

Orofacial pain of cardiac origin: hypothesis and review of the literature

Dor orofacial de origem cardíaca: hipótese e revisão da literatura

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ABSTRACT

Introduction: It is known that pain can be referred to orofacial structures from sources far from craniofacial structures. **Objective:** Demonstrate that many orofacial structures rather than the teeth can be affected by pain referred from cardiac structures. **Methodology:** The sets of words Orofacial pain + Cardiac structures, Orofacial referred pain; Orofacial pain + Cardiac structures + Convergence mechanism, were entered into the Google electronic site. **Results:** A total of 24 articles written in English and related to orofacial pain, referred pain and convergence mechanisms were retrieved. 22 articles were published between 2000-2016 and 2 articles were published before the year 2000. All papers were summarized in order to gather information about different subjects related to orofacial pain referred from cardiac structures. **Final considerations:** Based on the review of the literature it is concluded that the teeth are not so frequently affected with orofacial pain of cardiac origin as compared to other anatomic orofacial locations. Pain is most frequently referred to the throat, lower and upper jaw, temporomandibular joints and other structures; Intensity of pain and increased sensitization is considered by many researchers as one mechanism which facilitates the development of referred pain; the most common mechanism of referred cardiac pain is convergence of nociceptive signals and probably amplification in the subnucleus caudalis of the fifth cranial nerve. Fibers of the vagus nerve are thought to carry cardiac nociceptive signals to the Central Nervous System.

Descriptors: Orofacial pain. Preventive dentistry. Public health dentistry. Referred pain.

RESUMO

Introdução: A dor orofacial pode ser referida para estruturas mastigatórias a partir de regiões anatômicas distantes. **Objetivo:** Demonstrar que muitas estruturas anatômicas orofaciais e não apenas os dentes podem ser a fonte de dor irradiada a partir de estruturas cardíacas. **Metodologia:** Os termos Dor Orofacial + Estruturas cardíacas; Dor Orofacial Referida; Dor Orofacial Referida + Estruturas Cardíacas + Mecanismos de convergência foram introduzidos no local eletrônico www.google.com, com a finalidade de obter os artigos científicos relevantes. **Resultados:** 24 artigos científicos sendo 22 publicados entre 2000-2016 e dois artigos publicados entre 1986-1999, foram retirados, e resumidos de tal forma a poder escrever sobre os diversos tópicos relacionados com dor orofacial referida a partir de estruturas cardíacas. **Considerações finais:** Com base na revisão da literatura conclui-se que os dentes não são afetados tão frequentemente com dor referida a partir de estruturas cardíacas quanto outras estruturas anatômicas; a intensidade da dor e aumento da sensibilização central e periférica são considerados por alguns autores como um mecanismo da dor referida; a maioria dos autores considera que o mecanismo de convergência explica bem porque ocorre dor orofacial referida; o nervo vago transporta fibras cardíacas aferentes para o sistema nervoso central.

Descritores: Dor orofacial. Dor referida. Odontologia em saúde pública. Odontologia preventiva.

INTRODUCTION

Cardiovascular diseases are one of the primary reasons for mortality throughout the world. Usually, patients who are suffering from cardiovascular disease are vulnerable to physical and emotional stress.¹ Ischemic heart disease is a major cause of morbidity and mortality in adults. Moreover, the differentiation of pains caused by ischemic diseases from dental pain is of high

importance in early diagnosis and treatment of ischemic diseases.² Patients who have angina pectoris without chest pain run a higher risk of experiencing a missed diagnosis, thus, the dentist and/or specialist in orofacial pain have to be aware of cardiovascular symptoms which in some way are related to pain in the orofacial structures.³

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Pain that occurs at a site separate from its origin is called “referred pain”. Even if the origin of the pain is a location other than the teeth, dental pain can occur, and the patient will complain of a toothache.⁴ Pain referred to the orofacial structures can sometimes be a diagnostic challenge for the clinicians which in turn possess a therapeutic problem for many health professionals. If patient’s pain is not properly diagnosed and he or she is referred to other health professionals, this delay in the diagnostic process may result in the patient experiencing an acute myocardial infarction.⁵ In routine dental practice, clinicians often encounter different types of pain disorders which are felt in the orofacial structures. The clinician should be able to manage the orofacial pain by having thorough knowledge of many possibilities, so that a proper diagnosis can be established. Additionally, a wrong pain diagnosis in the craniofacial region may lead to unnecessary dental treatment.³ In the last few years, many studies have been published demonstrating that there is a relationship between cardiovascular disorders and dental pain of non odontogenic origin.^{3,6,7} However, there are reasons to believe that other anatomic areas rather than the tooth or teeth may be involved in the pain referral process, thus, it seems that orofacial pain rather than dental pain of cardiac origin, may be a more appropriate terminology to describe this type of pain. Additionally, it seems that all anatomic regions affected with referred orofacial pain have not been properly defined and the mechanism of referred pain from the heart to orofacial structures still remain obscure, thus, the goal of this study is to use the current literature about the relationship orofacial pain and cardiovascular disorders to test the hypothesis as follows: 1. Orofacial pain of cardiac origin is referred to many orofacial structures but less frequently to the teeth; 2. One mechanism of pain referral is intensity of pain and increased sensitization; 3. Convergence of nociceptive signals on the subnucleus caudalis of the trigeminal nerve is crucial to understand pain referral to orofacial structures.

METHODOLOGY

The electronic site “www.google.com” was chosen to retrieve and select scientific papers. The set of combined words Orofacial pain + Cardiac structures; Referred orofacial pain + Cardiac structures; Orofacial referred pain + Cardiac structures + Convergence mechanism were consecutively entered into such electronic site to collect scientific papers. Inclusion criteria were the following: papers written in English, papers presenting sufficient information about different subjects related to cardiac pain referred to orofacial structures, most papers should have been written from 2000-2016 with possible exceptions to those with high relevance to this subject. Exclusion criteria:

papers written in other languages rather than English, papers written before the year 2000, papers having scarce information about cardiac pain referred to orofacial structures.

RESULTS

An amount of 33 papers were retrieved, copied, read and examined carefully. However, between these papers, 2 publications dated before the year 2000 were retrieved due its relevance to this research and others 9 papers were discarded for presenting insufficient data and information to review the literature and for discussion of those most relevant subjects of this study. Once it was considered that sufficient information to review the literature and discuss different subjects had been obtained, all papers were summarized. Thus, this study was prepared from information from 24 different publications discussing different aspects of referred orofacial from cardiac structures including prevalence, anatomic regions affected with pain, mechanism, intensity of pain, central sensitization, pain transmission and pain mediators were obtained, copied, summarized and used to prepare the current study. Literature reviews and publications of case reports were included in the current study. It were noted that 24 papers would be sufficient enough to discuss and review different aspects involved in referred pain from cardiac structures to orofacial sites.

Ischemic heart disease/myocardial infarction

Typical ischemic coronary pain is an uncomfortable sensation in the centre of the chest in which pain usually radiates to the neck, shoulder, jaw, back or arm.⁸ Cardiac ischemia is a clinical disorder in which cardiac structures are deprived of oxygen with inadequate elimination of waste products. From a clinical viewpoint, myocardial ischemia is the result of decreased blood flow to the coronary arteries resulting in changes in blood pressure and heart rate associated with excessive physical exercise, psychological stress and/or coronary atherosclerotic lesions.⁹

Ischemia refers to a lack of oxygen due to inadequate perfusion of the myocardium, which causes an imbalance between oxygen supply and demand. The most common cause of myocardial ischemia is an obstructive atherosclerotic disease of epicardial coronary arteries.¹⁰ Angina is defined as oppressive pain usually felt in the thoracic region as a result of myocardial ischemia.¹⁰

Frequency

One investigation¹¹ evaluated 30 cardiovascular disorder patients who responded to a questionnaire while doing a treadmill exercise at a hospital facility and presenting with a previous

history of acute myocardial infarction or angina pectoris. Researchers reported a frequency of 11/30=36.7% of pain referred only to the mandible in the orofacial structures and in all cases pain was described as bilateral and occurring previously to or during the cardiac attack. These findings imply that not all patients presenting with cardiovascular disorders report pain referred to the orofacial region. In the absence of chest pain, craniofacial pain is far more frequent than pain in other anatomic areas.¹² One prospective investigation¹³ in 248 consecutive patients presenting with cardiac pain reported that 5.2% complained of craniofacial pain as the sole symptom of cardiac ischemia.

One research¹⁴, evaluated a group of 186 patients with a history of cardiac ischemic attack in which a questionnaire was used to collect clinical data. Researchers reported a frequency of 71 (38%) patients reporting pain in the craniofacial region during their cardiac ischemic attack. 85% of these patients reported pain in other anatomic regions including the chest, shoulder, back and arms. 11% of these 85% patients also reported craniofacial pain.

When all patients presenting with craniofacial pain during ischemic heart attack (n=71=38%) were analyzed separately, researchers¹⁴ reported that the most common anatomic craniofacial areas in which pain was reported included upper part of the throat (81.7%), left lower jaw (32=45.1%), right lower jaw (40.8%) and left auriculotemporal region (13=18.3%). Pain was also reported in the temporomandibular joint (TMJ) and ears (33.7%), the neck (11.2%), teeth (4.2%), head (4.2%), cervical area (2.8%), and maxilla (2.8%). In most cases, cardiac pain referred to craniofacial structures is bilateral whereas odontogenic pain occurs unilateral.¹⁴

One study², evaluated a large sample (n=350) of medical records of ischemic heart disease patients, but personal and family interviews were also used to gather data. Researchers found a frequency of 29.2% craniofacial pain. Further, craniofacial pain was observed more frequently in those patients with craniofacial pain and hypertension (44.3%), smoking (28.2%), diabetes (22.2%), and dyslipidemia (24.6%). The left side of the mandible was the most prevalent region in which the patients had experienced pain (18.6%) whereas the right side of the maxilla and tongue were those regions in which the lowest prevalence of pain was observed (8.8%).

One investigation¹³ assessed 248 consecutive patients presenting with signs and symptoms indicating ischemic heart disease. Researchers reported a frequency of 34.2% (n=85) patients presenting with craniofacial pain during a period of ischemia. Seventy two patients (84.7%), experienced pain in the craniofacial region together with chest, shoulders and arms pain and 15 patients (15.3%) reported pain in the craniofacial area with

no other concomitant symptoms.¹³ In this investigation, the frequency of craniofacial pain by anatomic region induced by cardiac ischemia was as follows (n=85): right mandible (34.5%); left mandible (42.4%); right TMJ/ear region (11.9%); left TMJ/ear region 13.1%; and an amount of 2 (2.3%) patients reported toothache in the mandibular teeth of both sides. Frequencies of craniofacial pain induced by myocardial infarction by anatomic region were as follows: Right mandible (15.5%); left mandible (14.6%); right TMJ/ear region (7.8%); left TMJ/ear region (9%).¹³ Findings from this multicentre study indicated that 34.2% of patients during a cardiac ischemic episode and 48% of patients during acute myocardial infarction experienced craniofacial pain.¹³ In this clinical investigation with 248 patients, cardiac pain localized solely in the craniofacial structures occurred in only 5.2% of all cases.¹³

Clinical signs and symptoms

The most characteristic clinical symptom of cardiac ischemia is substernal pain irradiating to shoulders, arms and neck. Usually anginous pain is described by patients as oppressive or tight located in most cases at the retrosternal region which can irradiate to the arms, neck and jaw. Other symptoms associated with pain in angina include difficulty to breath and/or a painful sensation located only in the neck, jaw, arms and wrist.¹¹ Pain in angina pectoris is described as oppressive or tight, a feeling of weight, and or burning pain localized retrosternally and radiating to the arm, neck, shoulder and mandible. Pain onset is gradual, then increases steadily and subsides in about 1-10 minutes.⁹ Symptoms of pain resulting from cardiac ischemia included but are not restricted to the chest, shoulder, arm, face and jaw pain.⁶

Anatomic orofacial areas of pain referral

Anginous pain is described as a painful sensation radiating to the lower and upper jaw and to the teeth.¹¹ In the current study in 30 patients with a history of myocardial infarction or angina pectoris, researchers found that 11/30 (36.7%) patients reported pain referred only to the mandible and in all eleven cases, the pain was bilateral. The review of the literature indicates that pain of cardiovascular origin can be referred to the throat, neck, temporal, head, infraorbital, maxilla, mandibular, zygomatic arch, TMJ, ear, teeth, shoulder and arms regions.¹¹ Temporomandibular joint and jaw pain induced by cardiac ischemia tends to occur bilaterally as opposed to referred pain of dental origin.¹⁴

A previous investigation¹² reported that pain in the craniofacial structures may be the only pain complaint during cardiac ischemia in 1/15 patients. One research⁶ reviewed the literature about orofacial pain of cardiac origin and data obtained from 18 clinical case reports. Researchers found that

craniofacial pain was unilateral in 7 case reports and bilateral in 9 case reports.

Regarding tooth pain as a symptom of cardiac ischemia, one literature review study⁶ indicated that only two case studies reported isolated tooth pain. Thus, even though many studies emphasizing pain of cardiac origin referred to the tooth or teeth have been published, it is apparent that pain referred to the tooth or teeth is not a common event in patients presenting with referred pain of cardiac origin. Additionally, one investigation¹⁴ in a large group of patients presenting with cardiovascular disorders, reported that only 3/186 (1.6%) patients had tooth pain.

Mechanism of pain referral

Pain referred to the orofacial region can be explained by convergent mechanism to the trigeminal complex. It is known that afferent and efferent somatic information from the upper limb, thorax and face converge all in the spinothalamic tract of the central nervous system.¹¹ As cardiac inputs enter the central nervous system and ascend to higher center for evaluation and interpretation, adjacent central neurons in the region of convergence can also become activated which result in stimulation of such neurons which are not directly involved with primary source of pain. As the information reaches cortical structures, nociceptive input is misinterpreted as pain in another site.¹² It may be that such misinterpretation is more likely to occur when pain from cardiac structures is more severe. In this case, some nociceptive input converging to spinal neurons, also reaches the subnucleus caudalis thus, cortical receptive fields interpret nociceptive information as coming from trigeminal structures.

Orofacial pain of cardiac origin is explained by the presence of cardiac afferent fibers which interconnect with other fibers in the upper cervical roots and with receptive areas in the descending spinal trigeminal complex.¹¹ Upper cervical spine segments form a convergence area for trigeminal, visceral and phrenic inputs.¹⁰ Pain referral is anatomically facilitated as the descending spinal trigeminal tract is located very close to the upper cervical segments, thus facilitating pain "spreading". The descending sub nucleus caudalis receives extensive convergence inputs from cutaneous, muscular, and visceral afferents.¹⁵ The clinical and physiological literature lends support to the notion that the vagus or tenth cranial nerve mediates afferent information to the throat, neck and jaw pain associated with coronary ischemia.⁸ Craniofacial pain is thought to result from activation of afferent fibers of the vagus nerve, which transmits nociceptive information to cervical neuron cells.¹⁶

Pain intensity

In one investigation¹¹, 30 patients presenting with a history of myocardial infarction or angina pectoris were evaluated using a questionnaire. Researchers reported a frequency of 11/30 (36.7%) patients reporting pain referred solely to the mandible. Such pain was described as bilateral and from mild to severe. Ramachandran and coworkers¹⁷ described the case of a 27-year-old male presenting with intolerable pain in the maxillary right first premolar region associated with an atrial septal defect. One study² described a clinical case of a 48-year-old man presenting paroxysmal severe bilateral sharp pain in the temporomandibular region ultimately diagnosed with angina pectoris. Another clinical case of a 65-year-old woman complaining of excruciating facial pain perceived in both zygomas and associated with a history of myocardial infarction, was described previously.¹⁸ This is not to say that all patients presenting with craniofacial pain of cardiac origin describe pain as severe.

Increased sensitization

It may be that increased sensitization occurs as a result of frequency and severe pain. For instance, in one investigation¹¹, in which 11/30 (36.7%) patients reported pain referred to the mandible, researchers reported that pain referred to the mandible in these eleven cases varied from mild to severe. These findings indicate that more severe pain may be a factor leading to increased sensitization of neural structures converging to the subnucleus caudalis of the trigeminal complex. This assumption is further supported by authors' information that in 8/11 (72.7%) cases, the pain was described as paroxysmal, indicating more severe pain. When orofacial pain in a given orofacial area persists, the pain-transmitting neurons become hypersensitive, a phenomenon called "central sensitization". As a result, the slightest stimulus propagates to the central nervous system via neurotransmission.⁴

Stimulation of nervous system neurons by cardiac nociceptive input can lead to pain referral to the craniofacial area.⁵ During myocardial infarction or ischemic heart attack, there may excessive convergence of nociceptive information of C1-C3 neurons which usually receive somatic inputs from cardiac structures.¹⁰ Part of such input converge to the subnucleus caudalis adjacent to C1-C3, thus, cortical structures may interpret part of this afferent information as pain from cardiac structures, and another part from craniofacial structures.

Pain transmission

Nociceptive input to upper centers is transmitted via A delta and C fibers which respond to a number of neurons-sensitive mediators including SP, NPY, CGRP,¹⁹ bradykinin, histamine, serotonin, prostaglandins¹⁹ and other chemical

mediators. Cardiac inputs from cardiovascular structures enter into to the central nervous system through the spinal cord and terminate mainly in the thoracic dorsal horn, where they synapse with spinothalamic tract neurons. This information is then, projected to the thalamus¹², but as it was said before, some information may reach the subnucleus caudalis of the trigeminal nerve. Animal models indicate that vagal and sympathetic afferent fibers are involved in the transmission of nociceptive input from the heart to C1-C2 spinal neurons which function as a nociceptive information integrating center.²⁰

Diagnosis

Pain of cardiac origin referred to orofacial structures is usually bilateral as compared with odontogenic pain which is usually described as unilateral.¹¹ It has been reported in the literature¹² that when patients present with orofacial pain of cardiac origin, the descriptors pressure and burning indicate that the pain has a cardiovascular origin, whereas descriptors like aching and throbbing usually indicate an odontogenic cause of the orofacial pain. There are reasons to believe that toothache is described as pulsatile and sharp whereas pain of cardiac origin is described as oppressive and burning. Further, it seems that pain is more intense in patients with toothache than in patients with pain of cardiac origin. Orofacial pain of cardiac origin is a bilateral pain, mainly located in the mandible and throat which can irradiate to other craniofacial structures and also to more common areas of irradiated pain including the arms, shoulders and chest.¹¹

The onset of pain of cardiac origin is usually spontaneous, can be triggered by physical exercise, it usually remains unchanged by movements or oral stimuli and is usually alleviated with adequate cardiac origin.¹¹

Because orofacial pain occurs frequently in patients with ischemic heart disease and/or acute myocardial infarction, pain of cardiac origin should be included in the differential diagnosis of referred craniofacial pain when a lack of local sources becomes evident¹³. The typical patient with angina is a man of above 50 years and woman above 60 years of age. Proper history taking and through physical examination is important in the diagnostic process.¹⁰

The dental practitioner should suspect that facial and or dental pain has a cardiac origin when there is no adequate dental or facial cause that explain the pain, toothache increases with physical activity, failure of analgesic block to arrest the pain, the presence of a history of chest pain which decreases with the nitroglycerin tablets.³

Treatment

Once proper diagnosis is carried out, patient should be referred to a cardiovascular unit. In one study¹¹ 2012, local and referred pain in a group of 30 patients was abolished once proper cardiovascular treatment was carried out. Case report studies indicate that the administration of vasodilators and angioplasty surgery is effective to abolish pain in those patients presenting with referred orofacial pain and cardiovascular disorders.¹¹ If craniofacial pain is associated with cardiac or chest pain, such a pain is most often relieved by sublingual nitroglycerin and immediate referral to a medical practitioner is strongly indicated.⁷

DISCUSSION

1. Pain of cardiac origin is referred to many craniofacial structures, but pain referred to the tooth or teeth does not occur commonly

It should be remembered that ischemic heart disease can rarely be felt as an orofacial pain complaint. Such a referred pain of cardiac origin can lead to a diagnostic dilemma for the clinicians.¹ Cardiac pain most commonly radiates to the left arm, shoulder, neck and face. In rare instances angina pectoris may present as dental pain.⁵ In one investigation²¹ in 186 patients presenting with a history of ischemic heart attack or acute myocardial infarct, researchers reported a frequency of only 4.2% of toothache. Such findings imply that dental pains do not occur frequently in patients with acute myocardial infarction.

In the previously mentioned study²¹, 71/186 (38.2%) patients presenting with myocardial ischemic attack complained of pain referred to the craniofacial structures. Because dental pain was reported in 3/71 patients or 4.2% affecting lower bilateral teeth in two patients and upper teeth in one patient, it is apparent that dental pain does not occur commonly in patients with cardiovascular disorders. We found that the literature review demonstrated that the frequency of pain referred to the tooth or teeth was very low, thus, this outcome is contradicted by one investigation¹⁴, asserting that commonly affected areas of pain of cardiac origin include the neck, throat, ear, teeth, mandible and headache. The pain of cardiac origin can irradiate to the throat, back, temporal region, head, infraorbital region, maxilla, mandible, ear regions, teeth, face, and zygomatic arch and/or to the thorax, shoulders and arms.⁸ One investigation²², evaluated 215 patients complaining with a history of ischemic heart disease and angina pectoris referred to a hospital facility. Researchers did not report any complaint of toothache in the sample indicating, that toothache of cardiac origin does not occur frequently in patients with angina pectoris and or ischemic heart disease. They also asserted that the prevalence of maxillofacial pain of cardiac origin is low.

2. Intensity of pain and increased sensitization of afferent pathways

It has been reported that pain of cardiac origin varies in intensity from mild to severe¹¹. Additionally, not all patients presenting with ischemic pain or myocardial infarction report pain referred to craniofacial structures. It may be that more severe pain is more likely to sensitize vagal nociceptive afferents, thus, causing referred pain to distant anatomic structures including the head, TMJs, jaws, face and teeth. One investigation² presented a clinical case of severe bilateral temporomandibular joint pain associated with angina pectoris. Franco and associates²³, reported the case of a 50-year-old diabetic woman complaining of excruciating pain in the upper and lower jaw and left temporal area associated with angina pectoris. It may be that severer pain increases the likelihood to sensitize nociceptive neurons and corresponding afferent pathways thus, causing referred pain.

3. Convergence of nociceptive signals to the subnucleus caudalis of the trigeminal nerve

Cardiac nociceptive input travels to the central nervous system and ascends to higher centers for processing in regions of convergence, where adjacent nociceptive neurons may become activated.⁵ The activation of adjacent neural networks not directly involved with the primary source of pain, may be misinterpreted in the cortex, causing unintentional pain input which is referred to other regions thus, resulting in heterotopic pain.⁷ Convergence mechanisms are involved in craniofacial pain which originates in the heart. It has been established that the upper cervical spine segments are convergence areas for trigeminal, visceral and phrenic inputs.²⁰

There is a connection between cardiac vagal afferents, trigeminal and trigemino-thalamic neurons; moreover, cardiac input have a modulatory effect on the trigeminal system. A recent investigation²⁴, indicates that 89% of the C1-C3 neurons that receive somatic inputs from the craniofacial structures, are also excited by cardiac nociceptive afferent fibers which can explain the referred pain to the face in cases of myocardial infarction. Additionally, vagal afferents from the heart contribute to craniofacial pain more commonly because somatic fields in the jaws and the neck are more reactive to vagal than to sympathetic experimental electrical stimulation²⁰.

FINAL CONSIDERATIONS

Based on the review of the literature to carry out this study, we conclude that:

1. There is strong evidence indicating that pain of cardiac origin may be referred to many orofacial structures including throat, lower jaw,

temporomandibular joint and maxilla. Pain originating from cardiovascular input does not occur frequently neither in other craniofacial structures nor in the teeth.

2. Because many studies indicate that orofacial pain including toothache of cardiac origin may be described as severe in many cases, and central sensitization is a relatively well known neurophysiologic mechanism explaining referred pain thus, severity of pain and central sensitization are two mechanism explaining referral of cardiac pain to the orofacial structures.

3. Most studies indicate that convergence of nociceptive input to C3-C1 and then to the subnucleus caudalis of the trigeminal system is responsible for pain referred to craniofacial structures.

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