

THE USE OF CRYOTHERAPY IN THE TREATMENT OF TEMPOROMANDIBULAR DISORDERS

O uso da crioterapia no tratamento das disfunções temporomandibulares

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ABSTRACT

The purpose of this research was to perform an integrative review of scientific bibliographic production on the use of cryotherapy on temporomandibular disorders treatment, highlighting the techniques, duration, body area stimulated and frequency of application. Literature review was accomplished on Medline, LILACS, SciELO, Cochrane Library and IBECs databases. The descriptors used were: Cryotherapy, Cold Temperature, Induced Hypothermia, Heat Transference, Temporomandibular Joint, Temporomandibular Joint Disorders, Temporomandibular Joint Dysfunction Syndrome and their equivalents in Portuguese and Spanish. Articles that addressed the cryotherapy for the treatment of temporomandibular disorders, published in English, Spanish or Portuguese, between 1980 and 2013, were included. The following data were collected: technique, duration of application, area stimulated and frequency of application. Initially, 34 studies were found, but just 13 contemplated the selection criteria proposed. Data were tabulated and presented in chronological order. The decrease of body heat can be conducted through application of cold compresses, cold bags or vapocoolant sprays applied to the painful areas, or trigger points regions, or in masticatory muscles. The average time of application of the stimulus was 10 to 15 minutes for cold bags and about 10 seconds for vapocoolant sprays, repeated approximately 2 to 4 times per day, preceding muscle stretching techniques. The literature has no consensus about the intensity of the thermal stimulus.

KEYWORDS: Cryotherapy; Hypothermia, Induced; Temporomandibular Joint Disorders; Heat Transference; Face; Skin Temperature

■ INTRODUCTION

Cryotherapy is the therapeutic application of any substance to the body to decrease the temperature in a particular region of it ¹. It is also known as thermotherapy by subtraction, due to the use of a thermal stimulus at a temperature below the one of the body so that the heat withdrawn from the body can occur. Heat is always transferred unidirectionally from the warmer body to the less heated one ².

Cryotherapy is indicated for the treatment of pain generated by traumatic and/or inflammatory musculoskeletal diseases, especially acute ones, to reduce swelling and to induce muscle relaxation ³. It

has been widely used in the treatment of temporomandibular disorders (TMDs) when the patient has painful symptoms.

The local effects of cryotherapy include: vasoconstriction; decreasing of inflammation and pain; myorelaxation, reduction of muscle spasm and stiffness ³. Analgesia occurs due to the decreasing of activity of the muscle spindles, the neuromuscular junction, the conduction velocity of the peripheral nerves and hence of the transmission of nociceptive information. The reduction of blood flow also helps to reduce pain by preventing excessive release of the chemical mediators that activate nociceptors ⁴.

Although very effective in relieving pain, it is rarely used, since most speech therapy professionals are not familiar with its usage. However, among the cutaneous stimuli, it is considered one of the most effective pain relief. Cold provides analgesia, often more effective, early and lasting than heat ³.

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The effectiveness of the technique, however, depends on several factors such as: duration of application, pressure held, body region covered, level of the physical activity previous or subsequent to the application and cryotherapy modality chosen.² The most effective technique, the time required to therapeutic cooling and optimal frequency of application are common questions among professionals of speech therapy.

Therefore the objective of this research was to conduct an integrative review of the scientific literature regarding the use of cryotherapy in the treatment of temporomandibular disorders, featuring the techniques used, duration of application of the technique, stimulated body area and frequency of application.

■ METHODS

It was conducted an integrative literature review which involved the following steps: elaboration of the guiding question; establishment of keywords and criteria for inclusion / exclusion of articles; selection of articles; critical evaluation of articles.

The question that guided this study was: "How is cryotherapy performed in patients with temporomandibular disorders?" For the selection of articles there was a collection in the national and international literature published in English, Portuguese or Spanish, using the Medline, LILACS, SciELO, Cochrane Library and IBECS data. The terms used in the survey were, in Portuguese, "crioterapia", "temperatura baixa", "hipotermia induzida" and "transferência de calor", associated with the terms "articulação temporomandibular", "transtornos da articulação temporomandibular" e "síndrome da disfunção da articulação temporomandibular"; in English, "cryotherapy", "cold temperature", "induced hypothermia" and "heat transference", associated with the terms "temporomandibular joint," "temporomandibular joint disorders," "temporomandibular joint dysfunction syndrome"; and, in Spanish, "crioterapia", "frio", "hipotermia inducida" and "transferencia del calor" associated with the terms "articulación temporomandibular", "transtornos de la

articulación temporomandibular" and "síndrome de la disfunción de articulación temporomandibular".

Articles that addressed cryotherapy as a treatment of facial pain, published in English, Spanish or Portuguese, in the period from 1980 to 2013, were included. The articles that did not address at least one of the following data were excluded: technique, duration of the application of the technique, stimulated body area and frequency of application.

The analysis of the material was carried out in stages. At first, the duplicated references in the consulted databases were eliminated. In the second step, by reading the abstracts, the articles that did not include the established objectives were excluded and the articles that included the objectives of this study were obtained in full. In the third step, the complete texts of the potentially relevant articles for the review were studied and the following data were collected: technique, duration of application of the technique, stimulated area and frequency of application. The articles that did not address at least one of these data were excluded. All stages of the study were performed by the same researcher.

■ LITERATURE REVIEW

Initially, 104 references were located. After the first stage, there were 34 articles, and, after the second stage, 21 articles. In the third stage, eight articles were excluded due to the established exclusion criteria, staying in the present study only 13 articles. It was conducted a brief description of each article, containing information such as: technique; time of application of the technique; body area covered by thermal stimulus; stimulus intensity and indications. The indications include which clinical situation the technique was used for.

It was found that cryotherapy has been mentioned by several authors in the treatment of temporomandibular joint dysfunction. However there is no consensus on the best technique to use. Figure 1 highlights the main findings of the literature with respect to the researched variables.

Author	Technique	Duration	Body Area	Frequency	Intensity	Indications
Selby (1985) ⁵	Crushed ice wrapped in a towel / Vapocoolant spray	-	-	Up to 8 times per day	-	TMD
Laskin e Block (1986) ⁶	Vapocoolant spray applied in a circular path / Ice packs, each followed by muscle stretching exercises	10s for the spray and 10 to 15 min for the packs	On the masticatory muscles	2 times a day during 2 to 3 days/ 3 to 4 times a day, respectively	-	Myofascial dysfunction in acute phase
Burgess et al. (1988) ⁷	Application of ethyl chloride spray preceding stretching exercises	-	Temporal, masseter, trapezius and sternocleidomastoid muscles	4 times a day	-	Myofascial pain and dysfunction of the masticatory system
Lande e Templeton (1988) ⁸	Application of fluorimethane spray preceding stretching	-	On the TMJ region	-	-	Chronic TMD
Felício et al. (1991) ⁹	Ice wrapped in a plastic bag applied to the face with circular motions	10 min	The whole face	-	-	TMD and pain syndrome
Santos (1995) ¹⁰	Cold compresses or vapocoolant spray	10 to 15 min for acute inflammation or trauma, and 30 min for chronic pain	-	Several times a day at intervals of 30 min, in the acute inflammation or trauma, and 2 times daily in chronic pain	-	Acute inflammation or trauma in the TMJ / chronic pain in the TMJ
Wright, Schiffman (1995) ¹¹	Ice wrapped in a thin washcloth	Apply until you begin to feel numbness. About 10 min.	Painful areas	-	-	Myofascial pain
Peláez et al. (1999) ¹²	Cold compresses	-	-	3 times a day	-	Osteoarthritis of TMJ
Rosa et al. (2002) ¹³	Crushed ice compresses wrapped in towels or plastic bag / compresses of artificial ice / evaporative vapocoolant sprays	Maximum 20 to 30 minutes for compresses	-	-	-	TMD with painful points in musculature
Syrop (2002) ¹⁴	Plastic bag containing ice, apply and keep on-site, preceding massages	2 to 3 min	On sore muscles	-	-	Acute TMD
Wig et al. (2004) ¹⁵	Bag containing a cold agent	10 min	Áreas of Pain	At least once a day	10-15°C temperature reduction in superficial and deep tissue	TMD
Kogut e Kwolek (2006) ¹⁶	Cold packs, ice compresses, vapocoolant sprays applied before kinesiotherapy	10 to 15 minutes	-	-	-	Acute muscle tension
Friction (2007) ¹⁷	Vapocoolant spray before handling stretching	-	On muscle regions with trigger point	-	-	TMD of muscular origin

Figure 1 - Main findings of the literature on the use of cryotherapy in the treatment of temporomandibular disorders

Techniques

The withdrawal of body heat can be conducted through application of cold compresses^{5,10-13,16}, Bags containing cold agents^{6,14-16} or vapocoolant sprays^{5-8,13,16,17}.

The compresses can be made by the simple use of crushed ice wrapped in towels¹³. The compresses with artificial ice are made up of layers of vinyl bubbles filled with water and glycerin wrapped in towels¹³.

Ice should not be applied directly to the skin, because of the risk of injuries to the skin tissue, even if it is in plastic bags. It should be wrapped in a towel or cloth⁵ and can be applied in a circular motion^{6,9}. They usually precede the stretching exercises of the muscles^{6,14}.

The technique of cooling by evaporation is the cutaneous spray of vapocoolant aerosols such as chlorofluoromethane or ethyl chloride ones. The vapocoolant aerosols promote abrupt cooling of the skin surface¹³. Initially the ethyl chloride was very used, but this is currently out of use for being flammable and because of its low boiling point (13°C), which makes it easy of being inhaled. Currently the most widely used is the chlorofluoromethane spray¹³.

It was described a technique for applying the vapocoolant spray on the skin, in muscle regions with trigger points, in patients with TMD of muscular origin¹⁷. A thin spray jet must be applied to the muscle area in a linear trajectory at an approximate distance of 30 to 50 cm of the skin. A new movement must be performed in a parallel adjacent area, slowly, at a rate of about 10 cm/s. The spray application must be followed by stretching massage. The sequence may be repeated up to four times as long as the therapist heat the area using his/her own hands or heated bags, thus preventing the supercooling of the region. Excessive cooling of the skin, according to the author, can aggravate the situation. The range of mandibular movement can be tested before and after the application of the technique as an indicator of the therapy success. However, other authors¹⁶ warn of the risk of tissue damage and point out this to be the reason for the vapocoolant spray not be commonly used. According to the authors, application of ice cubes or ice wrapped in a towel is effective and safer.

Another technique of using vapocoolant spray is the application in circular trajectories during 10 seconds, keeping the bottle between 30 to 45 cm away from the target muscle⁶. Immediately after the application, the area becomes reddish. The procedure is repeated two more times at intervals of 10 seconds between the applications. It is necessary to protect eyes and ears during this procedure

as well as nostrils, to prevent inhalation of the product⁵.

Some authors recommend the application of the fluoromethane spray on the innervated area by the auriculotemporal nerve⁸. Firstly eyes and ears of the patient are protected covering his/her face with a towel containing a hole or opening exposing only the area to be treated. The mouth should be comfortably open. With the spray at about 45 cm from the skin of the patient, parallel jets are slowly applied, beginning prior to the tragus and proceeding toward the temporal muscle, repeating the application 10 to 15 times until the area becomes whitish. When the region returns to the original color, moist heat is applied for three minutes. If, after this procedure, the patient still reports pain, it is recommended to repeat the application up to three times. After pain relief, it is performed muscle stretching. Twenty-four patients with pain in the temporomandibular joint (TMJ) were subjected to such treatment and 22% responded favorably.

In literature there is no consensus on which is the best technique for the application of cold stimulus. Overall, it is assumed that the best technique is the one capable of producing the greatest and more rapid decrease in body temperature^{2,18}. The various techniques have different thermodynamic properties and therefore may have different results. During application of ice there is a change from solid to liquid state, which does not happen with gel packs. According to the principles of thermodynamics, lower temperatures would be produced by modalities in state changing due to the higher heat absorption. Another factor that has an important influence on the decrease of the body temperature is the mode of heat transfer. In some modalities, the heat transfer occurs by conduction, while in others by conduction and evaporation and this is therefore more effective².

No papers comparing the modalities of cryotherapy in the face region were found. Some authors² compared the effectiveness of three modalities of cryotherapy applied to the anterior thigh: crushed ice bag (dry applied), ice bag (wet applied) and bag with frozen gel. They found that the bags with ice produced lower temperatures in the skin surface and in intramuscular area than the gel bag. The authors explain this by the fact that the ice goes through phase change (melting) which absorbs heat, while the same does not occur with the gel. Even if the gel bag presents lower initial temperatures, the modalities that employ the ice are more effective in absorbing body heat. Another fact to be noted is that the bag with ice (dry applied) and the gel bag absorb heat by conduction, ie, by direct contact. On the other hand the ice bag (wet applied),

besides the conduction mechanism, also absorbs heat by water evaporation, and therefore, in accordance with the principles of thermodynamics, would be more effective than the dry applied modalities ².

Other authors ¹⁸ compared three modalities of application of dry ice in the leg, in the region of the gastrocnemius muscle: in cubes, crushed and mixed with water, and found that the ice and water method was more effective in reducing skin temperature and both this modality and the application of ice cubes were more efficient than the application of crushed ice in reducing intramuscular temperature. The authors explain the higher efficacy of the water modality with the fact that the other methods use the air for transferring thermal energy between the pieces of ice, while it uses water that has greater specific heat (Cp), i.e., higher capacity of transferring thermal energy. The air transfers energy in a less efficient way than ice, what explains the advantage of ice cubes (denser) than the crushed ice (less dense, more air). Besides being more efficient, the mixture of ice and water has the advantage of easily mold themselves to the anatomy of the individual and, thus, increase the contact area of the stimulus to the body.

The modalities of cryotherapy involving ice, wet or dry applied, and package with commercially available gel were also compared in application on the skin near the triceps muscle. The wet modality resulted in lower temperatures on the surface of the skin. However the authors emphasize that the gel packs are practical, easy to apply and reusable. The wet application of ice is less desired by the patients, as it requires an appropriate place for application, since the ice melts during the procedure ¹⁹.

In addition to traditional ice cube bags and bags with gel, some authors ²⁰ used bags with frozen peas and bags with a mixture of water and alcohol in the ratio 4:1, in comparisons of skin temperature in the quadriceps femoris muscle region. The authors found that the bags with ice and mixture of water and alcohol were more effective in reducing skin temperature than the other modalities.

Time of application of the technique

The time of application of the stimulus depends on the technique. The literature indicates, in case of application in the facial region, for bags with ice, an average application time of the stimulus from 10 to 15 minutes ^{6,9,11,15,16}. In the case of vapocoolant spray, the application time must be shorter, at about 10 seconds ⁶. Some authors distinguish the duration of the application in accordance with the purpose. So, in case of acute inflammation or trauma they recommend 10 to 15 minutes of application and, in cases of chronic pain, 30 minutes ¹⁰. Other authors

recommend 20 to 30 minutes for application of cold compresses ¹³. The lowest recommended duration was 2 to 3 minutes, preceding massage for acute TMD ¹⁴.

An important aspect to consider in the choice of the technique is the time that the area remains cooled after the removal of the thermal stimulus. The longer the body area remains cold, more efficient the technique is considered. No studies were found that verify this time in the face region. In research involving cryotherapy in the gastrocnemius muscle region, the authors ¹⁸ found that the application of ice mixed with water was more effective in maintaining the low temperature of the skin after the removal of the stimulus, followed by ice cubes, and finally by the crushed ice. The first two modalities were equally effective in maintaining the low intramuscular temperature as compared to the modality that used the crushed ice.

Other authors ¹⁹ observed rewarming of the tissue after 15 minutes of the removal of the thermal stimulus, bag with ice applied both dry and wet in the leg region. This finding suggests that exercises should be initiated during the application or as soon as possible after removing the thermal stimulus and, in this region, they should not exceed 15 minutes. Remember that the facial region is composed of muscles of lower caliber, which possibly reduces the cooling time and the return to the initial temperature. It is necessary to conduct some researches in order to determine the time of the orofacial tissues cooling and of the return to the initial temperature in the various modalities of cryotherapy.

Area covered by the thermal stimulus

The literature indicates that the thermal stimulus should be applied to the painful areas ^{11,14,15}, on muscular regions with trigger points ¹⁷ or over masticatory muscles ⁶ and it can include the region of the trapezius and sternocleidomastoid muscles ⁷. A survey cites the application on the region of TMJ ⁸ and other one suggests the face altogether ⁹.

Studies in other body regions noted that cryotherapy should be avoided in anesthetized areas ³, because the sensitivity of the patient is the best way to prevent skin damage from prolonged time of application. It was also observed that the skin temperature is closely related to the temperature of adjacent tissues, ie, the lower the skin temperature, the lower the temperature of the subcutaneous tissue and thus more effective is the treatment ¹⁹ and, the larger the covered area, more efficient is the heat absorption ². However only the area in contact with the thermal stimulus is cooled, ie, areas near the site of application are not affected ¹⁹. This finding indicates that preparing the stimulating

agent with the appropriate size and position in the proper location is essential to the treatment.

Intensity of the thermal stimulus

It was obtained only one article ¹⁵ that points out the value for the ideal decreasing temperature for the treatment of muscle pain in the facial region. According to the authors ¹⁵, it is necessary a reduction of 10 to 15°C in the superficial and deep tissues.

Some studies conducted in other body regions indicate that the analgesia induced by cryotherapy begins to take effect when the skin temperature is approximately 13.6° C and, for decreasing the rate of cell metabolism, the temperature of the skin surface must be kept near 10°C ²⁰. Other studies have found that reducing the skin temperature to below 16°C is required to occur analgesia and sufficient relaxation to allow active or passive exercises in the painful area ¹⁹.

A study indicated ¹⁹ that neither the bag with ice nor the one with gel produced temperatures below 16°C on the skin surface of the triceps muscle region when they were applied for 15 minutes. Consequently none of these modalities was able to produce the desired therapeutic effects. Another study ²¹ showed that the package containing frozen peas reduced the skin temperature to less than 10°C, which is sufficient to achieve the therapeutic effects, while the same was not observed for the gel bag in the rectus femoris muscle region. Some authors ²⁰ found that the average temperature on the skin surface after 9 minutes of application of the bag with ice and with water and alcohol mixture was between 10°C and 13.6°C and did not change more than 1°C during the final 5 minutes of application. However, in the case of applying the gel pack and frozen peas, the temperature did not reach values lower than 13.6°C during the 20 minutes of application.

Importantly, patients with TMD are usually more sensitive to the pain caused by thermal stimulation when compared with normal subjects. A study compared the pain thresholds to cold stimuli among individuals with myogenous, arthrogenous and mixed TMD and normal subjects ²². Thresholds of pain for individuals with myogenous TMD were 6.01 ± 9.29°C, 7.93 10.44 ± 6.88°C and ± 8.39°C in the temporal, masseter and TMJ regions; for individuals with arthrogenous TMD, the thresholds were 17.10 ± 11.45°C, 18.02±11.47°C and 19.92±11.42°C and for TMD patients of mixed TMD, the pain thresholds were 10.10±6.75°C, 10.95±11.23°C and 12.96±11.46°C respectively. Normal subjects showed values of 3.36±4.85°C, 5.12±8.16°C and 5.73 ± 4.85°C in the temporal, masseter and TMD regions, respectively.

So, Individuals with arthrogenous TMD were much more sensitive to cold stimulation ²². This can be a complicating factor of the therapy, as low temperatures may initially worsen the pain status of the patient until it is reached the sufficient temperature to induce analgesia. If the patient does not persist in the stimulation, the therapy will not achieve the desired effect, ie, there will be no improvement of the symptoms ¹⁵.

Frequency of application

The frequency of application, in most cases, is related to the frequency of the exercises, since cryotherapy usually precedes the muscle exercises ^{6,7}. Thus Cryotherapy is generally performed about 2 to 4 times a day ^{6,7,12}.

Some authors suggest a more frequent application, up to 8 times a day ⁵ or less frequently, at least once a day ¹⁵. Other authors divide the frequency of application according to the patient's condition. Thus, cryotherapy may be performed several times a day at intervals of 30 minutes for acute inflammation or trauma and, in case of chronic pain, twice a day ¹⁰.

■ FINAL CONSIDERATIONS

Although often quoted as an effective strategy for treatment of facial pain, there is lack of research proving the efficacy of cryotherapy, as well as lack of current studies on the subject, possibly due to the development of more modern techniques for pain relief, as transcutaneous electrical stimulation and ultrasound ⁴. Then, the material discussed in this review is not recent.

The literature indicates that cryotherapy has a low rate of compliance by patients. A study ¹⁵ compared the compliance to five types of treatment for temporomandibular disorders: muscle relaxation, muscle stretching, thermotherapy by addition, cryotherapy and occlusal splint. The authors found that thermotherapy, whether by addition, or by subtraction, reached the lowest levels of compliance. The authors attribute the low compliance to the fact that such modalities require specific materials, longer time and can not be carried out anywhere. Low compliance compromises the outcome of treatment. Therefore it is recommended that various techniques are presented to the patient so that he/she can participate in the choice of the most comfortable technique or the one that best fits his/her lifestyle.

The withdrawal of body heat can be conducted through application of cold compresses, bags with cold agents or vapocoolant sprays, applied on the painful areas, on muscle regions with trigger points

or on masticatory muscles. The average time of application of the stimulus is 10 to 15 minutes for bags with cold agents and at about 10 seconds in the case of vapocoolant spray, and should

be repeated approximately 2 to 4 times a day, preceding the techniques of muscle stretching. The literature has no consensus on the intensity of the thermal stimulus.

RESUMO

Esta pesquisa teve por objetivo realizar uma revisão integrativa sobre a produção científica referente ao uso da crioterapia no tratamento das disfunções temporomandibulares, caracterizando as técnicas utilizadas, duração de aplicação da técnica, área estimulada e frequência de realização. Foi realizado um levantamento da literatura nas bases de dados Medline, LILACS, SciELO, Biblioteca Cochrane e IBECs. Os termos utilizados foram: *crioterapia*, temperatura baixa, transferência de calor, hipotermia induzida, articulação temporomandibular, transtornos da articulação temporomandibular, síndrome da disfunção da articulação temporomandibular e seus correspondentes em inglês e espanhol. Foram incluídos artigos que abordaram a crioterapia no tratamento das disfunções temporomandibulares, publicados em inglês, espanhol ou português, no período de 1980 a 2013. Foram considerados: técnica de aplicação, duração de aplicação, área corporal e frequência de realização. Inicialmente foram encontrados 34 estudos, dos quais 13 contemplaram os critérios de seleção propostos. Os dados foram tabulados e apresentados em ordem cronológica. A retirada do calor corporal pode ser realizada por meio da aplicação de compressas frias, bolsas com agentes frios ou aerossóis refrigerantes, aplicados sobre as áreas dolorosas, sobre regiões musculares com “*trigger points*”, ou sobre músculos mastigatórios. O tempo médio de aplicação do estímulo variou de 10 a 15 minutos para as bolsas com agentes frios e cerca de 10 segundos no caso do spray refrigerante, repetindo-se cerca de 2 a 4 vezes por dia, precedendo as técnicas de alongamento muscular. A literatura não apresenta um consenso quanto à intensidade do estímulo térmico.

DESCRITORES: Crioterapia; Hipotermia Induzida; Transtornos da Articulação Temporomandibular; Transferência de Calor; Face; Temperatura Cutânea

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