COMPARISON OF CRYOTHERAPY, EXERCISE AND SHORT WAVES IN KNEE OSTEOARTHRITIS TREATMENT

ADRIANA LUCIA PASTORE SILVA[1], DANIELA MAYUMI IMOTO[2], ALBERTO TESCONI CROCI[3]

SUMMARY

Osteoarthritis is the most prevalent form of joint disease. Physical agents such as ice and heat can fight the pain process, when correctly indicated and used. The objective of this study was to compare physiotherapy protocols involving the use of exercise, cryotherapy and short waves in individuals with knee osteoarthritis. In a prospective randomized study, 25 individuals were treated (25 knees), with ages ranging from 58 to 78 years. GROUP A: exercise and short-waves (n=9). GROUP B: exercise and ice (n=6). GROUP C: exercise alone (control) (n=9). Analyzed variables were: subjective perception of pain (Borg), functional quality (Lequesne), range of motion, flexibility and muscular strength. Pain significantly improved only for group B, with positive functional quality and flexibility in all groups. The improvement in range of motion was similar for groups B and C. Flexion strength was maintained for groups A and B, and strength gain for individuals in group C. In the extensors muscles, strength gain was seen in groups B and C, while strength loss was reported for group A. The best protocol was that one involving cryotherapy and exercises for pain relief. All groups showed improved functional quality; no correlation was found for range of motion gain, flexibility and strength gain associated with thermotherapy.

Keywords: *Osteoarthritis of the knee; Cryotherapy; Short wave; Physiotherapy*

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INTRODUCTION

Osteoarthritis (OA) is one of the most common diseases of the skeletal system, and can be defined as a degenerative condition affecting synovial joints(1), being the most prevalent form of joint disease, which does not lead to systemic involvement, without associated mortality(2).

Knee OA is a disease of inflammatory and degenerative nature causing joint cartilage destruction, leading to joint deformity(3).

Pain is typically the first impairing factor for OA, subsequently leading to joint, per-joint changes and progressive dysfunction(1).

Physical agents can fight the painful process when correctly indicated and used. Among these agents, we highlight cryotherapy, superficial and deep heat(1).

Although OA is associated to mechanical factors of joint overload leading to cartilaginous injury, weighted and regular physical activities can improve some of the secondary changes associated to this disease(1).

OA treatment must be continued, based on drug and physical therapy(2).

Literature shows interest on scientific validations of the propositions made by physical medicine, so far often grounded on observation and empirics. Reviews seek to prove the beneficial effect of certain techniques, but several proofs are required to establish the real usefulness of each method or instrument(2).

The objective of this study was to compare physical therapeutic treatment protocols involving the use of kinesiotherapy, cryotherapy and a form of deep heat (short waves) in patients diagnosed with knee OA receiving healthcare at the outpatient service of University of São Paulo's Medical College Orthopaedics and Traumatology Institute at Hospital das Clínicas.

CASE SERIES

Twenty five sedentary patients were assessed (19 females and 6 males), totaling 25 knees (15 right and 10 left knees) from May to December 2003, with a diagnosis of primary knee osteoarthritis, with ages ranging from 58 to 78 years (average: 67.56 years), body weight between 53 and 136 kg (average: 76.16 kg), height between 1.50 and 1.85m (average: 1.60 m), referred to the Arthroplasty Group of the Discipline of General Orthopaedics at IOT/HAC/FMUSP.

The inclusion criteria were the following:

a) individuals with ages ranging from 58 to 78 years;
b) individuals diagnosed with knee grade-I osteoarthritis, unilaterally;
c) absence of any other kind of associated disease affecting LLLL (e.g., ankylosing spondylitis, rheumatoid arthritis, degenerative diseases, Diabetes mellitus, ankle and feet fractures, Parkinson's disease, Brain Palsy);
d) no history of previous knee or hip arthroplasty at the studied limbs or contralaterally, or any other orthopaedic surgical procedure on lower limbs;
e) absence of any neurological disorders that could promote cognitive changes;
f) absence of any kind of metal implant and/ or pacemaker;

Study conducted at the Orthopaedics and Traumatology Institute, Hospital das Clínicas, Medical College, University of São Paulo (IOT HC FMUSP). Study design approved by FMUSP's Committee on Ethics

Correspondences to: Rua Tamandaré, 734 ap 154 bloco A – Liberdade – São Paulo – SP - Cep: 01525-000 – E-mail: adriana_pastore@hotmail.com

1. Physical therapist, Master in Orthopaedics and Traumatology Sciences, Orthopaedics and Traumatology Institute, HC/FMUSP.
2. Physical therapist, Orthopaedics and Traumatology Institute, HC/FMUSP.
3. Associate Professor, Department of Orthopaedics and Traumatology, and Coordinator of the Tissues Library, IOT/HC/FMUSP

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g) no regular physical activity practice at least for 3 previous months;
h) not been submitted to physical therapy for at least 6 previous months;
i) have free and available time twice a week to be submitted to treatment.

The exclusion criteria were the following:

a) treatment program dropout before the completion of 10 sessions;
b) two consecutive absences;
c) hypersensitivity to physical methods applied.

MATERIAL

Questionnaires were applied pre- and post-physiotherapeutic treatment in order to evidence personal data and issues associated to an individual's functional quality[4] with the key complaint of each patient.
A goniometer was used to measure range of motion; a pain scale[5] was used to measure the subjective perception of pain, and; a sphygmomanometer duly calibrated to assess muscle strength[6].
Physiotherapeutic treatment was applied according to the standards recommended by IOT HCFMUSP with sheets, ergometric bicycle, and cushion for proprioceptive drills, triturated ice and a shot wave instrument (Diatermed II®).

METHOD

After screening according to the inclusion and exclusion criteria, each patient, properly informed by the Free and Informed Consent Term approved by the Scientific Committee of the Institute, was randomly assigned by a member of the registration staff to be included in a given group.

The patients were divided into three groups:

GROUP A: application of short waves with the individual laying down with extended knees during 20 minutes plus exercises.
GROUP B: application of ice for 20 minutes plus exercises.
GROUP C: exercises only.
Three different treatment groups were built. The first one received kinesiotherapy plus short waves, comprising nine treated knees. The second group received kinesiotherapy plus ice, comprising nine treated knees. The third group served as control, being treated only with kinesiotherapy, comprising seven treated knees.
The patients were assessed before and after treatment regarding muscular strength, magnitude of pain, range of motion and functional quality in both limbs (the affected and the non-affected sides), because exercises were made bilaterally and the application of short waves and ice was done only at the affected side.
Screening and assessment were made by independent physical therapists (blind study) and all patients received care at the Physical Therapy outpatient facility of IOT HCFMUSP where 10 sessions were conducted at a frequency of twice a week, applying stretching and strengthening exercises (isometry) for the following muscles: sural triceps, hip abductors and adductors, quadriceps and ischiotibial, proprioception on cushion and ergometric bicycle, and application of short-waves or ice, depending on the group.

STATISTICAL ANALYSIS

For comparing non-parametric values, the Wilcoxon's and Kruskal-Wallis' tests were used, and for comparing parametric values, the Student's t (paired and non-paired) and variance analysis (ANOVA) tests were used.
For comparing groups A, B and C for inference of the differences among averages, the variance analysis with differences distinction (Tukey's test) was employed.
A significance level of 5% was adopted in all comparisons and statistically significant results were marked with an asterisk (*).

RESULTS

The results are presented as tables listing values for averages, standard deviation and standard error for each analyzed variable for the three different groups pre- and post-physiotherapeutic treatment and as charts showing statistical results (Tables 1, 2, 3, 4, Charts 1, 2, 3, 4).

Pain	Group A		Group B		Group C	
	Pre	Post	Pre	Post	Pre	Post
Average	7	4.33	7.43	4	5.56	6.22
Standard Deviation	2.74	4	2.15	2.83	2.46	3.03
Standard Error	13.04	30.76	0.81	1.06	0.81	1.01

***Table 1 -** Values for variable pain.*

Comparison	Test	p
Pain		
A pre x A post	Wilcoxon	0.742
B pre x B post	Wilcoxon	0.03125*
C pre x C post	Wilcoxon	0.3672
A x B x C	Kruskal-Wallis	0.3607

Label: Group A: OC; Group B: Ice; Group C: Only exercises;
* : significant

***Chart 1 -** Results of the comparisons made between the different treatment groups pre- and post- treatment, statistical method employed, and results achieved for pain.*

Functional Quality	Group A		Group B		Group C	
	Pre	Post	Pre	Post	Pre	Post
Average	11.83	8.89	15.36	9.50	15.12	10.89
Standard Deviation	4.16	6.15	3.42	3.67	3.65	3.74
Standard Error	11.72	23.07	1.29	1.38	1.21	1.24

***Table 2 -** Values for functional quality variable.*

Comparison	Test	p
Functional Quality		
A pre x A post	Wilcoxon	0.10155
B pre x B post	Wilcoxon	0.0078*
C pre x C post	Wilcoxon	0.0039*
A x B x C	Kruskal-Wallis	0.9374

Label: Group A: OC; Group B: Ice; Group C: Only exercises;
* : significant

Chart 2 - *Results of the comparisons made between the different treatment groups pre- and post- treatment, statistical method employed, and results achieved for functional quality.*

Passive flexion - affected	**Group A**		**Group B**		**Group C**	
	Pre	Post	Pre	Post	Pre	Post
Average	109.78	114.78	105.14	113.29	116.44	126.33
Standard Deviation	13.40	18	17.38	14.82	12.28	13.11
Standard Error	4.06	5.22	6.56	5.60	4.09	4.37
Passive flexion - unaffected	**Group A**		**Group B**		**Group C**	
	Pre	Post	Pre	Pre	Post	Pre
Average	110.33	115.56	112.29	118.71	119.33	129.89
Standard Deviation	14.09	17.77	12.61	9.46	10.54	6.94
Standard Error	4.25	5.12	4.76	3.57	3.51	2.31
Flexibility - affected	**Group A**		**Group B**		**Group C**	
	Pre	Post	Pre	Pre	Post	Pre
Average	156.22	163.78	150.71	157.43	139.56	155.67
Standard Deviation	8.09	12.35	12.50	8.46	5.81	12.65
Standard Error	1.71	2.51	4.72	3.19	1.93	4.21
Flexibility – unaffected	**Group A**		**Group B**		**Group C**	
	Pre	Post	Pre	Pre	Post	Pre
Average	158.56	163.11	161.86	164.57	143.33	158.89
Standard Deviation	6.77	9.06	9.81	8.70	11.92	12.17
Standard Error	1.42	1.85	3.70	3.28	3.97	4.05

Table 3 - *Values achieved for passive flexion and flexibility variables.*

Passive Flexion Affected side	**Test**	**p**
A pre x A post	t test	0.1108
B pre x B post	t test	0.0326*
C pre x C post	t test	0.0049*
A x B x C	Anova	0.1880
Passive Flexion Unaffected side		
A pre x A post	t test	0.1995
B pre x B post	t test	0.0150*
C pre x C post	t test	0.0407*
A x B x C	Anova	0.4721
Flexibility Affected side		
A pre x A post	t test	0.0886
B pre x B post	t test	0.1174
C pre x C post	t test	0.0019*
A x B x C	Anova	0.5115
Flexibility Unaffected side		
A pre x A post	t test	0.3327
B pre x B post	t test	0.0107*
C pre x C post	t test	0.1127
A x B x C	Anova	0.3424

Label: Group A: OC; Group B: Ice; Group C: Only exercises;
** : significant*

Chart 3 - *Results of the comparisons made between the different treatment groups pre- and post- treatment, statistical method employed, and results achieved for passive flexion and extension range of motion and flexibility.*

Flexors - affected	**Group A**		**Group B**		**Group C**	
	Pre	Post	Pre	Post	Pre	Post
Average	62.67	61.44	73.71	78.57	50.44	62.22
Standard Deviation	16.67	10.06	19.91	22.68	18.49	17.87
Standard Error	8.86	5.45	7.52	8.57	6.16	5.95
Flexors – unaffected	**Group A**		**Group B**		**Group C**	
	Pre	Post	Pre	Post	Pre	Post
Average	68.56	61.11	75.71	80	54.78	64.44
Standard Deviation	28.10	11.33	16.18	8.16	14.75	12.36
Standard Error	13.66	6.17	6.11	3.08	4.91	4.12
Extensors - affected	**Group A**		**Group B**		**Group C**	
	Pre	Post	Pre	Post	Pre	Post
Average	76.67	75.56	80	105.71	67.67	101.56
Standard Deviation	23.98	13.33	22.36	11.34	23.48	46.70
Standard Error	10.42	5.88	8.45	4.28	7.82	15.56
Extensors – unaffected	**Group A**		**Group B**		**Group C**	
	Pre	Post	Pre	Post	Pre	Post
Average	77.78	78.89	90	95.71	71	89.11
Standard Deviation	22.79	19.65	23.09	22.99	24.29	27.61
Standard Error	9.76	8.30	8.72	8.68	8.09	9.20

Table 4 - *Values achieved for muscular strength of flexor and extensor groups variable.*

Flexors strength Affected side	Test	p
A pre x A post	t test	0.3825
B pre x B post	t test	0.2448
C pre x C post	t test	0.0584
A x B x C	Anova	0.1129
Flexors strength Unaffected side		
A pre x A post	t test	0.0678
B pre x B post	t test	0.0171*
C pre x C post	t test	0.2513
A x B x C	Anova	0.0484*
A x B*	Tukey	< 0.05 *
A x C	Tukey	> 0.05
C x B	Tukey	> 0.05
Extensors strength Affected side		
A pre x A post	t test	0.4418
B pre x B post	t test	0.0083*
C pre x C post	t test	0.0870
A x B x C	Anova	0.1107*
Extensors strength Unaffected side		
A pre x A post	t test	0.4059
B pre x B post	t test	0.4270
C pre x C post	t test	0.2515
A x B x C	Anova	0.8452

Label: Group A: OC; Group B: Ice; Group C: Only exercises;

** : significant*

Chart 4 *- Results of the comparisons made between the different treatment groups pre- and post- treatment, statistical method employed, and results achieved for muscular strength.*

DISCUSSION

Our priority in this study was to determine which treatment protocol (ice, OC, kinesiotherapy) would be most efficient to deliver pain relief[5], improved functional quality[4], range of motion gain[7], ischiotibial flexibility[8] and strength gain[6], following the suggestions by Baker and McAlindor[9] and Fransen et al.[10] which reported that the mechanism of exercise remains unclear and deserves further studies to determine the best treatment consensus. Brandt[11] has also reported the lack of randomized clinical trials addressing heat and ice application for improving musculoskeletal status of patients with OA.

After screening, the enrolled patients were assessed according to Cipriano[12] who report that a full history constitutes one of the most important aspects of a clinical evaluation protocol. Clinical history was directly collected in a pre-physiotherapeutic treatment evaluation.

Individual pain complaint was assessed by means of the CR10 scale[5] which is a scale of general severity that can be used to estimate most of perceptive severity kinds.

An exercises program can be effective for reducing pain, as well as drug therapy with non-steroidal anti-inflammatory agents[11, 13]. OA patients' treatment must be comprehensive, with non-pharmacologic techniques regarded as first choice and analgesics and non-steroidal anti-inflammatory drugs as adjuvant therapy[11].

As described by Yates[14] and Minor[15] the objectives of an exercise program for patients with OA should be: to reduce disability and improve function; to reduce joint pain, to increase ADM and flexibility, and; to enable performance in AVDs; to protect the joint by reducing the risks of stress, joint forces attenuation, to improve biomechanics and prevent disability and sedentary conditions by improving physical shape.

Heat and ice application, or both, should be employed to relieve musculoskeletal pain in several diseases, including AO. However, no recent clinical controls exist comparing the application of heat and ice, in a recent review, approximately 60% of the patients with rheumatoid arthritis and OA receiving care at expert practices are indicated to heat, while only 22% reported using ice in painful joints[11]. In our study, we found that most of the patients assessed used some kind of heating (hot water bag) for pain relief.

Short-wave diathermy, which delivers deep heat, may present benefits, reducing symptoms severity, but this kind of therapy is expensive and requires randomized clinical trials where its application is followed up by a kinesiotherapy for muscular stretching and strengthening, although Brandt[11] reports that there are no evidence proving that heat-based treatments are more effective for pain relief than exercises alone.

Heat may provide pain relief and muscular relaxation because of the increased subcutaneous temperature; however, it is contraindicated for patients with blood stream deficit, or sedated, or in cases of sensitivity change and cancer[11]. Heat application is a limited portion of the therapeutic program and should be used only temporarily[14].

Using ice is advantageous because of its low cost, wide action spectrum and easy technical application, but when an individual already shows reduced pain sensitiveness, this reflects that voluntary contraction is compromised due to motor threshold increase resulting from the increased latency and of the duration of action potential. Ice acts directly at the muscular spindle and at tendinous body; therefore, an overload on exercising after muscle cooling, which can lead to a new muscle injury, since motor control threshold is changed[16]. Therefore, we based our study in an exercises program that could not cause muscular damages to individuals.

Pain variable achieved a significant improvement only for Group B.

This study evidenced that the therapy using only kinesiotherapy was not beneficial for pain variable, but presented positive results for functional quality improvement, range of motion gain and muscular strength gain, as opposite to the results reported by Brandt[11] and Fransen et al.[10] describing that therapeutic exercises only in individuals with hip and knee OA reduce pain and improve functional activity.

A study conducted by Teixeira and Olney[17] showed the existence of a correlation between pain and joint stiffness and between pain and function. This finding suggests that pain relief is directly associated to function gains, being thus an important objective to be considered when treating OA patients. These suggest that a therapeutic approach targeting pain relief and joint stiffness reduction is paramount for patients with OA to show a better functional performance.

Jitpraphai et al.[18] conducted a study on patients with knee OA and employed a treatment approach with heat and exercises, finding that exercises are appropriate for being easy, low-cost and safe. They achieved improvement on pain symptoms and ability to ambulate, with only 7.66% of the patients being submitted to surgical procedures.

The Lequesne's Functional Index[4,19] along with WOMAC's Functional Index present the effectiveness for assessing quality of life in patients with OA; however, in our study, we preferred using the Lequesne's Index[4,19], for being validated to Portuguese. Quality of live measured by this index achieved positive results in all groups, but statistically significant only for Group B and Group C; nevertheless, this improvement did not show differences when compared among the three groups, showing the benefits of exercising.

The use of cryotherapy to increase joint range of motion is still uncertain. An increased pain threshold and a reduced nervous conduction speed benefit muscular stretching; on the other hand, a reduced stretching ability of the connective tissue acts by reducing muscular flexibility[16].

Range of motion showed positive results when pre- and post-treatment phases were compared, with significance for Group B and Group C both in affected and unaffected sides. When the three groups were compared by variance analysis, this improvement was not shown to be statistically significantly different.

Flexibility gain was seen in all groups, but significant for pre- and post-treatment comparisons in group C only on affected knees and in Group B only on unaffected knees. When the three groups were compared by variance analysis, this improvement did not show differences. These results are controversial, since in all the unaffected knees kinesiotherapy was applied, and there are no studies evaluating this variable for comparison purposes.

Muscular strength evaluation is an important technique to diagnose disease etiology and to determine and assess rehabilitation strategies. Traditionally, muscular strength has been evaluated by means of manual muscular test, and this technique has been criticized due to its subjective nature. With the development of dynamometers, objective measurements of muscular torque became possible, and this is the best method for assessing muscular strength[17].

For being impossible to use an isokinetic dynamometer due to its high cost, knee's muscular strength was assessed according to the method described by Bastone, modified and validated by Helewa et al.[20] in 1981.

Reilly et al.[21], by assessing 300 individuals of both genders and ages ranging from 40 to 79 years, concluded that quadriceps muscle weakness is directly correlated to knee joint pain and joint disability, which was also found in our study during pre-treatment evaluations.

OA results in changes that affect not only intracapsular tissues, but also per-joint tissues, such as ligaments, capsule, tendons and muscles. AO patients compared to healthy individuals in the same age group showed quadriceps muscle weakness, reduced knee proprioception, reduced balance and position sense[13, 22].

Wilson and Mayer[23] reported that the presence of joint effusion, even if in small amounts, is a powerful inhibitory mechanism of reflex muscular activity of that joint. A reduced reflex muscular activity causes hypotrophy and early weakness, with the resultant associated mechanical damages[24].

Booth[25] reported that muscular strength is rapidly reduced during the time a limb is immobilized because of a reduction of the size of the muscle and of tension by unit of muscular cross-sectional area. The largest absolute muscular mass loss occurs at the beginning of hypotrophy process[24].

According to Greve et al.[24] pain inhibits reflex muscular activity, causing hypotrophy and muscular weakness. Painful process is previous to the muscular weakness picture. This statement suggests that exercises are beneficial for gaining strength and, consequently, pain relief.

The benefits of aerobic exercises include: increased aerobic capacity, muscular stretching and strengthening, endurance and weight loss. The most recommended ones are walks, bicycling, swimming, dancing, hydro-gymnastics. Isometric exercises are usually preferred at the beginning of the treatment instead of isotonic ones[11, 13].

In a controlled randomized study conducted by Brandt[11] and Bischoff and Ross[13] with patients with moderate OA who were submitted to muscular strengthening with isometry, a significant reduction was seen for joint pain, and patients with advanced OA, after eight weeks performing quadriceps isometry, are allowed to reduce their daily analgesics dosage.

This study evidenced the maintenance of strength intensity measured on knee flexor muscles in groups A and B for affected knees and in group B for unaffected knees; on the other hand, strength gain was achieved in affected and unaffected knees of the individuals from group C, and strength loss on unaffected knees in group A. Regarding knee extensor musculature, strength gain was achieved on affected knees of groups B and C, and strength loss in group A. For unaffected knees, strength gain was achieved in group C, strength loss in group B, and maintenance in group A.

Thus, we can infer that strength gain for flexor and extensor musculature of the knee may not be associated to ice or OC application. Data divergence may be due to the employed method of assessment, recommended treatment duration in this study, or to the treatment protocol for strength gain which was maintained during the whole period, not applying increasing loads in exercises, oppositely to Kisner and Colby[26] who state that a progressive increase of load is required for obtaining a significant strength gain.

We believe that further prospective clinical trials should be conducted in order to validate the method of strength measurement using a sphygmomanometer and to apply this protocol adjusting treatment time and load used.

CONCLUSIONS

1. The most appropriate protocol of treatment for pain relief was the one involving ice and kinesiotherapy.

2. The level of functional quality was improved in the three groups studied.

3. Range of motion, flexibility and muscular strength gains are not associated to improvements when therapy involves ice and heat application.

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