



Use of different doses of pulsed short waves in the treatment of patients with osteoarthritis of the knee

Ondas curtas pulsado em diferentes doses no tratamento de pacientes com osteoartrite de joelho

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ABSTRACT

Objective

To evaluate the effectiveness of the application of pulsed short waves in the reduction of pain, and functional improvement in patients with osteoarthritis of the knee, and also to investigate changes in treatment between the groups with doses of 17 kilojoules or 33 kilojoules.

Methods

Forty-two female subjects with type II or III osteoarthritis of the knee and over 40 years of age, participated in this study, and were submitted to the application of pulsed short wave doses of 17 or 33 kilojoules. They were evaluated by means of a knee and osteoarthritis score questionnaire, visual analog pain scale and knee flexion goniometry.

Results

The active groups of 17 or 33 kilojoules had less pain and improved function when compared with the control group. There was, however, no significant difference between the active groups.

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Conclusion

This study demonstrated that the application of both 17 and 33 kilojoule doses of pulsed short waves is efficient in pain reduction and improved function in the treatment of osteoarthritis of the knee.

Indexing terms: Pain. Physical therapy modalities. Osteoarthritis.

RESUMO

Objetivo

Avaliar a eficácia da aplicação de ondas curtas pulsadas na redução da dor e melhora funcional dos pacientes com osteoartrite de joelho. Investigar se há alguma diferença no tratamento entre os grupos com doses de 17 ou 33 kilobytes.

Métodos

Participaram deste estudo 42 mulheres portadoras de osteoartrite no joelho graus II ou III, com idade acima de 40 anos, submetidas à aplicação de ondas curtas pulsadas com doses de 17 ou 33 kilojoules, avaliadas por meio do questionário knee and osteoarthritis score escala visual analógica de dor e goniometria de flexão de joelho.

Resultados

Os grupos ativos de 17 ou 33 kilojoules obtiveram uma melhora do quadro algico e funcional quando comparados com o grupo controle, porém não se encontrou diferença significativa na análise entre os grupos ativos.

Conclusão

Este estudo demonstrou que a aplicação de ondas curtas pulsadas com doses de 17 ou 33 kilobytes é eficaz no tratamento da osteoartrite de joelho.

Termos de indexação: Dor. Modalidade de fisioterapia. Osteoartrite.

INTRODUCTION

Osteoarthritis (OA) is a chronic and multifactorial illness that leads to gradual functional incapacity and affects more than 60% of the world adult population, mainly subjects above 40 years old and female. The knee is one of the joints most affected by this disease, and it causes acute pain, joint stiffness, deformities, hypotrophy of the quadriceps muscles and a gradual reduction in function^{1,2}.

Many interventions are used to relieve pain, improve function, reduce disability and minimize the progression of illness. These interventions include a modified lifestyle, drug therapy, surgery, and specific physical therapy techniques^{1,2}.

Among the techniques used in physical therapy is electromagnetic radiation or short waves that can be applied in continuous or pulsed form³.

Pulsed short waves (PSW) are widely used as a therapeutic modality in the treatment of this disease; however, there are few scientific studies that demonstrate the method's effectiveness and its ideal application dose.

Some authors have used the PSW application with the intention of minimizing the thermal effects generated by conventional continuous application, emphasizing the incremental effects of cellular trophism^{4,5}.

The main effects of PSW application are: increase in local cellular activity, decrease in the inflammatory process, reduction in edema, increase

in the rate of deposit and orientation of fibrin and collagen, increased tissue healing, without interfering with the central nervous system or the hypothalamus⁶⁻⁹.

Recent studies have shown good therapeutic effects with PSW application, however unsatisfactory results can also be found. These conflicting results seem to be related to the great variation of energy dosages applied. For example, doses of energy between 2.1 and 180 kilojoules (Kj) and length of treatment between 15 and 40 minutes have been found^{1,5,10-12}.

The purpose of this study is to evaluate the effectiveness of PSW application in pain reduction and improved function in patients with knee OA, and to investigate if there is any difference in the treatment between doses of 17Kj and 33Kj.

METHODS

The subjects in this study were selected by medical evaluation between March and December 2006 having a diagnosis of knee OA. Forty-two subjects were randomly placed in 3 groups: 14 subjects in the control group (56 years \pm 17), 14 subjects in group I (68 years \pm 14) and 14 subjects in group II (71 years \pm 8). Three subjects in group I and three in group II were unable to attend regularly for PSW therapy.

Female patients above 40 years old were included with a diagnosis of types II or III knee OA, based on the criteria of Gupta *et al.*¹³, and who presented more than 3 months of knee joint pain. There was no upper age limit for exclusion.

Exclusion criteria were: surgery or some invasive procedure on the affected knee; physical therapy for knee disorders within the last month; specific drugs utilized such as chondro-protectors, or derivatives of glycosamine, and anti-inflammatory steroids or non-steroids. Paracetamol was the only type of analgesic that was allowed in instances of bouts of pain, except on the day of evaluation. Also

excluded were subjects with morbid obesity, or a body mass index above 40, neurological changes, such as limb sensitivity deficits, associated with diseases of the locomotor system, such as meniscal tears, fibromyalgia, traumatic injuries and/or ligaments, presence of metallic implants, cardiac pacemaker or history of tumors.

All the patients were informed of the procedures to 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 ISCMSP's Ethics Committee on Research, protocol 403/06.

The criteria used for selecting the subjects were determined in advance, and this was carried out by an examiner with no prior knowledge of the treatment to be implemented, and it consisted of the use of a questionnaire, which defined the subjects for the study. The distribution of the subjects into 3 specific groups was randomized and accomplished by drawing lots, with replacement. The same "blind" examiner was responsible for the evaluations before and after treatment (Figure 1).

Intervention

The subjects of the active groups (Groups I

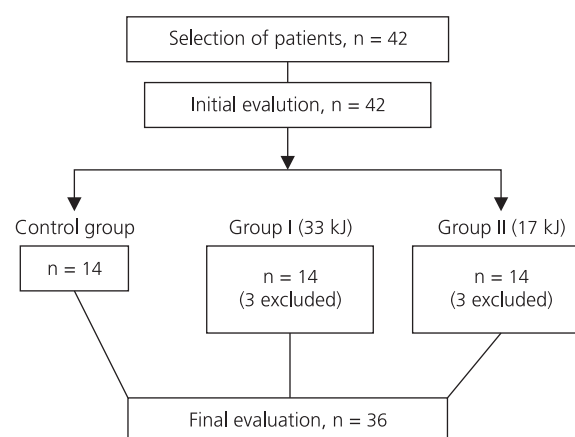


Figure 1. Block-type diagram delineating the proposed study.

and II) had been submitted to 3 applications per week of PSW for a total of 9 sessions. The device used was a Diatermed II with a frequency of 27.12MHz, peak power (Pp) of 250W and pulse width (Pw) of 400µs, or 400 x 10⁻⁶s. The maximum power supplied by the equipment was used with a pulse repetition rate (Prr) of 145Hz in order to obtain a mean power (Mp) of 14.5W.

The formula below was used to calculate the Mp^{7,14}:

$$Mp (W) = Pp (W) \times Pw (s) \times Prr (Hz)$$

PSW was applied with an electrode on the quadriceps muscle at approximately 5 cm above the top part of the patella and another electrode below the gastrocnemius muscle, with the patient in dorsal decubitus. The knee was kept at approximately 20° in semiflexion.

In group I, the treatment lasted 38 minutes per session with approximately 33Kj of total energy (E). Group II received 19 minutes of PSW application (t), totaling 17Kj of energy. The calculation of this amount of energy was obtained via the following equation^{7,14}.

$$E (J) = Mp (W) \times t (s)$$

The control group was composed of subjects that had not been submitted to treatment. The study sought to compare the results of this group with those obtained in the groups that received energy of 33Kj or 17Kj respectively.

Evaluation

The subjects were evaluated in two parts: initial evaluation (pre-treatment) and at the end of treatment (post-treatment). The patients that used daily medication such as anti-inflammatories and chondro-protectors were instructed to suspend use 15 days prior to treatment.

The questionnaire used was Knee and Osteoarthritis Outcome Score (KOOS) that consists of 5 subscales: pain, symptoms, sport and recreation

function, daily life activities, and quality of life¹⁵⁻¹⁸. Passive flexion goniometry of the knee joint was also utilized according to the criteria established by Hoppenfeld¹⁹ and subjective analysis of pain by a visual analog scale (VAS).

Statistical analysis

After the data was acquired, the *GraphPad InStat* statistical program was used to process the obtained values. The data found for the 5 KOOS subscales, goniometry of the knee and VAS between the groups was processed by analysis of variance (ANOVA) - Kruskal-Wallis test. The normalized values were expressed as a mean ± standard error of mean or median (50th percentile). The statistical significance was defined as $p < 0.05$.

An evaluation between groups I and II was also completed by a paired analysis (test-t), with the purpose of observing the relationship between the doses.

Using the KOOS results as the base, knee flexion gain and VAS had the data normalized for an index with the value of the final evaluation minus the initial evaluation and divided by the initial evaluation: (F-I)/I index. The values obtained were compared between active groups I and II in relationship to the control group and between the 3 groups.

RESULTS

KOOS

The following table shows the specific results of the mean and standard error of mean or median (Table 1). In the analysis of subscale "symptoms", the values obtained in the control group were 0.0; group I, 0.76 ± 0.38 and group II, 0.53 ± 0.27. There was no significant difference between the groups ($p > 0.05$).

In the subscale "pain", the control group presented a value of 0.04 ± 0.09; group I, 0.17 ± 0.71

and group II, 1.30. Groups I and II presented a significant difference in relation to the control group ($p < 0.05$). In the subscale "activity of daily life", the subjects in the control group presented a value of -0.1; group I, 0.56 ± 0.15 , and group II, 0.85 ± 0.4 . There was a statistically significant difference between group I and the control group ($p < 0.05$). In the analysis between the active groups for the subscales "pain" and "activity of daily life", there was no significant difference ($p > 0.05$).

For "sport and recreation function", the control group showed a value of -0.05, group I of 1.0 and group II of 1.0. Only group II obtained significant improvement in relation to the control group ($p < 0.05$). In the final data obtained for the scale "quality of life", the subjects in the control group showed a value of 0.3; group I of 1.0 and group II of 0.8. There was no significant difference between the groups ($p > 0.05$) (Figure 2).

The subjects of the control group had obtained an index of (F-I)/I of knee flexion during the treatment of 0.05; group I of 0.11 ± 0.05 and group II of 0.0. There were no significant differences when compared to groups I and II and the control group, and when compared to the active groups ($p > 0.05$).

The normalized results of pain relief in the joint were: control group, 0.0; group I, -0.49 ± 0.12 and group II, -0.52 ± 0.05 . Groups I and II presented significant improvement when compared to the control group, but the analysis between the active groups did not present a significant difference ($p < 0.05$). All the data presented for KOOS scale, knee flexion and VAS were obtained by the (F-I)/I index.

DISCUSSION

The results of this prospective and random study demonstrate an effective means to reduce pain and improve function by utilizing PSW in patients with knee OA, when compared to the control group.

Some divergent aspects were found in the literature for the treatment of patients with OA. The

Table 1. Comparison of the (F-I)/I index to the KOOS subscales, VAS, and Knee flexion for the 3 groups analyzed with a mean \pm standard error deviation or median.

KOOS	Control n=14	Group I n=11	Group II n=11
Symptoms	0	0.76 (\pm 0.38)	0.53 (\pm 0.27)
Pain	0.04 (\pm 0.09)	0.71 (\pm 0.17)	1.3
ADL	-0.10	0.56 (\pm 0.15)	0.85 (\pm 0.40)
SRF	-0.05	1	1
QL	0.30	1	0.8
VAS	0.00	-0.49 (\pm 0.12)	-0.52 (\pm 0.05)
Knee Flexion	0.05	0.11 (\pm 0.05)	0

KOOS subscales (Symptoms, Pain, ADL - Activities of daily life; SRF: Sport and recreative function, QL: Quality of life; VAS: Visual analogic scale, Knee Flexion; n: number of subjects).

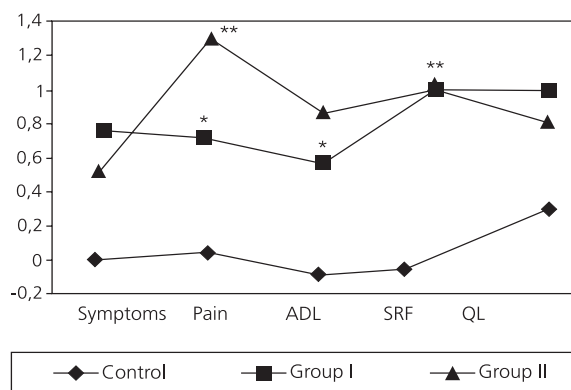


Figure 2. Comparison between the (F-I)/I index between the 3 groups analyzed for the KOOS subscales.

Notes: KOOS subscales (Symptoms, Pain, ADL: Activities of daily life; SRF: Sport and recreative function; QL: Quality of life); Group I (33 kJ) and Group II (17 kJ).

* $p < 0.05$ (group I x control group); ** $p < 0.05$ (group II x control group).

authors did not demonstrate satisfactory therapeutic results in PSW applications with mean power varying between 1.8W and 23W^{8,11-12}. According to Laufer *et al.*⁸ in 2005, an application with mean power of approximately 1.8W is considered non-thermal, while a mean power of 18W would be considered thermal. As for Moffet *et al.*¹¹ in 1996, they considered a mean power of 23W as sub-thermal. In this study, however, a power of 14.5W was used to minimize the thermal effect^{5,8,11,20}, while obtaining satisfactory results with PSW applications when compared with the control group.

Beyond these divergences in relation to the specific mean power for production of thermal or non-thermal effects, the ideal dose is the subject of some controversy. For obtaining therapeutic doses, applications have been recommended with total energy above 40Kj^{8,12,21}. On the other hand, in the present study, doses of 17Kj and 33Kj were utilized for 19 and 38 minutes respectively. Significant results were obtained when compared with the control group. No significant difference was found between these two active groups. It should be stressed that treatment was not administered over a prolonged period of time.

As demonstrated previously, approximate dosages of 40Kj are the most suitable according to the literature, and for this reason, the group used 33Kj. The option of using a dosage of 17Kj was simply an attempt to reach the same therapeutic objective within a shorter time period.

During the second part of this study the "KOOS" questionnaire was utilized for qualitative and quantitative evaluation of the effectiveness of treatment in patients with knee OA. As previously observed, the group that received a dose of 17Kj presented improvement in "pain" and "sport and recreation function" and the group with a dose of 33Kj presented improvement in "pain" and "daily life activities" when compared with the control group. Irrespective of the dose used, improvement of function was observed, except for "symptoms" and "quality of life". Perhaps with a larger sample, a significant difference could be found for these two forms of evaluation.

The active groups with doses of 17Kj or 33Kj presented significant differences in the VAS in relation to the control group. However, there was no significant difference between the active groups, bearing in mind the fact that these two doses had provided similar outcomes for pain.

During the analysis of the data of the KOOS subscale "pain", the groups with 17Kj and 33Kj presented statistical differences in relationship to the control group. This information is similar to the data obtained for VAS evaluation, because the two active groups presented significant results.

In the evaluation of knee flexion gain, no significant differences between the groups were found, and this occurred because the initial values of the groups were approximately normal.

A similar study associating exercise and ultrasound was tested by Tuzun *et al.*² in 2003. They applied PSW with a mean power of 8W and 26W, and provided doses of 7.2Kj and 23.76Kj, finding significant results when compared with the control group.

It was not possible in the present study to compare the active groups with a placebo group because the local ethics committee did not give its approval. In the future, studies including placebo groups and different PSW doses should be performed.

One of the most important contributions of this paper is the fact that a prolonged application is not always necessary. A total time of approximately 20 minutes is enough to reach the therapeutic window suggested in the literature.

CONCLUSION

PSW therapy seems to be an effective tool for pain relief and functional improvement in the treatment of patients with knee OA, regardless of the 17Kj or 33Kj doses. This conclusion should, however, be restricted to the methodology used.

REFERENCES

1. Marques AP, Kondo A. A fisioterapia na osteoartrose: uma revisão da literatura. *Rev Bras Reumatol.* 1998; 38(2):83-90.
2. Tuzun HE, Otman S, Kird N. Comparison of different methods of pulsed shortwave diathermy in knee osteoarthritis. *Pain Clinic.* 2003; 15(4):421-7.
3. Shields N, O'Hare N, Boyle G, Gormley J. Development and application of a quality control procedure for short-wave diathermy units. *Med Biol Eng Comp.* 2003; 41(1):62-8.
4. Garret LC, Draper OD, Knight LK. Heat distribution in the lower leg from pulsed short-wave diathermy and ultrasound treatments. *J Athl Train.* 2000; 35(1):50-5.

5. Guerra SR, Fukuda YT, Chicuto RD. Tratamento de pacientes com osteoartrite através da aplicação de ondas curtas pulsado atérmico: dosage ideal e tempo de aplicação. *Med Reab.* 2005; 24(1):15-9.
6. Evans P. The healing process at the cellular level: a review. *Physiotherapy.* 1980; 66(8):256-9.
7. Kitchen S, Partridge C. Review of shortwave diathermy continuous and pulsed patterns. *Physiotherapy.* 1992; 78:243-52.
8. Laufer Y, Zilberman R, Porat R, Nahir AM. Effect of pulsed short-wave diathermy on pain and function of subjects with osteoarthritis of the knee: a placebo-controlled double-blind clinical trial. *Clin Rehab.* 2005; 19(3):255-63.
9. Wang JL, Chan RC, Cheng HH, Huang CJ, Lu YC, Chen IS, *et al.* Short waves induced enhancement of proliferation of human chondrocytes: involvement of extra-cellular signal-regulated map-kinase. *Clin Exp Pharmacol Physiol.* 2007; 34(7):581-5.
10. Trock DH, Bollet AJ, Dyer Jr. RH, Fielding LP, Miner WK, Markoll R. A double-blind trial of the clinical effects of pulsed electromagnetic fields in osteoarthritis. *J Rheumatol.* 1993; 20(3):456-60.
11. Moffett JA, Richardson PH, Frost H, Osborn A. A placebo controlled double blind trial to evaluate the effectiveness of pulsed short wave therapy for osteoarthritis hip and knee pain. *Pain.* 1996; 67(1): 121-7.
12. Callaghan MJ, Whittaker PE, Grimes S, Smith L. An evaluation of pulsed shortwave on knee osteoarthritis using radiolouescintigraphy: a randomized, double-blind, controlled trial. *Joint Bone Spine.* 2005; 72(2): 150-5.
13. Gupta KB, Duryea J, Weissman BN. Radiographic evaluation of osteoarthritis. *Radiol Clin N Am.* 2004; 42(1):11-41.
14. Bjordal JM, Couppé C, Chow RT, Tunér J, Ljunggren EA. A systematic review of low level laser therapy with location-specific dosages for pain from chronic joint disorders. *Australian J Physiother.* 2003; 49(2):107-16.
15. Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health status instrument for measuring clinically important patient relevant outcomes to anti-rheumatic drug therapy in patients with osteoarthritis of the hip or knee. *J Rheumatol.* 1988; 15(12):1833-40.
16. Roos EM, Roos HP, Lohmander LS. WOMAC osteoarthritis index: additional dimensions for use in subjects with posttraumatic osteoarthritis of the knee. Western Ontario and MacMaster Universities. *Osteoarthritis Cartilage.* 1999; 7(2):216-21.
17. Xie F, Li SC, Roos EM, Frong KY, Lo NM, Yeo SJ, *et al.* Cross-cultural adaptation and validation of Singapore English and Chinese versions of the Knee injury Osteoarthritis Outcome Score (KOOS) in Asians with knee osteoarthritis in Singapore. *Osteoarthritis Cartilage.* 2006; 14(11):1098-103.
18. Paradowski PT, Bergman S, Sundén-Lundius A, Lohmander LS, Roos EM. Knee complaints vary with age and gender in the adult population. Population-based reference data for the knee injury and Osteoarthritis Outcome Score (KOOS). *BMC Muscularskeletal Dis.* 2006; 7:38.
19. Hoppenfeld S. *Propedêutica ortopédica: coluna e extremidades.* São Paulo: Atheneu; 2002.
20. Scott LD, Pipitone N. Magnetic pulse treatment for knee osteoarthritis: a randomised, double-blind, placebo-controlled study. *Curr Med Res Opin.* 2001; 17(3):190-6.
21. Svarcová J, Trnavský K, Zvárová J. The influence of ultrasound, galvanic currents and short wave diathermy on pain intensity in patients with osteoarthritis. *Scand J Rheumatol Suppl.* 1987; 67: 83-5.

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