Effects of deep heating to treat osteoarthritis pain: systematic review

Efeitos do calor profundo no tratamento da dor na osteoartrite: revisão sistemática

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ABSTRACT

BACKGROUND AND OBJECTIVES: Osteoarthritis is an inflammatory and degenerative joint disease, causing pain, musculoskeletal disorders and impact on functionality, daily life activities and quality of life. The action of physical agents by means of deep heating seems to be an alternative to treat such disease. This study aimed at verifying the effects of deep heating on osteoarthritis patients.

CONTENTS: A systematic review was carried out in Medline, Scielo and LILACS databases as from keywords "Osteoarthritis", "Induced Hyperthermia", "Physiotherapy" and "Ultrasound", and other keywords such as "Deep heat", "Microwaves" and Short-waves", in Portuguese, English and Spanish, in the period from January 2005 to January 2016, and 986 articles were found. Initially, 16 potentially relevant articles were selected for the study and, after a judicious qualitative analysis, nine complete articles meeting inclusion criteria were selected.

CONCLUSION: Physical deep heating physical agents (ultrasound, short-waves diathermy and microwaves) were beneficial to manage pain and other variables in individuals with osteoarthritis in different levels of severity, especially in the long term. However, these effects are better observed when applied simultaneously with kinesiotherapy.

Keywords: Induced hyperthermia, Osteoarthritis, Pain, Physiotherapy, Ultrasound.

RESUMO

JUSTIFICATIVA E OBJETIVOS: A osteoartrite é uma doença articular inflamatória e degenerativa, que provoca dor, agravos osteoarticulares e impacto na funcionalidade, nas atividades de vida diária e na qualidade de vida. A ação de agentes físicos por meio do calor profundo parece ser uma alternativa no tratamento dessa doença. O objetivo deste estudo foi verificar os efeitos do calor profundo em indivíduos com osteoartrite.

CONTEÚDO: Realizou-se uma revisão sistemática nas bases de dados Medline, Scielo e LILACS, a partir dos descritores "Osteoartrite", "Hipertermia Induzida", "Fisioterapia" e "Ultrassom" e outras palavras-chaves como "Calor profundo", "Micro-ondas" e "Ondas curtas", nas línguas portuguesa, inglesa e espanhola, no período de janeiro de 2005 a janeiro de 2016. Encontraram-se 986 artigos. Inicialmente, 16 artigos potencialmente relevantes foram selecionados para o estudo, e, após uma análise qualitativa criteriosa, selecionaram-se 9 artigos completos que preencheram os critérios de inclusão exigidos.

CONCLUSÃO: Os agentes físicos em forma de calor profundo (ultrassom, diatermia por ondas curtas e micro-ondas) ofertam benefícios no manuseio da dor e outras variáveis em indivíduos com osteoartrite em diferentes graus de acometimento, especialmente no longo prazo. Contudo, esses efeitos são mais bem observados quando aplicados em concomitância à cinesioterapia.

Descritores: Dor, Fisioterapia, Hipertermia induzida, Osteoartrite, Ultrassom.

INTRODUCTION

Osteoarthritis (OA) is a degenerative inflammatory joint disease resulting from chondrocytes and synoviocytes-mediated responses, in addition to presenting higher serum and synovial inflammatory cytokine levels as compared to individuals not affected by the disease[1-3].

OA is multifactorial and involves changes in osteoarticular alignment causing joint instability[4]. This is the most common form of arthritis, being considered one of the ten more disabling diseases in developed countries and one of the most prevalent rheumatic diseases among the elderly[5-7].

Although able to affect any body region, it preferably affects joints supporting major weight loads and requiring frequent use, such as the knees[3]. Clinical results show increased joint volume due to synovitis caused by synovial effusion or thickening, pain at rest, morning stiffness, deformities, instabilities, movements limitation,

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incapacity and muscle weakness[8-10]. Pain intensity may vary from no pain to individuals' immobilization and physical incapacity[2].

In this sense, physiotherapy attempts to attenuate OA-induced injuries and adverse effects of drugs[11]. In addition to kinesiotherapy, some physical resources, such as deep heating involving tools such as ultrasound (US), short-waves diathermia (SWD) and microwaves (MW), have been used with analgesic and anti-inflammatory action[12,13], and have shown good results with regard to pain and functionality of OA patients[13].

This study aimed at reviewing in the literature sources documenting the effects of deep heating on pain management of OA individuals.

CONTENTS

A systematic search was carried out looking for articles published in journals indexed in Medline, Scielo and LILACS databases. Descriptors used for search were according to Health Science Descriptors, as from the primary descriptor "osteoarthritis" crossed with secondary descriptors such as "induced hyperthermia", "physiotherapy" and "ultrasound". In addition, the following keywords were used: "deep heating", "microwaves" and "short waves". A search was also carried out with variations of these words in Portuguese and Spanish.

Included in the study were randomized clinical trials; studies carried out exclusively with humans; studies with pain evaluation as outcome, being or not followed by other variables, such as mobility, joint movement amplitude, muscle strength, gait velocity, functionality, incapacity and/or quality of life; studies found in full and available for free; studies in Portuguese, English or Spanish; studies published between January 2005 and December 2015. Exclusion criteria were unfinished studies, studies involving individuals submitted to some surgical procedures due to OA or those not complying with mentioned criteria.

Initially, titles and abstracts were identified and independently evaluated by a reviewer, to select those meeting eligibility criteria. Potentially relevant studies were kept for further analysis of the full text.

Table 1 shows the strategy for studies search and selection.

Among selected studies, four involved the use of SWD, four the use of US (continuous or pulsed) and one involved MW. Sample size of included studies has varied from 25 to 203 OA individuals, being that 100% had knee joint affected. Most samples were predominantly females and elderly. All studies had comparison between at least two groups.

Table 2 shows sample characterization of included studies. Table 3 shows used evaluative tools and intervention protocols, as well as outcomes found in included studies.

Selected studies suggest a limitation of the subject proposed by this review, since in a period of tem years, just nine studies have contemplated the effects of deep heating on pain management of OA patients, according to required criteria. It is possible to observe that scientific interest on the subject seems to be recent, because seven studies were carried out in the last five years.

However, included studies have shown that heating tools are beneficial for pain management of OA patients. Although they do not stand out with regard to conventional kinesiotherapy, they may complement treatment when used simultaneously with physical exercises. Such measures were of major interest for managing OA-induced impacts and complications, especially with regard to pain.

Table 1. Studies search and selection

	Studies identified by electronic search in Medline (n=873), Scielo (n=98) and LILACS (n=15) databases	
Screening	970 were excluded by title and abstract	Other physiotherapeutic approaches: 396
		Outside of the subject: 364
		Non-randomized studies: 64
		Duplication of themes: 52
		Surgical approach: 39
		Pharmacological approach: 34
		Unfinished studies: 21
Eligibility	16 complete evaluated articles	7 have not met inclusion criteria
		3 had no outcome variables
		2 were not available in full and for free
		1 was unfinished
		1 was a systematic review
Inclusion	9 articles were included in the qualitative synthesis	

Table 2. Sample characterization of recruited studies on deep heating effects for osteoarthritis pain management

Authors	Number	Age (years)	Gender	Affection	Osteoarthritis level
Akyol et al.[10]	40	±58.2	40 females 0 males	Bilateral	I, II or III
Rabini et al.[13]	54	±65.15	45 females 9 males	Uni or bilateral	II or III
Jan et al.[14]	30	±65.7	24 females 6 males	Uni or bilateral	I, II or III
Silva, Imoto & Croci[15]	25	±67.56	19 females 6 males	Unilateral	I
Fukuda et al.[16]	121	±60	121 females 0 males	Not specified	II or III
Carlos, Belli e Alfredo[17]	30	±63.33	21 females 9 males	Uni or bilateral	II, III or IV
Atamaz et al.[18]	203	±61.48	167 females 36 males	Uni or bilateral	II or III
Mascarin et al.[19]	40	±62.4	40 females 0 males	Bilateral	Not specified
Chen et al.[20]	120	±63.0	102 females 18 males	Bilateral	III

Table 3. Evaluative tools, intervention protocols and outcomes of studies on the effect of deep heating on osteioarthritis pain management

Authors	Evaluation tools and intervention protocol	Outcomes
Akyol et al.[10]	Evaluation: WOMAC, VAS, isokinetic dynamometry, SF-36, TC6, Beck inventory. Intervention: G1 (n=20): kinesiotherapy (muscle strengthening on isokinetic dynamometer) + SWD (frequency 27,12 MHz, intensity according to patients' sensitivity, time of 20 minutes); G2 (n=20): kinesiotherapy (same protocol as G1); IT: 12 sessions, 3x/week, 4 weeks.	SWD has no additional significant effect on pain and other variables (functionality, stiffness, depression, gait velocity, muscle strength and quality of life).
Rabini et al.[13]	Evaluation: WOMAC, BMRC, VAS. Intervention: G1 (n=27): MW (potency of 40W, temperature of 38°C, time of 30 minutes). G2 (n=27): hot compresses (temperature of 38°C, time of 30 minutes). IT: 12 sessions, 3x/week, to 4 weeks.	MW has decreased pain and improved other variables (muscle strength and physical function) with long term benefits.
Jan et al.[14]	Evaluation: ultrasound, VAS. Intervention: G1 (n=11): SWD (intensity tolerated by patient, time of 20 minutes); G2 (n=10): SWD (same protocol as G1) + drugs (non-steroid anti-inflammatory drugs); G3 (n=9): control. IT: 30 sessions, 3x to 5x/ week, up to 8 weeks.	SWD has significantly decreased pain and synovial thickness.
Silva, Imoto & Croci[15]	Evaluation: sphygmomanometer, VAS, goniometry, Lequesne index. Intervention: G1(n=9): SWD (20 minutes, without specifying parameters) + kinesiotherapy (without specification); G2(n=6): criotherapy (20 minutes) + kinesiotherapy (without specification); G3(n=9): kinesiotherapy (without specification); IT: 10 sessions, 2x/week.	Most adequate protocol for improving pain was that of G2. Both protocols were effective in improving functionality, joint movement amplitude and flexibility, while only G3 has improved muscle strength.
Fukuda et al.[16]	Evaluation: KOOS questionnaire; Intervention: G1 (n=35): control. G2 (n=23): placebo (19 minutes). G3 (n=32): pulsed low dose SWD (power 14,5W, time 19 minutes; total energy 17 kJ); G4 (n=31): pulsed high dose SWD (power 14,5W, time 38 minutes; total energy 33kJ). IT: 9 sessions, 3x/week.	Pulsed SWD is an effective method to decrease pain and improve other variables (functionality and quality of life) in the short term.

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Table 3. Evaluative tools, intervention protocols and outcomes of studies on the effect of deep heating on osteioarthritis pain management – continuation

Authors	Evaluation tools and intervention protocol	Outcomes
Carlos, Belli & Alfredo[17]	Evaluation: WOMAC, Lequesne Index, VAS, goniometry, portable dinamometry and TGUG. Intervention: G1(n=10): CUS (intensity 1.5 W/cm², continuous mode – 100%) + kinesiotherapy (heating, muscle strengthening, time 45 minutes); G2(n=10): PUS (intensity 2.5 W/cm², pulsed mode 20% – pulse repetition frequency 100 Hz) + kinesiotherapy (same protocol as G1); G3(n=10): kinesiotherapy (same protocol as G1). IT: G1 and G2: 24 sessions (first 12; use of US and for other exercises). IT G3: 24 sessions (kinesiotherapy alone).	CUS associated to kinesiotherapy was the most effective protocol to decrease pain and improve other variables (joint mobility, functionality and quality of life).
Atamaz et al.[18]	Evaluation: VAS, WOMAC, TC15, goniometry, drug ingestion. Intervention: G1 (n=37): TENS sham and kinesiotherapy*; G2 (n=37): TENS (frequency 80Hz, intensity 10 to 30 mA, time 20 minutes) + kinesiotherapy*; G3 (n=35): CI sham + kinesiotherapy*; G4 (n=31): CI (modulation frequency in amplitude of 100 Hz, time 20 minutes) + kinesiotherapy*; G5 (n=32): US sham + kinesiotherapy*; G6 (n=31): US (frequency of 27.12MHz and intensity of 3.2 W/cm², time 20 minutes) + kinesiotherapy*; *kinesiotherapeutic program used for all groups: warm up, muscle elongation and muscle strengthening. IT of physical agents: 15 sessions, 5x/week. IT of kinesiotherapy exercises: 09 sessions, 3x/week.	Groups using physical agents have decreased pain and drug ingestion in a more significant way, although all groups have shown improvements.
Mascarin et al.[19]	Evaluation: WOMAC, VAS, goniometry, TC6. Intervention: G1 (n=16): kinesiotherapy (muscle elongation and strengthening, time 20 minutes); G2 (n=12): TENS (frequency of 100 Hz, pulse width 50 mS, intensity according to individual sensitivity, mode 50% frequency, quadratic, two-phase symmetric pulse, during 20 minutes) + kinesiotherapy (same protocol as G1); G3 (n=12): US (frequency of 01 MHz and intensity at 0.8 W/cm², time 25 minutes) + kinesiotherapy (same protocol as G1); IT: 24 sessions, 2x/week.	Both groups were effective in decreasing pain and improving WOMAC variables. However, just G2 and G3 have improved travelled distance in TC6.
Chen et al.[20]	Evaluation: goniometry, VAS, Lequesne Index, isokinetic dinamometry. Intervention: G1 (n=30): isokinetic muscle strengthening (muscle elongation, application of warm compresses on affected site, heating, muscle strengthening of knee extensors and flexors). G2 (n=30): PUS (frequency of 1 MHz, intensity of 2.5 W/cm², pulse of 25%, time 10 minutes). G3 (n=30): shock waves (density 0.03-0.4 mJ/mm², frequency 1-8 Hz and pressure range of 11-82 MPa). G4 (n=30): control. IT: 24 sessions (3x/week), except G3 (18 sessions).	Shock waves therapy was better than USP to decrease pain and other variables (joint movement amplitude, functionality, muscle strength).

BMRC = British Medical Research Council; IC = interferential current; SWD = short waves diathermy; VAS = visual analog scale; G1 = group 1; G2 = group 2; G3 = group 3; G4 = group 4; G5 = group 5; G6 = group 6; MW = microwaves; SF-36 = Short Form Health Survey-36; TC6 = 6 minutes walking test; TC15m = 15 meters walking test in shorter time; TENS = transcutaneous electrical nerve stimulation; TGUG = timed get up and go; IT = intervention time; CUS = continuous ultrasound; PUS = pulsed ultrasound; WOMAC = Western Ontario and McMaster Universities Osteoarthritis Index. * = Kinesiotherapeutic program consisting of heating, muscle stretching and muscle strengthening.

DISCUSSION

OA is a disease causing more persistent musculoskeletal pain and may affect one out of five individuals, especially females and the elderly, causing chronic pain and incapacity especially on the knees[5,21], which can be observed in selected studies, since in 100% of the reviewed content, samples had knee OA (levels from I to IV, with predominance of level III among studies), and in eight out of nine studies mean age was above 60 years, characterizing predominantly elderly samples.

Interaction of factors such as disease worsening, pain, associated comorbidities, psychological and social factors, decreased aerobic work and lower limbs muscle weakness are determining factors for physical incapacity in OA individuals[15].

Functional impairment may negatively interfere with quality of life of these people, especially if they are old aged, females

and symptomatic. OA knee pain prevalence is high (32.2% for males and 58.0% for females) which increases in up to five times the risk of poorer lower limbs function[22,23].

Lequesne and WOMAC indices are specific and reliable tools for OA evaluation[15]. It was observed that studies have used such protocols, being that five have used WOMAC index[10,13,17-19], three have used Lequesne index[15,17,20] and one has used the KOOS questionnaire, a scale of 11 questions to evaluate pain and functionality[16].

In this sense, induced hyperthermia seems to be a strategy to manage OA pain since it is a conservative, low cost and non-invasive therapy[24], which has led to the choice of this therapy as the target of our study.

Four recruited studies[10,15,17,18] have used physical agents as aid or intervention to physical exercises (kinesiotherapy). It was observed that groups adopting deep heating as treatment strategy have improved pain and other evaluated variables, without the adverse effects of individuals submitted to intervention protocols. From these, one has compared the action of physical agents and their placebos and has observed improved pain and functionality, movement amplitude and functional independence, without statistically significant difference among groups[18]. However, intervention groups have presented lower drug ingestion, indicating higher impact on OA treatment.

So, it is possible to observe the importance of conventional kinesiotherapy to decrease pain and improve other variables of knee OA individuals, being that physical agents may act as optimizers of the physiotherapeutic protocol. In addition, such resources decrease the use of drugs by OA patients and their possible adverse effects.

Studies suggest that US is beneficial to treat knee OA, because it is a safe strategy, decreases pain and improves physical functions, regardless of the mode (continuous or pulsed). Treatment duration should be adapted to specific needs of each individual[25].

Two studies[19,20] have compared the effects of deep heating (US) and conventional kinesiotherapy or even other non-thermal physical agents. Their results show benefits with regard to pain, functionality, movement amplitude, functional independence[19] and muscle strength[20], without significant difference among approaches[19]. However, it is worth highlighting that such experiments were carried out just with US and in one of them US with kinesiotherapy has been superior in the distance travelled by the individual[19]. The other has shown just immediate US effects[20], which is in disagreement with most authors, since they report deep heating as therapy with long term benefits.

MW is a noninvasive method increasing in vivo temperature of internal tissues (±0.2°C), in a depth of 3 to 7cm[26]. Its properties are beneficial to treat OA, since joint heat stimulation increases chondrocytes metabolism and partially generates cartilaginous matrix[24].

A study has compared MW therapy (deep heating) with the use of hot compresses (superficial heat) and has concluded that deep approach has significant effect on pain, stiffness, physical limitation and muscle strength in knee OA individuals[13], in the long term, since such disease is chronic and generates severe pain.

SWD aims at decreasing pain in the clinical practice[10]. SW therapy in low (power of 14.5W; duration 19 minutes; total energy 17kJ) or high doses (power of 14.5W; duration 38 minutes; total energy 33kJ) is beneficial for pain relief and increased muscle strength in the long term, especially in low doses[16]. It may decrease joint inflammatory process, being or not associated to drugs[14].

Two recruited studies[14,16] have evaluated the effects of deep heating exclusively with physical agents, observing positive effects on evaluated variables, such as those measured by WOMAC index, pain, joint movement amplitude or muscle strength. However, authors are not sure about its isolated efficacy.

CONCLUSION

Physical agents in the form of deep heating (US, SWD and MW) are beneficial to manage pain and other variables such as muscle strength, joint movement amplitude, functionality, stiffness, daily life activities and quality of life in individuals with different levels of OA, especially in the long term. However, it has to be highlighted that such effects are better observed when applied simultaneously with kinesiotherapy.

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