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Permalink

<https://escholarship.org/uc/item/67m7x7s8>

Journal

Journal of Emergency Medicine, 46(6)

ISSN

0736-4679

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Publication Date

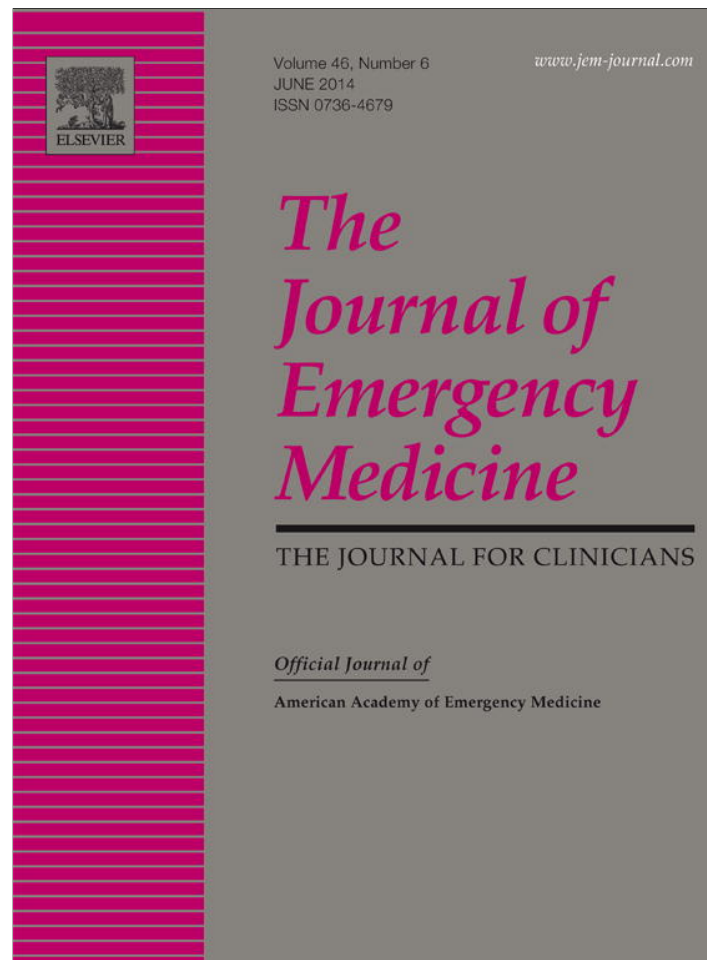
2014-06-01

DOI

10.1016/j.jemermed.2013.11.071

Peer reviewed

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<http://dx.doi.org/10.1016/j.jemermed.2013.11.071>

Clinical Reviews

THE TOOTH, THE WHOLE TOOTH, AND NOTHING BUT THE TOOTH: CAN DENTAL PAIN EVER BE THE SOLE PRESENTING SYMPTOM OF A MYOCARDIAL INFARCTION? A SYSTEMATIC REVIEW

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Abstract—Background: Pain symptoms related to cardiac ischemia can vary greatly from patient to patient. However, should emergency physicians consider the possibility of myocardial infarction in patients who present solely with dental pain? **Objective:** This is a systematic review of the literature investigating the incidence of jaw, tooth, or facial pain as the sole symptom of cardiac ischemia. **Methods:** Studies investigating jaw, tooth, or facial pain of cardiac origin were identified using the PubMed database. All English studies in which cardiac pain originated in the face, teeth, or jaw were screened for inclusion. Data were abstracted from each study utilizing a structured review process, and rated for methodological quality. **Results:** Eighteen studies met study criteria: 16 were case reports, and the remaining 2 were prospective cohort studies. After quality assessment and categorization, nine reports were categorized as weak, eight moderate, and one strong methodological quality. **Conclusion:** Cardiac ischemia may present in no anatomic location other than face or jaw. However, despite frequent claims in the literature to the contrary, the lack of methodological quality of the studies investigated impedes a firm conclusion of face, jaw, or tooth pain as the only symptom of cardiac insufficiency. © 2014 Elsevier Inc.

Keywords—jaw pain; tooth pain; facial pain; myocardial infarction; cardiac ischemia

INTRODUCTION

Cardiovascular disease accounts for 29.3% of all deaths annually, and approximately 2–3% of acute myocardial infarctions are missed in the emergency department (1,2). Symptoms of pain resulting from cardiac ischemia often have varying presentations, which include chest pain, shoulder pain, arm pain, face pain, or jaw pain. Craniofacial pain is thought to result from afferent fibers of the vagus nerve, which transmit nociceptive information to cervical neuron cells (3). Therefore, whereas cardiac disease often manifests as crushing substernal chest pain or anginal equivalents, classic teaching is that cardiac ischemia can present with tooth, jaw, or facial pain as its chief or sole symptom. However, a proposed mechanism for referred cardiac pain does not trump clinical findings. In this study, we seek to conduct a systematic review of the available literature regarding the prevalence of facial, tooth, or jaw pain as the sole presenting symptom of cardiac ischemia.

OBJECTIVES

This systematic review seeks to evaluate and analyze all existing literature on the incidence of jaw, tooth, or facial

pain as the sole presenting symptom of cardiac insufficiency. A comprehensive database search and analysis of screened studies was conducted.

METHODS

This review followed published criteria for conducting systematic reviews (4). The PubMed database was searched for all years through June 15, 2012 utilizing the following search terms: “Jaw pain AND (heart attack OR cardiac ischemia OR coronary heart disease OR acute coronary syndrome),” “Jaw pain of cardiac origin,” “Tooth pain AND (heart attack OR cardiac ischemia OR coronary heart disease OR acute coronary syndrome),” “Tooth pain of cardiac origin,” “Orofacial pain AND (heart attack OR cardiac ischemia OR coronary heart disease OR acute coronary syndrome),” “Orofacial pain of cardiac origin,” “Temporomandibular pain AND (heart attack OR cardiac ischemia OR coronary heart disease OR acute coronary syndrome),” “Temporomandibular pain of cardiac origin,” and “Nonodontogenic tooth pain.” All abstracts that were acquired with these search terms were then manually inspected for studies that fit the inclusion and exclusion criteria.

Inclusion/Exclusion Criteria

All studies in which cardiac pain originated in the face, teeth, or jaw in human subjects were included. All review papers and non-English articles were excluded. However, the references of selected articles and review papers during the same time period were also analyzed to include all relevant literature.

Data Analysis

Data abstracted from the studies included the number of participants and funding sources. The main conclusions were analyzed in a descriptive manner. Each included study was then assessed for bias and methodological rigor by the first author using a previously validated Methodologic Quality Instrument by Cho and Bero (reprinted in the Appendix) (5). The instrument grades the studies based on 24 different points, including study design, subject selection, and statistical methods. Two points were given if the item was contained in the article, 1 point if the item was not completely reported, and 0 points if the item was not present. Based on the score received divided by the possible score for the study, a number between 0 and 1 was given to determine its methodological quality. The highest possible quality study would receive a score of 1 and the lowest, a score of 0. The quality score was then utilized to label the studies as exhibit-

ing weak (0.00–0.33), moderate (0.34–0.66), or strong (0.67–1.00) methodological quality.

RESULTS

The search terms returned a total of 247 studies (Figure 1), which were subsequently manually reviewed. Nineteen studies ranging from the years 1963 to 2011 met all inclusion and exclusion criteria (6–24). One study by Sandler et al. was a review article with an associated case report (24). However, this case report did not present a case in which cardiac problems were the cause of the dental pain and was therefore excluded. The review of reference lists from included articles did not yield any additional studies. The 18 remaining manuscripts subsequently underwent detailed analysis and grading.

Overview of Studies

Of the 18 included studies, 16 were case reports (6–15,18–23). The other two studies were prospective cohort studies (16,17). The case reports all reported on an individual patient except for one, in which three cases were presented (23). The prospective cohort studies had 186 and 474 participants (16,17). The studies varied in methodology and number of participants (Table 1). Additionally, funding sources and affiliations of authors are reprinted in Table 2 to disclose any possible sources of bias. There was no clear correlation between funding and conclusions presented in any of the studies.

Case Reports

All case reports scored < 0.50 on the methodological quality scale. Only seven manuscripts attained a methodological score > 0.33, indicating that most were of weak methodological quality.

Prospective Cohort Studies

The two prospective cohort studies were scored higher than any of the case reports. Kreiner et al. (2007) scored a 0.49 methodology score, classifying it as moderate methodological quality (16). Kreiner et al. (2010) scored a 0.69 methodology score, classifying it as strong methodological quality (17). Kreiner et al. (2007) indicated that 6% of cardiac ischemia patients reported craniofacial pain as their only symptom (16). The results of Kreiner et al. (2010) showed that 6% of patients with pain of cardiac origin had jaw or face pain as their only symptom, but all of these patients except one described the pain as “pressure” or “burning” (17). Patients with pain of

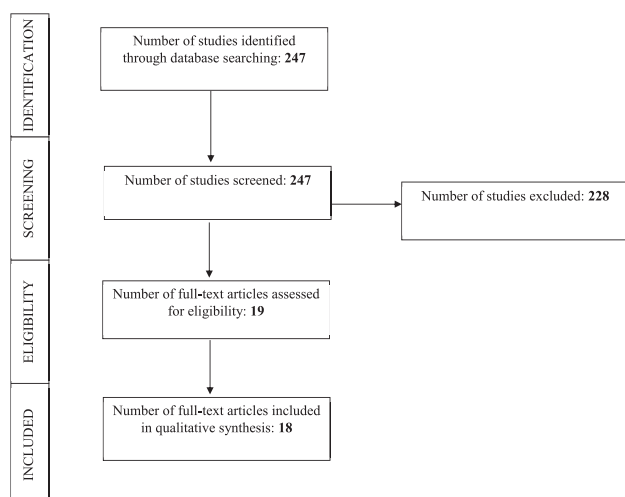


Figure 1. Flow diagram of the study selection.

odontogenic origin, on the other hand, typically described their pain as “throbbing” or “aching.”

Location of Craniofacial Pain

The location of the craniofacial pain varied throughout the cases (Table 1). Of the case studies, the craniofacial pain was reported to be unilateral in seven cases (6,9,13,15,18,20,21). The other nine case studies reported 11 cases of bilateral craniofacial pain or did not specify lateralization of the pain (7,8,10–12,14,19,22,23). As for the prospective cohort studies, Kreiner et al. (2010) did not specify the locations of craniofacial pain reported by their subjects, but Kreiner et al. (2007) reported that the most frequently reported location of craniofacial pain was the upper throat (81.7%), the left mandible (45.1%), the right mandible (40.8%), and the left temporomandibular joint/ear region (18.3%) (16,17). Additionally, Kreiner et al. (2007) stated that the ratio of bilateral referral pattern of pain in the craniofacial region vs. unilateral was 6:1 in its subjects (16). As it pertains to isolated tooth pain as a symptom of cardiac ischemia, only two case studies, those by Drinnan and Okajima et al., mentioned isolated tooth pain (9,22). As for the two prospective cohort studies, Kreiner et al. (2007) mentioned that 3 out of 186 patients had tooth pain, but did not mention if the pain was isolated to the teeth (16). Again, Kreiner et al. (2010) did not mention any specific locations for the pain (17).

Associated Symptoms

All studies had patients whose focal symptom was tooth, jaw, or facial pain. Seven studies reported instances where jaw, tooth, or facial pain were the sole symptoms

of cardiac insufficiency (8,9,14,16,17,19,22). Although jaw, tooth, or facial pain was the chief symptom of the other studies, they presented with additional pain symptoms including back, shoulder, clavicle, chest, arm, and neck pain. Eleven studies presented chest pain as another symptom of the cardiac ischemia (7,10,11–13,15,16,18,20,21,23).

DISCUSSION

The findings of the present review indicate that craniofacial pain does occasionally present as the sole symptom of cardiac insufficiency, with an estimated incidence of approximately 6% reported by two studies of moderate and strong methodological quality (16,17). In addition to the prospective cohort studies, three case reports ranked as moderate methodological quality report craniofacial pain as the sole symptom of cardiac insufficiency. Dalband and colleagues describe a case where a patient presented with temporomandibular pain as the sole symptom related to cardiac disease, Okajima et al. describe a case of a 13-year-old patient whose only symptom of vasospastic angina was a recurrent toothache of 3 years duration, and Groah and Menter describe a case where a history of tooth pain could only be explained by the patient’s heart disease (8,14,22). However, the patient in this last case was tetraplegic. Thus, symptoms may not generalize to other patients. In general, there is a lack of quality studies on this topic. Of the seven studies that note jaw, tooth, or facial pain as the lone symptom of cardiac origin, only one was found to be of strong methodological quality (17).

In the results of the study with the highest methodological quality, Kreiner and colleagues interviewed 115 patients with confirmed acute myocardial infarction (MI), which was defined using American College of Cardiology guidelines (17). These patients were asked to describe their pain either in their own words or using descriptors from the McGill pain questionnaire. The study did not specify the regions of craniofacial pain. However, craniofacial pain of cardiac origin was most often described as “pressure” or burning,” whereas pain of odontogenic origin was most often described as “throbbing” or “aching.”

These findings extended the results of Kreiner et al. (2007), rated as moderate methodological quality in our study, which investigated 186 patients with confirmed MI (16). In this earlier study, post-MI patients, defined using similar American College of Cardiology definitions, were asked to recall their heart attack symptoms. Recall was aided by a picture of the body divided into regions. Here, Kreiner et al. reported a 6:1 ratio of bilateral to unilateral referral of craniofacial pain of cardiac origin (16). In addition to the descriptive words presented

Table 1. Summary of Included Studies

Reference	Study Design	Number of Patients	Craniofacial Location of Pain	Other Pain Symptoms	Methodologic Quality Score (Range 0–1)	Category
Batchelder et al., 1987 (6)	Case report	1	Left mandible (unilateral)	Back, shoulder, clavicular pain	0.28	Weak
Christoforidou & Bridger, 2006 (7)	Case report	1	Bilateral maxillae/jaw	Chest pain	0.28	Weak
Dalband et al., 2011 (8)	Case report	1	Bilateral TMJ	None	0.40	Moderate
Drinnan, 1978 (9)	Case report	1	Unilateral mandible(side not stated)	None	0.20	Weak
Durso et al., 2003 (10)	Case report	1	Bilateral jaw	Chest pressure	0.28	Weak
Franco et al., 2005 (11)	Case report	1	Bilateral zygomas/jaw	Chest and arm pain	0.40	Moderate
Franco et al., 2006 (12)	Case report	1	Bilateral jaw and left temporal region	Chest pain	0.32	Weak
Graham & Schinbeckler, 1982 (13)	Case report	1	Left jaw	Chest and arm pain	0.32	Weak
Groah & Menter 1998 (14)	Case report	1	Teeth and jaws	None	0.40	Moderate
Kreiner & Okeson, 1999 (15)	Case report	1	Left mandibular molar	Thoracic and arm pain	0.44	Moderate
Kreiner et al., 2007 (16)	Prospective cohort	186	Upper throat (81.7%), left mandible (45.1%), right mandible (40.8%), left TMJ/ear (18.3%)	Chest, shoulder, back, arm pain	0.49	Moderate
Kreiner et al., 2010 (17)	Prospective cohort	474	Not specified	None explicitly stated	0.69	Strong
Laurent et al., 2010 (18)	Case report	1	Unilateral jaw, forehead, and neck	Chest pain	0.24	Weak
Matson, 1963 (19)	Case report	1	Bilateral mandible, neck, zygoma and temporal areas	None	0.32	Weak
Natkin et al., 1975 (20)	Case report	1	Left maxillary teeth	Chest, shoulder, and back pain	0.36	Moderate
Norman, 1970 (21)	Case report	1	Right mandible	Chest pain	0.28	Weak
Okajima et al., 2007 (22)	Case report	1	Teeth (side not specified)	None	0.44	Moderate
Tzukert et al., 1981 (23)	Case report	3	Bilateral maxillae, jaws, and bilateral mandible	Chest, shoulder, and neck pain	0.44	Moderate

TMJ = temporomandibular joint.

in Kreiner et al. (2010), the lateralization of the referred pain may be a tool utilized to identify its origin (17). Importantly, however, this study did not ask about a history of typical angina symptoms, such as pain provoked by exercise. In addition, although investigators encouraged patients to report “symptoms constituting the main complaint but also any other symptoms” (p. 75), this study may nonetheless have biased patients towards anatomic descriptions of pain with the use of a diagram. Thus, other important symptoms such as dyspnea, diaphoresis, and fatigue were not reported and may not have been assessed in this study.

Limitations

Considering the extensive number of keywords utilized in the database search, it is unlikely that we missed any significant studies in PubMed. Nonetheless, relevant studies may have been unpublished or missing in the PubMed database. A further limitation of this review is that the main results are presented as descriptive synthesis

instead of meta-analysis. However, we decided not to combine the data due to the wide variety of study questions, the varying study designs, and the variable symptom-reporting methodology. Thus, presenting the evidence quantitatively may distort the findings.

Although the methodological instrument used is not entirely comprehensive, it is a previously validated instrument examining high standards of methodology in studies (5). A score of 1.00 would be difficult to attain, but it is unfortunate to find the methodology of the collected studies to be so weak. What this indicates is that, of the available studies, there was a great presence of bias, lack of controls, and overall poor methodological rigor. The lack of comprehensiveness in many of the studies hindered the assessment of their methodological quality.

The studies had a lack of consistency regarding the classification of associated symptoms and whether the tooth, jaw, or facial pain was the sole symptom of the cardiac insufficiency. As an exception, Kreiner et al. (2007) utilized a standard pain symptom assessment

Table 2. Funding Affiliations of Included Studies

Author	Funding Source/Affiliation
Batchelder et al., 1987 (6)	U.S. Air Force, School of Dental Medicine (University of Connecticut)
Christoforidou & Bridger, 2006 (7)	Derriford Hospital (Plymouth, United Kingdom)
Dalband et al., 2011 (8)	Hamadan University of Medicine Sciences(Hamadan, Iran), Dental School Shahid Beheshti University of Medical Sciences (Tehran, Iran)
Drinnan, 1978 (9)	School of Dental Medicine - State University of New York (Buffalo, NY)
Durso et al., 2003 (10)	Federal University of Rio de Janeiro (Brazil)
Franco et al., 2005 (11)	Hospital das Clinicas and Heart Institute - University of Sao Paulo Medical School (Sao Paulo, Brazil)
Franco et al., 2006 (12)	Hospital das Clinicas and Heart Institute - University of Sao Paulo Medical School (Sao Paulo, Brazil)
Graham & Schinbeckler, 1982 (13)	Indiana University School of Dentistry, Wishard Memorial Hospital
Groah & Menter 1998 (14)	Craig Hospital (Englewood, Colorado)
Kreiner & Okeson, 1999 (15)	University of Uruguay (Montevideo, Uruguay), University of Kentucky College of Dentistry (Lexington, Kentucky)
Kreiner et al., 2007 (16)	Universidad de la Republica (Montevideo, Uruguay), The Faculty of Medicine, Umea University(Sweden), Swedish Medical Research Council (Stockholm, Sweden)
Kreiner et al., 2010 (17)	Comision Sectorial de Investigacion Cientifica – Universidad de la Republica (Uruguay), Umea University (Sweden)
Laurent et al., 2010 (18)	Not stated
Matson, 1963 (19)	Bronx Municipal Hospital Center (Bronx, NY)
Natkin et al., 1975 (20)	University of Washington School of Dentistry
Norman, 1970 (21)	United Sheffield Hospitals (Sheffield)
Okajima et al., 2007 (22)	Chiba Prefectural Togane Hospital (Chiba Prefecture, Japan), Chiba Children's Hospital (Chiba Prefecture, Japan), Graduate School of Medicine and School of Medicine (Chiba city, Japan)
Tzukert et al., 1981 (23)	Hebrew University-Hadassah Schools of Dental Medicine and Medicine (Jerusalem, Israel)

(i.e., pictures of the body) at which patients could point (16). However, most other studies provided little information about the procedures used when assessing pain location, even when claiming that jaw, tooth, or facial pain was the sole presenting symptom.

Additional limitations to our study include the lack of randomized controlled trials (RCT) on this topic. However, due to the nature of the topic, an RCT is difficult if not impossible.

Finally, our study utilized only one grader to score the methodology of the studies. Although this investigator is trained in epidemiology, the use of a single grader does not allow for establishment of inter-rater reliability and does not eliminate bias. As with all systematic reviews, publication and selection bias are always a possibility. The use of inclusion and exclusion criteria during the literature search may lessen this possibility.

CONCLUSIONS

Given the prevalence of mortality from cardiac disease throughout the world, identifying atypical presentations of cardiac ischemia is critical. Based on studies from a single group, isolated craniofacial pain occurs in 6% of cardiac ischemia patients and there is a 6:1 ratio of bilateral referral of craniofacial pain of cardiac origin to unilateral, in contrast to odontogenic pain. However, utilizing other available studies, many of weak methodological quality, does not allow for estimation of the frequency of isolated tooth pain as a symptom of cardiac ischemia. Our systematic review did find that the pain of

cardiac origin is often described as “pressure” or “burning.”

Whether cardiac pain presents solely as tooth or jaw pain without other symptoms such as nausea, shortness of breath, or diaphoresis, however, is not as well supported by existing literature. Despite claims to the contrary, it seems plausible that craniofacial pain of cardiac origin is usually accompanied by some of these other symptoms or by a suggestive history such as pain provoked by exercise. However, symptoms other than anatomic site of pain have not yet been properly assessed, nor the completeness of the patient's presenting history well described, in studies of high methodological quality. Thus, a routine electrocardiogram cannot yet be recommended for all patients with tooth or jaw pain, unless that pain is bilateral and is accompanied by other worrisome symptoms or history.

Finally, there is a dearth of studies of strong methodological quality on this topic, and further well-designed studies are needed. In the meantime, health care and dental providers should be aware of the possibility of atypical presentations of cardiac ischemia when assessing patients with tooth, jaw, or facial pain, and should consider asking questions about other more typical cardiac symptoms as well.

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APPENDIX

Methodological Quality Instrument Items by Cho and Bero (5)

	Points
Study Design (out of 5)	
Case report = 1 point	
Time series or uncontrolled experiment = 2 points	
Cohort or case-control studies = 3 points	
Unrandomized control trials = 4 points	
Randomized control trials = 5 points	
Possible responses to following items: Yes = 2 points; Partial = 1 point; No = 0 points; Not applicable	
Was the study question sufficiently described?	
Was the study design appropriate to answer the study question?	
Were both inclusion and exclusion criteria specified? (If case study, check N/A.)	
For case studies only: Were patient characteristics adequately reported? (If not case study, check N/A.)	
Were subjects appropriate to the study question?	
Were control subjects appropriate? (If no controls were used, check No.)	
Were subjects randomly selected from the target population?	
If subjects were randomly selected, was the method of random selection sufficiently well described? (If subjects were not randomly selected, check N/A.)	
If subjects were randomly allocated to treatment groups, was the method of random allocation sufficiently described? (If subjects were not randomly allocated, check N/A.)	
If blinding of investigators to intervention was possible, was it reported? (If not possible, check N/A.)	
If blinding of subjects to intervention was possible, was it reported? (If not possible, check N/A.)	
Was measurement bias accounted for by methods other than blinding?	
Were known confounders accounted for by study design? (If no known confounders, check N/A.)	
Were known confounders accounted for by analysis? (If no known confounders, check N/A.)	
Was there a sample size justification before the study?	
Were post hoc power calculations or confidence intervals reported for statistically nonsignificant results?	
Were statistical analyses appropriate?	
Were the statistical tests stated?	
Were exact values or confidence intervals reported for each test?	
Were attrition of subjects and reason for attrition recorded?	
For those subjects who completed the study, were results completely reported?	
Do the findings support the conclusions?	
TOTAL POINTS FOR STUDY:	
TOTAL POSSIBLE POINTS:	
METHODOLOGIC QUALITY SCORE (0-1):	

ARTICLE SUMMARY

1. Why is this topic important?

Common teaching is that myocardial infarction can present with tooth, jaw, or facial pain as its only symptom. It is unknown how often this occurs in clinical practice.

2. What does this review attempt to show?

This review highlights the prevalence of tooth, face, or jaw pain due to cardiac ischemia in an attempt to make physicians, dentists, and all health care personnel more aware of the possibility of this atypical symptom presentation.

3. What are the key findings?

Tooth pain as the sole symptom of myocardial infarction has been claimed to occur in up to 6% of confirmed cases of myocardial infarction. However, studies that report this statistic are of poor to moderate methodological quality. There is a lack of studies of high methodological quality on this topic.

4. How is patient care impacted?

This review displays the need for physicians, dentists, and all health care personnel to be aware of the possibility that myocardial infarctions can present with tooth, jaw, or facial pain as its sole symptom. Health care providers should consider this possibility when formulating a plan of action for patients presenting with tooth, jaw, or facial pain.