

Systematic Review

Revisão sistemática

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Keywords

Hot Temperature
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Descritores

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 Transferência de Calor
 Face
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The use of superficial heat for treatment of temporomandibular disorders: an integrative review

O emprego do calor superficial para tratamento das disfunções temporomandibulares: uma revisão integrativa

ABSTRACT

Purpose: To perform an integrative review of scientific bibliographic production on the use of superficial heat treatment for temporomandibular disorders. **Research strategy:** Literature review was accomplished on PubMed, LILACS, SciELO, Bireme, Web of Science, and BBO databases. The following descriptors were used: hot temperature, hyperthermia induced, heat transference, temporomandibular joint, temporomandibular joint disorders, temporomandibular joint dysfunction syndrome, and their equivalents in Portuguese and Spanish. **Selection criteria:** Articles that addressed the superficial heat for the treatment of temporomandibular disorders, published in English, Spanish, or Portuguese, between 1980 and 2013. **Data analysis:** The following data were collected: technique of applying superficial heat, duration of application, stimulated body area, temperature of the stimulus, frequency of application, and benefits. **Results:** Initially, 211 studies were found, but just 13 contemplated the proposed selection criteria. Data were tabulated and presented in chronological order. **Conclusion:** Several techniques for superficial heat application on treatment of temporomandibular disorders were found in the literature. The moist heat was the most widely used technique. Many studies suggested the application of heat for at least 20 minutes once a day. Most authors recommended the application of heat in facial and cervical regions. The heat treatment resulted in significant relief of pain, reduced muscle tension, improved function of the mandible, and increased mouth opening.

RESUMO

Objetivo: Realizar revisão integrativa sobre a produção científica referente ao emprego do calor superficial para tratamento das disfunções temporomandibulares. **Estratégia de pesquisa:** Foi realizado levantamento na literatura nas bases de dados PubMed, LILACS, SciELO, Bireme, Web of Science e BBO. Os termos utilizados foram: temperatura alta, transferência de calor, articulação temporomandibular, transtornos da articulação temporomandibular, síndrome da disfunção da articulação temporomandibular e seus correspondentes em inglês e espanhol. **Crítérios de seleção:** Foram incluídos artigos que abordaram o calor superficial no tratamento das disfunções temporomandibulares, publicados em inglês, espanhol ou português, no período de 1980 a 2013. **Análise dos dados:** Foram considerados: técnica de aplicação de calor superficial, duração de aplicação, área corporal estimulada, temperatura do estímulo, frequência de realização e benefícios. **Resultados:** Inicialmente, foram encontrados 211 estudos, dos quais 13 contemplaram os critérios de seleção propostos. Os dados foram tabulados e apresentados em ordem cronológica. **Conclusão:** Várias técnicas de aplicação de calor superficial para tratamento das disfunções temporomandibulares foram encontradas na literatura. O calor úmido foi a modalidade mais empregada. Muitos estudos sugerem a aplicação de calor por 20 minutos, e a frequência mínima foi uma vez ao dia. A maioria dos autores recomenda a aplicação do calor nas regiões facial e cervical. O tratamento com calor apresentou benefícios como alívio da dor, redução da tensão muscular, melhora das funções da mandíbula e aumento da abertura de boca.

Study carried out at Pontifícia Universidade Católica – PUC-Minas – Belo Horizonte (MG), Brazil.

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INTRODUCTION

Thermotherapy involves the application or removal of heat to the body for therapeutic purposes⁽¹⁾. Application of heat to the body, thermotherapy by addition, is commonly used in speech therapy clinical practice for the treatment of temporomandibular disorders (TMD), in cases of increased muscle tension and pain crises⁽²⁾. Effects include vasodilation, increased blood flow and consequently oxygenation, elimination of metabolic waste, reduction of nerve pain conduction, reduction of joint stiffness, and muscle relaxation⁽¹⁾.

In this context, superficial heat is widely used and can be applied by various techniques (hot-water bag, electric heating pad, compress, etc.), preceding exercises and handling techniques⁽³⁾. The literature suggests that superficial heat application techniques are less effective than diathermy (temperature rise within the tissues by the use of electric current)⁽⁴⁾, but it presents the great advantage of being suitable for home application⁽⁴⁾.

There is no consensus on the most suitable superficial heat application technique to treat TMD⁽⁵⁾. There is no standard as to the technique employed, the application time, the frequency and the temperature of the stimulus either. Procedures vary according to the professional, and there are few studies on this topic in the literature of the field.

Knowing the techniques of superficial heat application is important for the professional to choose the most convenient and effective technique for a patient, as well as the ideal temperature and time of application⁽⁶⁾.

OBJECTIVE

To analyze the use of thermotherapy with superficial heat for the treatment of TMD, featuring techniques used, application method, duration, stimulated body area, stimulus temperature, frequency and benefits by means of an integrative review.

RESEARCH TECHNIQUE

An integrative literature review was conducted, involving the following steps: preparation of guiding question; establishment of key words and inclusion/exclusion criteria of articles; selection of items; critical evaluation of articles.

The question that guided this study was: "How is superficial heat applied in patients with TMD?". To select the articles, we searched the national and international literature published in English, Portuguese or Spanish languages, using PubMed, LILACS, SciELO, Bireme, Web of Science and BBO. The keywords in Portuguese used in the search were "*temperatura alta*", "*hipertermia induzida*" and "*transferência de calor*", associated with "*articulação temporomandibular*", "*transtornos da articulação temporomandibular*" and "*síndrome da disfunção da articulação temporomandibular*"; in English, "hot temperature", "hyperthermia induced" and "heat transference", associated with "temporomandibular joint", "temporomandibular

joint disorders", "temporomandibular joint dysfunction syndrome"; and, in Spanish, "*calor*", "*hipertermia inducida*" and "*transferencia del calor*" associated with "*articulación temporomandibular*", "*transtornos de la articulación temporomandibular*" and "*síndrome de la disfunción de articulación temporomandibular*".

SELECTION CRITERIA

Our selection included articles that addressed superficial heat as treatment for temporomandibular disorders, regardless of the type of dysfunction (muscle or joint), published in English, Spanish or Portuguese in the period between 1980 and 2013.

The languages covered were the most representative ones in the national and international scientific literature. The period of search covered a period when the approach of thermotherapy for treatment of TMD began in original scientific research published in the abovementioned databases to date.

Articles that did not address at least one of the following topics were excluded: technique, duration of technique application, body part, temperature stimulus, and application frequency. Articles only mentioning or indicating the use of heat, but not using it in the research, were also excluded.

DATA ANALYSIS

Data analysis was carried out in stages. First, duplicate references in databases were eliminated. Then, by reading the abstracts, articles that did not cover the objectives established were also excluded. In the third stage, articles contemplating the goals of this study were obtained in full. An additional search was conducted based on the references of selected articles.

The complete texts of potentially relevant articles for the review were analyzed, and the following data were collected: superficial heat application technique, duration, stimulated body area, frequency, stimulus temperature, and benefits achieved.

RESULTS

In total, 211 references were located initially, but after the third step, 13 articles remained in this study.

Thermotherapy was mentioned by several authors as related to the treatment of temporomandibular and neuromuscular dysfunction. However, there is no consensus on the technique to be used, stimulus intensity and frequency of application. Chart 1 shows the main findings in the literature with respect to these variables, the duration of application, body part that received the stimulus, and benefits of treatment.

In none of the articles thermotherapy was the only treatment used for TMD. Superficial heat was used along with other techniques such as: occlusal splint^(7,8,13-15), restriction to chew solid foods^(3,7,9,10,13,15), elimination of harmful oral habits^(3,10,12,15), muscle stretching and relaxation techniques^(8,10,12-15), myofunctional therapy^(8,13,15) and myotherapy⁽¹²⁻¹⁵⁾.

SUPERFICIAL HEAT TECHNIQUES

The use of moist heat application techniques was more frequent, for example, towels soaked in hot water^(3,9,12), electric heating pad^(3,7,17), hot-water or silica gel pack⁽¹⁶⁾ coated in tissues soaked in warm water. In the case of use of wet towels only, they can be periodically re-heated in hot water or in a microwave oven⁽³⁾. When the use was associated with electric

heating pad, the heat is maintained by the source, which makes it the most practical⁽³⁾.

Heat application may also be made dry by means, using a hot-water bag or an electric heating pad placed directly on the patient's skin^(5,17). The principles of thermodynamics suggest that the application of moist heat is more effective than the application of dry heat, since energy is transferred by diffusion in heat conduction process, involving interactions between molecules;

Chart 1. Main findings in literature about the use of superficial heat to treat temporomandibular dysfunctions

Author	Technique	Duration	Body part	Frequency	Heat intensity	Benefits
Nelson and Ash (1988) ⁽⁷⁾	Electric heating pad coated with a wet tissue	20 minutes	Face, unilateral or bilateral; neck area	Twice to three times a day	70°C	Pain relief
Felício et al. (1991) ⁽⁸⁾	Warm water compresses before massage	5 minutes	TMJ and muscles of mastication	Four times	–	Pain relief, improved jaw mobility, increased mouth opening
Nelson et al. (1991) ⁽³⁾	Electric heating pad and wet towel	20 minutes	Face, unilateral or bilateral	Twice or three times a day	According to tolerance	Increased mouth opening and pain relief
Paiva et al. (1994) ⁽⁹⁾	Towel soaked in warm water	30 minutes	Both sides of the face	Once a day (before going to bed)	–	Pain relief in acute patients
Poindexter et al. (2002) ⁽⁵⁾	Electric heating pad directly on the skin or coated with a wet tissue	20 minutes	Hemiface	–	–	–
De Laat et al. (2003) ⁽¹⁰⁾	Warm pad	20 minutes	–	Once at night	–	Pain relief and improved jaw function
Wig et al. (2004) ⁽¹¹⁾	Heat pack	–	Painful areas	At least once a day	–	–
Mangilli et al. (2006) ⁽¹²⁾	Warm water compresses	–	Masseter	–	–	Adequate mouth opening, postoperative pain relief (benign hypertrophy of the masseter muscle)
Felício et al. (2007) ⁽¹³⁾	Hot and moist compresses	20 minutes	Mastication, shoulder and neck muscles	Daily	–	Muscle relaxation and pain relief
Diraçoglu et al. (2009) ⁽¹⁴⁾	Hot pack	20 minutes	–	Once a day	–	Pain relief, increased jaw movements after mandibular displacement
Felício et al. (2010) ⁽¹⁵⁾	Hot and moist compresses	20 minutes	Mastication, shoulder and neck muscles	Daily	–	Pain relief, muscle relaxation, improved jaw mobility
Nozaki et al. (2010) ⁽¹⁶⁾	Silica gel pad	15 minutes	Masseter	Twice a week	–	Increased twisting force in Duchenne muscular dystrophy
Furlan et al. (2011) ⁽¹⁷⁾	Electric heating pad directly on the hemiface or coated in a towel soaked in warm water	20 minutes	All the hemiface	–	42°C	–

the higher the number of free molecules conducting heat, it will occur more rapidly. In a liquid case, therefore, heat conduction is faster⁽⁵⁾. However, studies comparing the two heat application modes found no differences between them with respect to tissue heating^(5,17). This can be explained by the production of sweat during dry heat therapy, which equals the conditions in both modes. The authors suggested that the application of dry heat is more convenient because it is easier and faster to perform, which improves patient's compliance to treatment and the frequency of therapy⁽⁵⁾. However, in the end of the study, participants reported they preferred moist over dry heat⁽⁵⁾.

Studies comparing the different techniques for superficial heat application in the facial region were not found. One study compared blood flow in forearm skin in thermotherapy modes, dry heat and moist heat⁽¹⁸⁾. The heat source was an infrared lamp. The authors added moistened towels on the skin for the application of moist heat, and a drying agent was applied to the skin to prevent sweating during the application of dry heat. The skin temperature was maintained at 40 °C and monitored by means of thermocouples for 15 minutes. The authors observed a significant increase in blood flow in moist heat compared to dry heat. Another study showed that skin sweat alters the response of vascular endothelial cells to local heat application⁽¹⁹⁾.

A study found that superficial moist heat in combination to myorelaxant occlusal splint was more effective to reduce pain compared to the splint only, without heat application⁽⁷⁾. Another study compared the effectiveness of both methods of superficial moist heat to relieve symptoms of acute muscular TMD: electric heating pad and moistened towel. Both treatments were associated with guidelines regarding removal of harmful oral habits and restricted diet. For both modes, relief of TMD symptoms was achieved. Mouth opening increased by 9 mm in the group submitted to electric heating pad and 3.5 mm in the group using moistened towel. Thirty-one percent of subjects required no other form of treatment after 12 days of therapy⁽³⁾.

Since there is no consensus in literature regarding the most effective method of superficial heat application, it is suggested that the method is chosen at the patient's preference, for this will influence treatment adherence and hence therapeutic success.

DURATION OF SUPERFICIAL HEAT APPLICATION

Eleven studies have described the time of superficial heat application^(3,5,7-9,13-17) of least 5 minutes⁽⁸⁾ and at most 30 minutes⁽⁹⁾. However, most studies mentioned 20 minutes of heat application^(3,5,7,13,15), with improvement of pain in all participants.

The time of application depends on the technique and the intensity of heat. In the study using thermotherapy for 5 minutes, the procedure was repeated 4 times, but the length of intervals between applications was not specified. In the research that used heat for 30 minutes, the application occurred from 10 to 10 minutes at intervals of 5 minutes without heat stimulus. The protocol was applied in 6 patients with acute painful symptoms, but only one of them had pain relief after 8 days of use of technique⁽⁹⁾.

One cannot compare the benefits achieved according to the duration of heat application because studies have

different methodologies and populations, besides not using thermotherapy alone, but along with other techniques. In a survey, speech therapists applied dry and wet heat methods in the hemiface of 3 females aged 24 to 28 years, by means of an electric heating pad at approximately 42°C for 20 minutes. A thermocouple was placed on the extraoral involvement and another one on the intraoral involvement of the cheek, with temperatures recorded every minute. Heat stimuli increased the intraoral temperature gradually, stabilizing at around 38°C after 11 minutes of therapy for both techniques⁽¹⁷⁾.

In a similar study, in approximately 5 minutes extraoral temperature reached the maximum value (39.28 to 40.11°C) and was kept stable, while intraoral temperature reached its peak (36.11 to 37.22°C) after 30 minutes. Increased blood flow is one factor contributing to stabilize the temperature and prevent overheating⁽⁵⁾.

BODY PART SUBJECTED TO SUPERFICIAL HEAT

Eleven original articles indicate the body part submitted to superficial heat^(3,5,7-9,11-13,15-17). The authors applied the heat in the facial^(3,5,7,9,17) and/or cervical^(7,13,15) regions, unilaterally or bilaterally, depending on the painful area reported by the patient^(3,7,11). Some authors applied the techniques on the region of muscles of mastication^(8,12,13,15,16).

INTENSITY OF HEAT STIMULUS

Thermotherapy by addition has been cited by several authors in the treatment of TMD and neuromuscular disorders, but few studies address the range of temperature reached or the change of temperature employed. The consensus seems to be warming the area as much as the patient can comfortably tolerate⁽²⁰⁾. Temperature values in thermotherapy by addition can vary from 40 to 90°C depending on the technique used⁽²¹⁾.

Only two original articles showed the values of temperature applied^(7,17). One of them used an electric heating pad that can reach approximately 70°C, but patients could control the temperature of the by the bag on-off switch button⁽⁷⁾. In other study, an electric heating pad set to stay at 42°C⁽¹⁷⁾ was used. In some research, the temperature was set as tolerated by the patient^(3,7).

Important to note that patients with TMD are usually more sensitive to thermal pain, which results in lower values of heat pain limit compared to normal individuals. Heat pain limit in the face for patients with myogenic TMD is 46.57±2.75°C; in individuals with arthrogenic TMD, 42.22±3.23°C; and in normal individuals 47.21±2.25°C⁽²²⁾. Higher values can worsen the pain⁽¹¹⁾.

FREQUENCY OF SUPERFICIAL HEAT APPLICATION

Ten research cited heat application frequency^(3,7-11,13-16), with minimum of twice a week⁽¹⁶⁾. Overall, the authors performed the application of heat once a day^(9-11,14) and twice to three times

a day^(3,7). However, one cannot compare the benefits achieved according to the frequency of application, for studies have different methodologies and populations.

BENEFITS OF THE TREATMENT

The main benefit of thermotherapy found in literature was pain relief^(3,7-9,12-15). A study was conducted with 27 patients with TMD symptoms and muscle impairment, where they were divided into two groups. Study group, composed of 19 patients, was submitted to treatment with occlusal splint and thermotherapy; while Control Group used the occlusal splint only. Symptoms of pain were reduced in 34.7% of patients of the study group and only in 3.75% of patients in control group⁽⁷⁾.

Muscle pain mechanism has been described partly as resulting from the accumulation of metabolic waste when blood irrigation is insufficient in certain muscles, inducing them to anaerobic metabolism. The increase of metabolic residues within the muscle stimulates and perpetuates pain and spasm even after elimination of the factor causing them. Thermotherapy, therefore, relieves the pain by causing vasodilation and consequently increasing local blood circulation, therefore causing oxygenation and removing metabolic residues⁽²⁰⁾. Some authors point out that one of the advantages of superficial heat compared to drug therapy and other techniques for pain relief is that it can be applied locally, directly on the pain spot⁽³⁾.

Other benefits brought by heat are reduction in tension and muscle stretching due to increase in extensibility by the collagen of the muscle, with consequent improvement in mouth opening and jaw functions^(3,8,10,12,14,15).

A study⁽¹⁶⁾ reported increase in bite force in patients with Duchenne muscle dystrophy. The authors used thermotherapy followed by massages on the masseter muscle, upward and downward, with both hands, 24 times per minute; immediately after this handling, patients were asked to open their mouth with resistance for 5 minutes. This sequence provided increase in bite force.

Heat and moistened pads on their masseter muscle region was indicated in postoperative period of benign hypertrophy of the masseter. Thermotherapy was not used alone, but rather in association with orientations of change in harmful oral habits, intra and extraoral handling, stretching of face and neck muscles, and joint mobility exercises. Results were adequate mouth opening and pain relief⁽¹²⁾.

In an investigation of therapy adhesion in 5 types of conservative treatment for TMD (jaw relaxation, jaw joint exercises, thermotherapy by addition, cryotherapy, and occlusal splint), the treatment with lesser degree of adhesion was thermotherapy. This level of non-adhesion was explained by the time required to apply therapy, materials used, and the need of an appropriate place to perform it. Besides that, superficial heat in patients with TMD can initially worsen the symptoms, for these patients have usually low tolerance to heat. If the patient is not persistent to superficial heat application, benefits are not achieved⁽¹¹⁾.

A study compared the efficacy of three techniques to treat acute myofascial pain: moist heat, myorelaxant splint, and electrical stimulation. The authors found that moist heat was the less effective technique when it came to acuteness remission. They also attributed this to non-adhesion to treatment, which could happen due to their skepticism regarding the treatment mode's simplicity⁽⁹⁾.

Although some benefits have been reported as to pain relief, improved jaw mobility, increased mouth opening and other outcomes, thermotherapy effectiveness for TMD is controversial, once studies found used thermotherapy along with other techniques. Difference in methodologies and populations also prevent an accurate comparison of results.

Thermotherapy by addition is contraindicated in cases of inflammation, trauma or hemorrhage. In such cases, thermotherapy by subtraction (cryotherapy) is recommended⁽¹⁾.

CONCLUSION

Many superficial heat techniques for the treatment of TMD were found in literature. The moist heat was the most used mode. The time of application of thermal stimulus ranged 5 to 30 minutes, but most of the studies mentioned application of superficial heat for 20 minutes. Most authors used thermotherapy in the face and neck regions at least once a day. According to most articles found, the heat was proven to bring benefits such as pain relief, reduced muscle tension, improved jaw functions and increased mouth opening, which explains the clinical use of this technique in TMD therapy.

**All authors participated in all phases of the Project: conceiving the research, analyzing and interpreting data, writing and reviewing the paper.*

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