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>SD</td>
<td>M</td>
<td>SD</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D1</td>
<td>117.150</td>
<td>6.343</td>
<td>118.975</td>
<td>6.090</td>
<td>-1.856</td>
<td>158</td>
</tr>
<tr>
<td>D2</td>
<td>117.450</td>
<td>6.125</td>
<td>118.663</td>
<td>5.989</td>
<td>-1.266</td>
<td>158</td>
</tr>
<tr>
<td>D3</td>
<td>117.350</td>
<td>5.998</td>
<td>118.750</td>
<td>6.243</td>
<td>-1.446</td>
<td>158</td>
</tr>
<tr>
<td>D4</td>
<td>117.688</td>
<td>6.284</td>
<td>118.925</td>
<td>6.168</td>
<td>-1.257</td>
<td>158</td>
</tr>
<tr>
<td>D5</td>
<td>117.775</td>
<td>6.418</td>
<td>118.775</td>
<td>6.034</td>
<td>-1.015</td>
<td>158</td>
</tr>
<tr>
<td>D6</td>
<td>117.700</td>
<td>6.204</td>
<td>118.563</td>
<td>6.324</td>
<td>-0.871</td>
<td>158</td>
</tr>
<tr>
<td>D7</td>
<td>118.418</td>
<td>6.603</td>
<td>118.613</td>
<td>6.328</td>
<td>-0.190</td>
<td>157</td>
</tr>
<tr>
<td>D8</td>
<td>118.463</td>
<td>6.121</td>
<td>118.525</td>
<td>6.004</td>
<td>-0.065</td>
<td>158</td>
</tr>
<tr>
<td>D9</td>
<td>118.975</td>
<td>6.384</td>
<td>118.538</td>
<td>6.102</td>
<td>0.443</td>
<td>158</td>
</tr>
<tr>
<td>D10</td>
<td>118.938</td>
<td>6.151</td>
<td>118.538</td>
<td>6.084</td>
<td>0.414</td>
<td>158</td>
</tr>
<tr>
<td>D11</td>
<td>119.038</td>
<td>6.194</td>
<td>118.150</td>
<td>6.144</td>
<td>0.910</td>
<td>158</td>
</tr>
<tr>
<td>D12</td>
<td>119.038</td>
<td>6.371</td>
<td>118.438</td>
<td>6.156</td>
<td>0.606</td>
<td>158</td>
</tr>
<tr>
<td>D13</td>
<td>119.313</td>
<td>6.247</td>
<td>118.500</td>
<td>6.224</td>
<td>0.824</td>
<td>158</td>
</tr>
<tr>
<td>D14</td>
<td>119.300</td>
<td>6.108</td>
<td>118.475</td>
<td>6.329</td>
<td>0.839</td>
<td>158</td>
</tr>
<tr>
<td>D15</td>
<td>119.388</td>
<td>5.908</td>
<td>118.463</td>
<td>6.125</td>
<td>0.972</td>
<td>158</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Paired Comparison of Range of Motion Left Knee</th>
<th>Mean</th>
<th>SD</th>
<th>95% Confidence Interval of the Difference</th>
<th>$t$-value</th>
<th>df</th>
<th>$p$-value 1-tailed</th>
<th>Cohen’s $d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-treatment</td>
<td>117.483</td>
<td>6.156</td>
<td>-1.285 -0.735</td>
<td>-7.318</td>
<td>79</td>
<td>.000</td>
<td>1.157</td>
</tr>
<tr>
<td>During Treatment</td>
<td>118.493</td>
<td>6.190</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During Treatment</td>
<td>118.493</td>
<td>6.190</td>
<td>-0.895 -0.550</td>
<td>-8.343</td>
<td>79</td>
<td>.000</td>
<td>1.319</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>119.215</td>
<td>6.103</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-treatment</td>
<td>117.483</td>
<td>6.156</td>
<td>-2.000 -1.465</td>
<td>-1.2886</td>
<td>79</td>
<td>.000</td>
<td>2.038</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>119.215</td>
<td>6.103</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

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

<table>
<thead>
<tr>
<th>Independent Comparison (Range of Motion Left Knee)</th>
<th>Mean N=160</th>
<th>SD</th>
<th>95%Confidence Interval of the Difference</th>
<th>t-value</th>
<th>df</th>
<th>p-value 1-tailed</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-treatment</td>
<td>117.483</td>
<td>6.156</td>
<td>-3.237 - 0.567</td>
<td>-1.759</td>
<td>158</td>
<td>.084</td>
<td>0.270</td>
</tr>
<tr>
<td>Control</td>
<td>118.818</td>
<td>6.023</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During Treatment</td>
<td>118.493</td>
<td>6.190</td>
<td>-1.977 - 1.852</td>
<td>-13.918</td>
<td>158</td>
<td>.474</td>
<td>2.135</td>
</tr>
<tr>
<td>Experimental</td>
<td>118.549</td>
<td>6.072</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Control</td>
<td>118.405</td>
<td>6.079</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

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 ($\alpha<.01$) 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

<table>
<thead>
<tr>
<th>Paired Comparison (Range of Motion Right Knee)</th>
<th>Mean N=80</th>
<th>SD</th>
<th>95%Confidence Interval of the Difference</th>
<th>t-value</th>
<th>df</th>
<th>$p$-value 1-tailed</th>
<th>Cohen’s $d$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-treatment</td>
<td>118.523</td>
<td>5.774</td>
<td>-1.340 to -0.765</td>
<td>-7.285</td>
<td>79</td>
<td>.000</td>
<td>1.152</td>
</tr>
<tr>
<td>During Treatment</td>
<td>119.575</td>
<td>6.102</td>
<td>-0.739 to -0.335</td>
<td>-5.295</td>
<td>79</td>
<td>.000</td>
<td>0.837</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>120.112</td>
<td>5.848</td>
<td>-1.849 to -1.331</td>
<td>-12.227</td>
<td>79</td>
<td>.000</td>
<td>1.933</td>
</tr>
</tbody>
</table>

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 ($\alpha>.01$). 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

<table>
<thead>
<tr>
<th>Paired Comparison (Range of Motion Right Knee)</th>
<th>Mean N=79</th>
<th>SD</th>
<th>95%Confidence Interval of the Difference</th>
<th>t-value</th>
<th>df</th>
<th>p-value 1-tailed</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-treatment</td>
<td>120.187</td>
<td>5.250</td>
<td>0.095 - 0.370</td>
<td>3.372</td>
<td>78</td>
<td>.000</td>
<td>0.537</td>
</tr>
<tr>
<td>During no Treatment</td>
<td>119.954</td>
<td>5.191</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>During no Treatment</td>
<td>119.954</td>
<td>5.191</td>
<td>-0.034 - 0.179</td>
<td>1.361</td>
<td>78</td>
<td>.089</td>
<td>0.217</td>
</tr>
<tr>
<td>Post-no treatment</td>
<td>119.882</td>
<td>5.165</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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

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

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 ($\alpha<.01$) 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

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

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 ($\alpha < .01$) 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 $\alpha < .01$ (Table XXI).

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

<table>
<thead>
<tr>
<th>Paired Comparison (Mobility)</th>
<th>Mean</th>
<th>SD</th>
<th>95% Confidence Interval of the Difference</th>
<th>t-value</th>
<th>df</th>
<th>p-value 1-tailed</th>
<th>Cohen's d</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
<td>(Mobility)</td>
<td>Lower</td>
<td>Upper</td>
<td>t-value</td>
<td>df</td>
</tr>
<tr>
<td>Pre-treatment</td>
<td>11.946</td>
<td>2.385</td>
<td>t-value</td>
<td>-1.433</td>
<td>-0.798</td>
<td>-6.991</td>
<td>84</td>
</tr>
<tr>
<td>During Treatment</td>
<td>13.061</td>
<td>2.725</td>
<td>df</td>
<td>-0.821</td>
<td>-0.553</td>
<td>-10.194</td>
<td>84</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>13.748</td>
<td>2.628</td>
<td>p-value 1-tailed</td>
<td>-2.133</td>
<td>-1.472</td>
<td>-10.842</td>
<td>84</td>
</tr>
</tbody>
</table>

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 ($\alpha < .01$) 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

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

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

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

**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.

References


9 Moore, K. Lasers and Pain Treatment. Department of Anesthesia, The Royal Oldham Hospital, UK. (lecture series) 2003; www.laser.partner.org


22 Moskvin, S. V. & Khadartsev, A.A. Basic techniques of low level laser therapy. Moscow-Tver. 2017


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