

# Pulsed Short Wave Effect in Pain and Function in Patients with Knee Osteoarthritis

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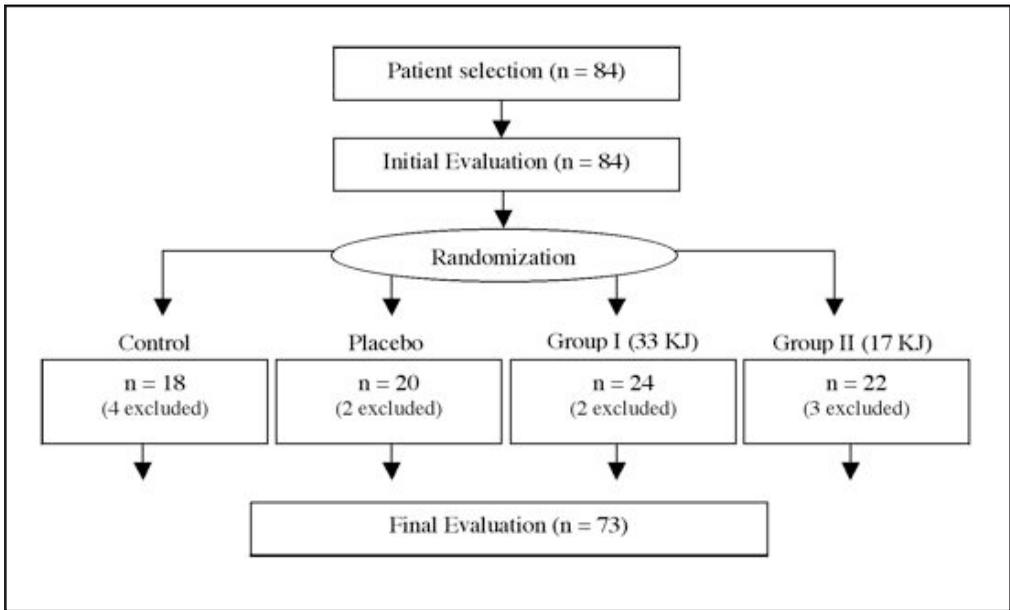
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## ABSTRACT

There is a divergence in the literature about the pulsed short wave (PSW) clinical application. However, some studies have shown good benefits in the osteoarthritis patient's treatment. Considering the controversial results in this condition, the aim of this study was to evaluate the effects of PSW therapy with doses of 33 KJ and 17 KJ in the pain and function in patients with knee osteoarthritis. Eighty-four patients that

participated in this study had knee osteoarthritis and were submitted to 17 and 33 KJ PSW doses and evaluated by a Lequesne's Algofuncional Questionnaire, Lysholm Knee Scoring Scale, visual analogical scale (VAS), and knee goniometry. After 9 sessions of PSW, the patients of the 17 and 33 KJ and placebo group were compared with the control group. In the Lequesne's Questionnaire, pain improvement was found in the 33 KJ group when compared with the placebo and control groups. The 17 KJ group presented significant results only when compared with the control group. A significant dif-



**Figure 1:** Diagram block-type delineating the proposed study.

ference in the Lysholm Scale was also established between the 33 and 17 KJ when compared to the placebo and control. For knee flexion, there were statistical differences among the treatment groups when compared to the control. In summary, in the VAS, the 33 KJ group presented a significant improvement when compared to the 17 KJ, placebo and control groups. Significant therapeutic results were shown in the 33 and 17 KJ groups when compared to the placebo and control. The PSW is effective to relieve pain and improve function in patients with knee OA.

## INTRODUCTION

Osteoarthritis (OA) is a clinical syndrome characterized by inflammation and degeneration that generally results in the progressive loss of joint cartilage associated with sclerosis of the subchondral bone, which, in many cases, leads to the formation of bone cysts and osteophytes. In addition to joint alterations, other signs and symptoms may also be present, such as joint pain, reduced or restricted movement of the affected site,

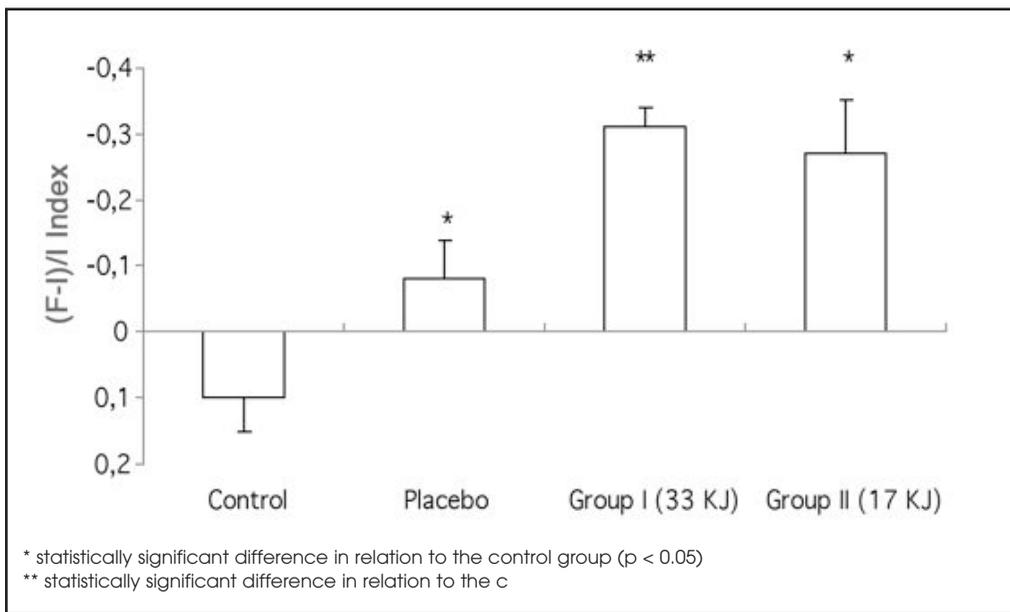
crepitation, joint effusion, and deformity.<sup>3,24</sup>

This disease affects over 60% of the world's adult population over the age of 40, especially women, and its incidence is augmenting as the population ages. Among all of the joints, the knee is usually the most commonly affected.<sup>14,15</sup>

The etiology of OA has yet to be discovered, however, it is frequently associated with excessive loads and repeated micro traumas related to occupational tasks, as well as hereditary, metabolic, and endocrinological factors.<sup>2</sup>

The goal for knee OA treatment is to alleviate pain, improve function, prevent and correct deformities, and retard this disease's progression.<sup>4,13</sup> Many interventions have been used for this, including changes in the affected individual's lifestyle, drugs, surgical and physical therapy that use specific techniques such as exercise, and other physical resources.<sup>11,23</sup>

Among the techniques used in physical therapy, electromagnetic radiation is commonly referred to as short wave (SW), and can be applied in a continu-



**Figure 2:** Comparison between the (F-I)/I indexes obtained from the Lequesne Questionnaire in the 4 studied groups.

ous or pulsed form.<sup>20</sup>

Authors have used pulsed short wave (PSW) therapy with the goal of minimizing thermal effects generated by conventional continuous applications, while emphasizing the effects of incremental cellular tropism.<sup>6,7</sup>

Among the effects of PSW application are: to increase local cell activity, reduce the inflammatory process, reduce edema, increase the rate of fibrin and collagen deposits, and aid in tissue regeneration without interfering with the central nervous system, nor the hypothalamus.<sup>5,12,13</sup>

Few recent studies have demonstrated the positive therapeutic effects of PSW in patients with OA,<sup>7,23</sup> however, unsatisfactory results were found in greater quantity.<sup>4,9,17,22</sup> These conflicting results seem to be related to the great variation of the applied energy and treatment duration, which ranged between 2.1 and 180 KJ and 15 to 40 minutes, respectively.<sup>4,7,9,17,22,23</sup>

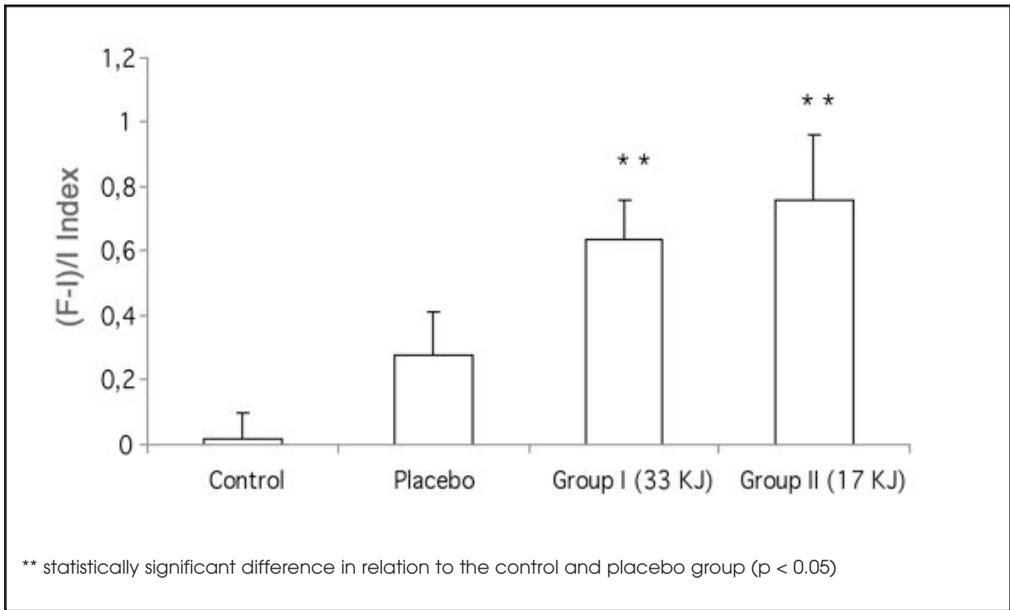
This single-investigator blinded, controlled study aims to evaluate the effects

of PSW therapy on pain and function in patients with knee OA, and to determine if there is any difference in efficacy between the groups treated with 33 KJ and 17 KJ.

## METHODS

### Patients

This is a prospective, randomized, and controlled study in which the studied subjects diagnosed with knee OA were selected by means of medical referrals to the Physical Therapy Department of Irmandade Santa Casa of Misericórdia in São Paulo (ISCMSP), and the Institute of Orthopaedic and Traumatology of the Clinics Hospital at the University of Sao Paulo Medical School (IOT/HCFMUSP), between February and December 2007. Eighty-four individuals were selected and randomly distributed into 4 groups: 18 patients in the control group (60 years  $\pm$  10); 20 individuals in the placebo group (57 years  $\pm$  09); 24 patients in group I (63 year  $\pm$  09); and 22 patients in group II (62 years  $\pm$  08).



**Figure 3:** Comparison between the (F-I)/I indexes obtained by the Lysholm scale in the 4 studied groups.

Female patients were included, over the age of 40 years, having a diagnosis of knee OA, grade II or III, based on the criteria of Gupta et al,<sup>8</sup> and chronic knee pain for more than 3 months. There was no superior age limit for exclusion.

The exclusion criteria included surgery, or any invasive procedure of the affected knee, physical therapy in the last month for knee problems, use of controlled medication or derivatives of glycosamine, and hormonal anti-inflammatory. Only the use of the analgesic acetaminophen was permitted in case of pain during the days of evaluation. Also excluded were patients with a body mass index (BMI) over 40; neurological alterations such as paresthesia of the limb; associated diseases of the locomotive system such as fibromyalgia; traumatic lesions of the meniscus and/or ligaments; presence of metallic implants; cardiac pacemakers; or a history of tumors.<sup>4,13,17</sup>

### Procedures

All the volunteers were informed of the

procedures that would be performed and they signed an Informed Consent form according to the norms of the National Health Council, Resolution 196/69. This study was approved by the Ethics Committee on Research of the ISCMSP, protocol 403/06.

The inclusion criteria had been previously established, and patient selection was performed by an examiner without knowledge of the treatment that was to be employed. It consisted of a questionnaire that defined which individuals were going to participate in the study. The patients were assigned to 4 specific groups and were randomly distributed. The same “blind examiner” was responsible for the pre and post-treatment evaluations (Figure 1).

### Intervention

The individuals in the active groups (Groups I and II) were submitted to 3 applications of PSW per week for 3 months, totaling 9 sessions. The instrument used was the Diatermed II, previously calibrated to a carrying frequency

**Table 1: Characterization of the 4 studied groups**

		Control	Placebo	Group I	Group II
Age (years)		60 ± 10	57 ± 09	63 ± 09	62 ± 08
Weight (Kg)		68.9 ± 20	65.9 ± 14.4	67.2 ± 14.4	66.9 ± 14.4
Height (m)		1.63 ± 0.04	1.59 ± 0.06	1.62 ± 0.06	1.58 ± 0.06
Affected knee	Left	05 (35.7%)	2 (11.1%)	3 (13.6%)	4 (21.1%)
	Right	09 (64.3%)	16 (88.9%)	19 (86.4%)	15 (78.9%)

of 27.12 MHz, with a peak power (Ppeak) of 250 watts and pulse duration of 400 µs. The maximum power that the equipment could provide was used, with a pulse frequency (f) of 145 Hz in order to obtain a mean power (Mp) of 14.5 watts.

To calculate the mean potency, the following formula was used:

$$Mp (W) = Ppeak (W) \times \text{Pulse Duration (s)} \times f (Hz)$$

The application of the PSW was administered using a standard size malleable electrode upon the anterior area of the thigh, 5 cm above the superior border of the patella and a second electrode on the posterior area of the leg, with the patient recumbent face-up. The knee was kept in a semi flexion at 20°.

In group I, the treatment had a duration of 38 minutes per session, with an approximate 33 KJ of total energy. Group II received 19 minutes of PSW application, totaling 17 KJ of energy. To calculate these energy values, the following equation was used:<sup>1,12</sup>

$$\text{Total energy (J)} = Mp (W) \times \text{Application time (s)}$$

The control group was composed of individuals that were not submitted to any form of treatment. A placebo group was established, in which the apparatus was turned on but kept in stand-by mode during 19 minutes without any electrical current being applied in the patients. The control and placebo groups were used to compare the results to the groups that received 33 KJ and 17 KJ of energy, respectively.

## Evaluations

The patients were evaluated twice, first with an initial evaluation (pre-treatment) and then with an evaluation at the end of the treatment (post-treatment). The patients that reported the daily use of medications, such as anti-inflammatory and chondro-protectors were oriented to interrupt use during the study period.

Two nationally and internationally validated evaluation scales were administered: the “Lysholm Knee Scoring Scale” proposed by Peccin et al,<sup>19</sup> and the Lequesne Algorfuntional Questionnaire for Knee Osteoarthritis, proposed by Marx et al.<sup>16</sup>

The Lequesne Algorfuntional Questionnaire for Knee Osteoarthritis is composed of 11 questions concerning pain, discomfort, and function; 6 questions pertaining to pain and discomfort; 1 question about distance when walking; and 4 questions about daily activities. The sum total is 24 points.

The Lysholm Knee Scoring Scales questionnaire is composed of 8 questions and multiple alternatives, with a final result expressed in ordinal form totaling 100 points.

Passive goniometry in joint flexion of the knee, according to the Hoppenfeld<sup>10</sup> criteria and subjective analysis of pain using the analogical visual scale (VAS) were also used.

It is important to emphasize that higher values of the evaluations using the Lysholm questionnaire and the knee goniometry, represent a better therapeutic

**Table 2: Results of the mean  $\pm$  standard deviation and median of the (F-I)/I index of the Lequesne, Lysholm, ROM and VAS.**

	Control	Placebo	Group I	Group II
Lequesne	0.10 $\pm$ 0.20 (0.06)	-0.08 $\pm$ 0.27 (-0.12)	-0.31 $\pm$ 0.13 (-0.31)	-0.27 $\pm$ 0.37 (-0.33)
Lysholm	0.22 $\pm$ 0.27 (-0.04)	0.28 $\pm$ 0.55 (0.21)	0.64 $\pm$ 0.57 (0.51)	0.76 $\pm$ 0.86 (0.52)
ROM	-0.02 $\pm$ 0.04 (0.00)	0.04 $\pm$ 0.08 (0.01)	0.05 $\pm$ 0.10 (0.02)	0.07 $\pm$ 0.08 (0.04)
VAS	-0.02 $\pm$ 0.34 (-0.04)	-0.21 $\pm$ 0.38 (-0.22)	-0.18 $\pm$ 0.30 (-0.19)	-0.42 $\pm$ 0.42 (-0.45)

tic result. On the other hand, the final, higher values of the evaluations using the Lequesne questionnaire and VAS, represent a worse therapeutic result.

### Statistical analysis

After data acquisition, the statistical software package *GraphPad Instant* was used to process the values obtained from the 4 groups. For the Lysholm, Lequesne and knee goniometry, the analysis of variance (ANOVA) - Tukey test and, afterwards, the non-paired t-test for parametric samples was used. For the values obtained from VAS, the Kruskal-Wallis test and non paired t-test for non-parametric samples were used.

The values were expressed in mean,  $\pm$  standard deviation, and median, with statistical significance considered when  $p < 0.05$ .

### RESULTS

Eighty-four patients began treatment, however, 11 patients did not undergo the final evaluations due to lack of regularity, and were automatically excluded. In a pre-treatment analysis of all the groups, homogeneity was found in relation to the scales used.

Table 1 characterizes the patients by means, standard deviations, age, weight, height, and knee affected in all of the groups analyzed.

Based on the results obtained from the Lysholm and Lequesne scales, goniometry of knee flexion and VAS, a standardization of the data was performed using an index with the value of

the final evaluation minus the initial evaluation divided by the initial evaluation (F-I)/I, and the values obtained were compared between the groups.

Table 2 demonstrates the specific results of means,  $\pm$  standard deviations, and median obtained in the study.

### Lequesne Algofunctional Questionnaire

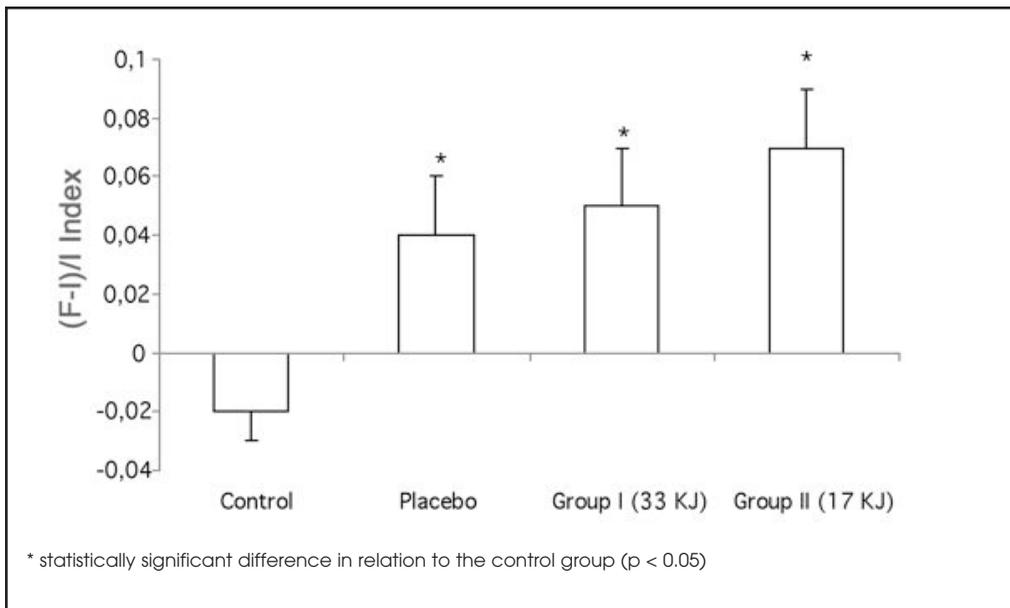
In the analysis of this questionnaire, the obtained values were: control group 0.10  $\pm$  0.2 (0.06); placebo group -0.08  $\pm$  0.27 (-0.12); group I -0.31  $\pm$  0.13 (-0.31) and group II -0.27  $\pm$  0.37 (-0.33), with a significant difference between the placebo group ( $p < 0.05$ ), group I ( $p < 0.0001$ ) and group II ( $p < 0.001$ ) when compared to the control group. A significant difference was also established between group I and the placebo group ( $p < 0.005$ ) (Figure 2).

### Lysholm Scale

In the analysis of this scale, the obtained values were: control group 0.02  $\pm$  0.27 (-0.04); placebo group 0.28  $\pm$  0.55 (0.21); group I of 0.64  $\pm$  0.57 (0.51); and group II of 0.76  $\pm$  0.86 (0.52), with a significant difference between group I ( $p < 0.0001$ ) and group II ( $p < 0.001$ ) when compared to the control group. Significant differences were also found between groups I ( $p < 0.05$ ) and II ( $p < 0.05$ ) when compared to the placebo group (Figure 3).

### Knee flexion

The values obtained from the (F-I)/I index in the knee flexion goniometry for the 4 groups was: control group -0.02  $\pm$



**Figure 4:** Comparison between the (F-I)/I indexes obtained by knee goniometry in the 4 studied groups.

0.04 (0.00); placebo group  $0.04 \pm 0.08$  (0.01); group I of  $0.05 \pm 0.10$  (0.02); and group II of  $0.07 \pm 0.08$  (0.04). There were statistical differences between the placebo group ( $p < 0.05$ ), group I ( $p < 0.05$ ), and group II ( $p < 0.0001$ ) when compared to the control group (Figure 4).

### Visual Analogical Scale

Figure 5 presents the standardized results of the VAS of the 4 groups: control group  $-0.02 \pm 0.34$  (-0.04); placebo group  $-0.21 \pm 0.38$  (-0.22); group I  $-0.18 \pm 0.30$  (-0.19); and group II with  $-0.42 \pm 0.34$  (-0.45). Group II presented a statistically significant improvement when compared to the control group ( $p < 0.005$ ) and group I ( $p < 0.05$ ).

### DISCUSSION

The aim of this study was to evaluate the effects of PSW therapy in patients with OA of the knee. In order to perform an application that would minimize the thermal effects of the equipment, we used Mp of 14.5 W. Concerning the

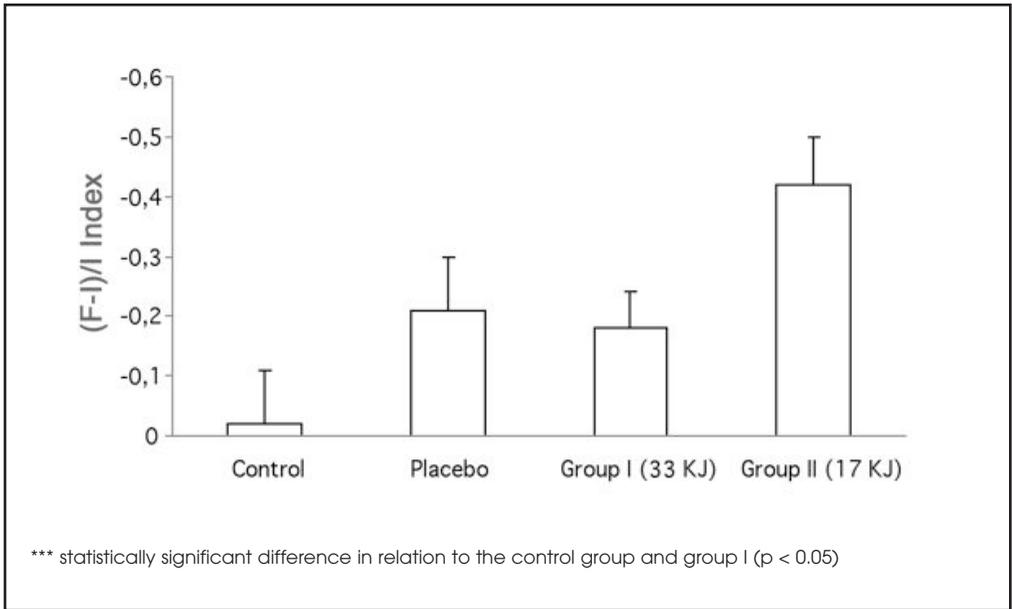
doses of 17 and 33 KJ, these were based on the time of application normally used clinically with Brazilian equipment, which is between 20 to 40 minutes.

The evaluation of pain and functional capacity of the patients was measured using the Lysholm and Lequesne scales, goniometric measures of knee flexion and VAS. The questionnaires selected were designed for patients with OA of the knee, and had national and international validation.

The option of working with female patients in this study was based in the higher incidence of OA in this group. The choice of the knee joint and patient's age followed the same criteria.<sup>3,14,15,24</sup>

The results of this study suggest that PSW therapy is effective for the treatment of knee OA when compared to the active groups (17 and 33 KJ), and the control and placebo groups. Such findings, when confronted with the literature, present discordances.

Moffet et al,<sup>17</sup> in a similar study did not find significant differences between



**Figure 5:** Comparison between the (F-I)/I indexes obtained by VAS in the 4 studied groups.

the active group and the placebo and control groups. In this study, the Mp used was of 23 W, which is considered sub-thermal. The application time was 15 minutes and the patients received 3 applications per week, for a total of 9 applications.

When comparing the active groups with the control and the placebo groups, Laufer et al,<sup>13</sup> evaluated 103 patients that received 20-minute applications of 1.8 and 18 W. The results indicated a reduction in pain and knee stiffness, however, statistical significance was not established between the groups.

Callaghan et al,<sup>4</sup> evaluated 27 patients that were divided into two active groups and one control group. The active groups received a Mp of 10 W, which is considered low potency, and a 20 W, which is considered high potency. Three weekly applications of 20 minutes each were applied for 2 weeks. The authors concluded that PSW presented little or no anti-inflammatory effects and that the objective and functional measures did not reveal significant differences between the groups, except for the

improvement in the range of movement (ROM) of the knee in the placebo group. In the present study, very similar parameters were used with those cited previously, yet with satisfactory results.

There are few studies in the literature that demonstrates positive results with the use of PSW for OA of the knee. However, in a study similar to the present one, Tuzun et al,<sup>23</sup> applied PSW with a Mp of 8 and 26 W, and providing doses of 7.2 KJ and 23.8 KJ with significant results compared to the control group. However, in their study, ultrasound and exercise were also utilized.

Corroborating these findings, Nadasdi,<sup>18</sup> and Svarcova et al,<sup>21</sup> found a reduction of pain and an inhibition of inflammatory processes.

The ideal dose for PSW application has also been a reason for discussion in the literature. In order to obtain therapeutic doses, applications with a total dose over 40 KJ have been recommended.<sup>4,13,21</sup> Conversely, in the present investigation, doses of 17 and 33 KJ were used with a time of 19 and 38 minutes respectively, with significant results

when compared to the control and placebo group. Because a significant difference was not established between the active groups, we believe that long-term treatment should not be necessary.

In the evaluations of the results from the Lequesne and Lysholm scales, the groups treated with 17 and 33 KJ presented significant differences when compared to the control and placebo groups, demonstrating that the active groups had a greater reduction of the symptoms and functional improvement. The goal of this study was not to observe physiological alterations that could explain this improvement in function; however, the possible effects reported in the literature seem to be an increase in the synovial fluid, relaxation of muscles, and inflammatory control of the reactive synovitis.  
5,6,12,13

In the evaluation of knee flexion, a significant improvement was found among the 17 KJ, 33 KJ, and placebo groups when compared to the control group, without any difference found between the active groups and the placebo group. This demonstrates that the application of PSW does not change ROM, even though every patient from every group did not present significant passive flexion reduction in the beginning of the study.

In addition to the effectiveness of PSW therapy as a complementary treatment for OA of the knee, it is important to point out that a prolonged application time is not necessary, since a total time of 20 minutes can reach the therapeutic window recommended in the literature. It is important to emphasize that the results were obtained without exercises, thus making PSW an important tool that should be associated with kinesiotherapy during the physical therapy treatment. The inclusion of exercise and longer follow-up should be considered in a future study.

## CONCLUSION

PSW therapy is an effective resource for alleviating pain and providing functional improvement in the treatment of patients with knee OA, regardless whether the dose is 17 KJ or 33 KJ.

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