ODONTOGENIC INFECTIONS AND CARDIORESPIRATORY COMPLICATIONS

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ABSTRACT

Odontogenic infections are common conditions in clinical dental practice, originating from inflammation of dental and periodontal tissues, with the potential to spread to adjacent structures and cause systemic infections. Among systemic complications, those affecting the cardiorespiratory system are particularly relevant, ranging from infective endocarditis to lung abscesses. The present study seeks to understand the relationship between these infections and systemic complications, especially those that affect the cardiovascular system and infections, contribute to the prevention, diagnosis and treatment of these conditions. A literature review was carried out in the Scielo, PubMed and Google Scholar databases to contribute to the process of systematizing and analyzing the results of other publications, with the aim of understanding the topic through independent studies. The results highlight a significant manifestation between odontogenic infections and complications in the cardiorespiratory system. Odontogenic infections are directly associated with cardiorespiratory complications, which reinforces the importance of a preventive approach and early diagnosis

Keywords: *Oral health; odontogenic bacteremia; systemic complications.*

1 INTRODUCTION

Odontogenic infections are common conditions in clinical dental practice, arising from inflammations of dental and periodontal tissues, with the potential to spread to adjacent structures. These infections constitute a considerable public health concern due to their inherent severity and associated systemic effects (Kumar *et al*., 2018). Among the associated systemic complications, those affecting the cardiorespiratory system are particularly significant, ranging from infectious endocarditis to pulmonary abscesses.

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The relationship between odontogenic infections and cardiorespiratory complications has been increasingly studied within the scientific community, as it has demonstrated an association between dental infections, such as periodontitis and periapical disease, and an increased risk of developing cardiovascular conditions such as atherosclerosis, myocardial infarction, stroke, and infectious endocarditis (Goulart *et al*., 2017). Additionally, there is evidence suggesting an association between odontogenic infections and systemic respiratory complications (Weise *et al*., 2019).

Investigating the relationship between odontogenic infections and cardiorespiratory complications, as well as exploring strategies for prevention, diagnosis, and treatment of these conditions, is of utmost importance in the realm of public health (Ekici, O., 2023). Given the relevance of the topic, this study aims to review the scientific literature on the relationship between these infections and cardiorespiratory complications, addressing their pathophysiological mechanisms, main clinical outcomes, and strategies for prevention and treatment. By elucidating this relationship, the study seeks to reinforce the importance of early diagnosis and an interdisciplinary approach in the management of these infections.

2 MATERIALS AND METHODS

This study is a qualitative exploratory research aimed at correlating odontogenic infections with their complications in the cardiorespiratory system, by analyzing data available in the most current literature on the subject. A literature review was conducted to contribute to the process of systematizing and analyzing the results of other publications, with the goal of understanding the topic through independent studies. The strategy for identifying and selecting articles involved searching for indexed publications in open-access databases available online, such as Scielo, PubMed, and Google Scholar, between February and July 2024. The criteria for article selection included publications with abstracts and full texts available for analysis, published in Portuguese, English, or Spanish, between 2009 and 2024, and articles that contained the following Health Sciences Descriptors (DeCS) in their titles and/or abstracts: "Odontogenic Infections"; "Cardiorespiratory Complications"; "Oral Health"; "Odontogenic Bacteremia"; "Systemic Complications." Articles that did not meet the above inclusion criteria were excluded. From this review, an article will be produced

for discussion, following a thorough analysis and comparison with the existing literature on the topic. The articles obtained in the survey were analyzed through careful reading, highlighting those that addressed the objective of this study, in order to organize and tabulate the data.

3 BACTERIAL INFECTIONS IN THE HEAD AND NECK REGION: A DETAILED ANALYSIS

Bacterial infections in the head and neck region represent a significant concern, with more than 90% of these infections traced to an odontogenic origin (Vilén *et al*., 2023). In rare cases, these infections can progress to sepsis, posing a life-threatening risk to the patient. Vilén *et al*. (2023) highlight that risk factors such as diabetes mellitus, obesity, chronic alcohol and nicotine abuse, rheumatism, and poor oral hygiene can increase susceptibility to severe odontogenic infections.

Retrospective analyses have revealed that severe odontogenic infections can spread across multiple maxillofacial and cervical regions, often accompanied by septic laboratory signs. These patients require intensive care and immediate surgical treatment, including incision, drainage, and intraoperative and postoperative irrigation. Additionally, the results of intraoperative swabs have shown a polymicrobial spectrum of aerobic and anaerobic bacteria typical of oral flora, particularly anaerobes and streptococci, such as *Streptococcus viridans* (Vilén *et al*., 2023).

On the other hand, previous studies (Weise *et al*., 2019) support the importance of early and appropriate treatment of odontogenic infections. They emphasize that the combination of surgical debridement, incision, drainage, and antibiotic therapy generally yields good outcomes. Furthermore, they highlight that common pathogens in odontogenic infections include *Streptococcus viridans* and *Prevotella* species, a gram-negative anaerobic bacterium (Weise et al., 2019).

A comparative analysis between the studies underscores the need for an interdisciplinary and personalized approach to the treatment of bacterial infections in the head and neck region. While Vilén *et al*. (2023) emphasize the severity of severe odontogenic infections and the importance of immediate surgical intervention, Weise *et al*. (2019) highlight the effectiveness of a combination of surgical debridement and antibiotic therapy. Both studies stress the importance of controlling and preventing risk

factors, as well as the appropriate selection of antibiotics based on antibiogram results for effective treatment of these infections.

These findings underscore the ongoing need for research and interdisciplinary collaboration to improve treatment and prevention protocols for bacterial infections in the head and neck region, thereby reducing their associated morbidity and mortality.

4 PERIODONTAL DISEASES AND INFECTION

4.1 PATHOGENESIS OF PERIODONTAL DISEASES

Periodontal diseases, such as gingivitis and periodontitis, are the primary causes of odontogenic infections, with their pathogenesis associated with the presence of microorganisms in the oral cavity. The formation of dental plaque is a crucial factor in this process, with bacteria like *Prevotella intermedia* playing a significant role. Periodontal diseases are infectious, chronic, and asymptomatic, resulting from the action of bacteria on the supporting tissues of the teeth (Soares *et al*., 2022). When the oral microbiota becomes imbalanced, it can become pathogenic, leading to periodontal and dental changes with the potential to cause systemic infections (Affonço *et al*., 2022).

The presence of anaerobic and periodontopathogenic microorganisms, such as *Porphyromonas gingivalis, Tannerella forsythia*, and *Treponema denticola* in the dental biofilm, contributes to subgingival inflammatory stages characteristic of periodontitis (Campos *et al*., 2023). Moreover, the destruction of periodontal tissues by periodontitis facilitates the entry of bacteria and inflammatory mediators into the body, potentially resulting in systemic complications such as cardiovascular diseases, hypertension, respiratory problems, and diabetes (Larvin *et al*., 2020).

In addition to microorganisms, genetic factors also play an important role in the development of periodontal diseases. According to recent studies, shared genetic loci between atherosclerotic cardiovascular diseases and periodontitis have been identified, highlighting the influence of genes on susceptibility to these conditions. The interaction between periodontal inflammation and dysbiosis in dental plaque is fundamental to understanding the pathobiology of periodontitis (Loos; Dyke, 2020).

4.2 CARDIORESPIRATORY COMPLICATIONS

Periodontal disease has been increasingly associated with cardiovascular dysfunctions. Microorganisms such as *Staphylococcus aureus*, *Streptococcus viridans*, and *Streptococcus milleri*, commonly found in periodontitis, are frequently linked to systemic inflammation and vascular damage (Silva, P. C. P. *et al*., 2022). The periodontal pocket acts as a chronic infectious and inflammatory focus, favoring the proliferation of oral bacteria and facilitating their entry into the bloodstream, especially after dental procedures. This transient bacteremia may allow pathogens to reach compromised heart valves, the endocardium, and vascular tissues.

The inflammatory response induced by periodontal microorganisms leads to the release of chemical mediators such as tumor necrosis factor-alpha (TNF-α), interleukins (ILs), and prostaglandin E2 (PGE2), which contribute to endothelial dysfunction and atherosclerosis progression (Silva, P. C. P. *et al*., 2022). In chronic stages, systemic dissemination of oral pathogens can play a role in the development of cardiovascular diseases, including atherosclerosis, peripheral arterial disease, and myocardial infarction, as well as other complications such as angina and sinusitis (Vigilato; Schwingel, 2023).

Myocardial infarction remains one of the most severe cardiovascular events, with studies suggesting a possible association between oral infections and increased vascular risk, particularly in the first weeks following invasive dental procedures. Although oral conditions alone may not be sufficient to cause infarction, they can act as contributing risk indicators (Vigilato; Schwingel, 2023).

Endothelial dysfunction, a key element in atherogenesis, results from impaired vasodilation and inflammatory activation, fostering monocyte adhesion and reactive oxygen species production. Periodontal pathogens have been detected in vascular endothelium, reinforcing their potential role in vascular injury and systemic inflammation (Vigilato; Schwingel, 2023).

Infective endocarditis, characterized by vegetations formed by bacteria, platelets, and fibrin on heart valves, can originate from odontogenic bacteremia. This condition presents high morbidity and mortality and predominantly affects individuals

with predisposing factors such as native valve disease, prosthetic valves, or intravenous drug use. Early dental intervention and antibiotic prophylaxis are essential in at-risk patients (Souza *et al*., 2023).

Peripheral arterial disease, mainly caused by atherosclerosis, is also significantly associated with periodontal disease. Studies demonstrate that individuals with periodontitis have a markedly higher risk - up to 5.842 times - of developing peripheral vascular disease, even after adjusting for confounding factors such as age, diabetes, and hypertension (Vigilato; Schwingel, 2023).

These findings underscore the critical role of oral health in the prevention of cardiovascular morbidity, highlighting its relevance beyond the confines of localized oral conditions. Given the systemic repercussions of periodontal infections, it becomes imperative to deepen the understanding of the biological mechanisms through which oral pathogens exert influence on distant organ systems. In this regard, the dissemination of microorganisms from periodontal sites and their systemic inflammatory impact serves as a pivotal link between oral and systemic health. This perspective provides the foundation for the subsequent discussion on the association between periodontitis and cardiorespiratory diseases, emphasizing the bidirectional relationship between oral infections and systemic pathophysiological processes.

4.3 CARDIORESPIRATORY DISEASES AND PERIODONTITIS

To analyze the relationship between periodontal diseases and systemic infections, it is crucial to consider how bacteria from the oral cavity can enter the bloodstream and cause inflammation in other organs. Periodontitis can lead to the dissemination of pathogenic bacteria into the bloodstream, a phenomenon known as bacteremia. These bacteria can reach other organs and trigger inflammatory responses, contributing to the development of systemic infections (Del Giudice *et al*., 2021).

In the context of cardiovascular diseases, the relationship between periodontitis and atherosclerosis, myocardial infarction, and stroke has been investigated. The inflammation caused by periodontal infection plays a significant role in the development of these cardiovascular conditions. The presence of pathogenic bacteria

in the mouth can trigger systemic inflammatory responses that contribute to the progression of atherosclerosis and increase the risk of adverse cardiovascular events (Mohammad;Thiemermann, 2021).

Additionally, the association between periodontitis and respiratory diseases, such as pneumonia and chronic obstructive pulmonary disease (COPD), is also relevant. The literature shows that bacteria present in the oral cavity can be inhaled and reach the lungs, exacerbating pre-existing respiratory conditions. The dissemination of periodontal pathogens to the lungs can trigger local inflammatory responses, contributing to the progression of respiratory diseases.

5 THE DISSEMINATION OF ODONTOGENIC INFECTIONS AND THEIR SERIOUS IMPLICATIONS: SURROUNDING MUSCLE AND ITS FACIAL ATTACHMENTS

The spread of odontogenic infections is a critical process that involves the propagation of the infection through the alveolar bone and its extension into the surrounding muscle and facial attachments. Odontogenic infections follow the path of least resistance, traversing the outer cortex of the alveolar bone. Typically, the apices of the dental roots are positioned above the muscle attachment. When the infection penetrates the alveolar bone, it usually presents as an abscess in the vestibular space and, in some cases, in the buccal space (Hupp, J. R., 2020).

After eroding through the bone, the infection can manifest in various locations, depending on the thickness of the underlying bone and the relationship of the muscle attachments to the site of perforation. The infection can spread from the primary fascial spaces to the secondary or deeper fascial spaces of the neck, significantly increasing the risk of severe complications. The spread to the deep fascial spaces is associated with significant morbidity and, in severe cases, can result in fatalities due to the substantial risk of infection in the cardiorespiratory pathways. Early diagnosis and rapid intervention are essential to prevent these severe and potentially fatal complications (Hupp, J. R., 2020).

Furthermore, the relationship between periodontal diseases and systemic infections, including cardiovascular and respiratory diseases, highlights the importance of oral health for the overall homeostasis of the body. Periodontal diseases have been

associated with systemic infections, and understanding the mechanisms by which oral bacteria can cause inflammation in other organs is fundamental for developing effective prevention and treatment strategies. Maintaining oral health is, therefore, crucial not only to prevent local complications but also to improve overall bodily health (Cullinan *et al*., 2009).

Developing effective prevention and treatment strategies for oral health is essential to prevent local and systemic complications, contributing to the improvement of general health. The spread of odontogenic infections and their serious implications underscore the importance of proper dental care in preventing severe infections and promoting overall health.

6 NON-PHARMACOLOGICAL TREATMENT

Non-pharmacological treatment for periodontal diseases with possible cardiovascular and respiratory complications has gained attention due to the association between chronic periodontal inflammation and systemic conditions. Periodontal pathogens can enter the bloodstream, contributing to atherosclerosis and increasing the risk of respiratory diseases through aspiration of oral microorganisms (Medeiros; Lins; Lemos, 2017). In this context, the search for alternative therapeutic approaches has grown, with Photodynamic Therapy (PDT) and Photobiomodulation Therapy (PBMT) emerging as promising strategies for the treatment of periodontitis.

6.1 USE OF PHOTODYNAMIC THERAPY (PDT)

Photodynamic Therapy (PDT) is a therapeutic approach that utilizes a photosensitizing dye activated by a specific light source, generating reactive oxygen species that promote the destruction of periodontopathogenic microorganisms. According to Medeiros; Lins; Lemos (2017), this technique has been proposed as an adjunct to conventional periodontitis treatment, as it does not induce microbial resistance and is a low-cost and painless alternative.

The mechanism of action of PDT is based on the combination of the dye with light, which triggers chemical reactions leading to the formation of highly reactive free radicals, ultimately causing cell lysis and bacterial death (Ribeiro *et al*., 2023). Studies

indicate that this therapy can effectively reduce probing depth and gingival bleeding index in patients with chronic periodontitis (Ribeiro *et al*., 2023). Moreover, its applicability extends beyond periodontitis, showing promising results in the treatment of peri-implant infections and severe periodontal lesions, contributing to a reduced inflammatory response and improved tissue healing (Ribeiro *et al*., 2023).

6.2 USE OF PHOTOBIOMODULATION THERAPY (PBMT)

Photobiomodulation Therapy (PBMT) utilizes low-intensity light to stimulate biological processes, promoting tissue recovery and modulating the inflammatory response. Ribeiro *et al*. (2023) conducted an integrative review highlighting its effectiveness in reducing bacterial load and improving clinical parameters of periodontitis. The mechanism of action of PBMT involves the interaction of emitted light with cell mitochondria, stimulating ATP production and enhancing the anti-inflammatory response, which leads to pain reduction and accelerated healing (Chen *et al*., 2020). Clinically, PBMT has been shown to provide significant benefits when used as an adjunct therapy to scaling and root planing, improving bleeding indices and clinical attachment levels (Gandhi *et al*., 2019). Additionally, its applicability extends beyond periodontitis, with successful use in the treatment of temporomandibular disorders, oral mucositis, and postoperative pain relief in periodontal surgeries (Gandhi *et al*., 2019).

7 PHARMACOLOGICAL TREATMENT

The pharmacological treatment of odontogenic infections is a topic of great importance in dentistry, particularly due to the complications that can arise from inadequately treated infections. This paper reviews the existing literature to provide a comprehensive overview of the most commonly used antibiotics, their indications, and their efficacy in treating odontogenic infections.

The study by Souza *et al*. (2023) highlights that amoxicillin is one of the most commonly prescribed antibiotics for odontogenic infections due to its broad spectrum of action and low bacterial resistance. The combination of amoxicillin with clavulanate is frequently used to enhance efficacy against beta-lactamase-producing bacteria

(Souza et al., 2023). In a study conducted by Lima *et al*. (2022), clindamycin was observed to be an effective alternative for patients allergic to penicillin. The study emphasizes that clindamycin has excellent tissue penetration and is effective against a wide range of anaerobic pathogens present in odontogenic infections (Lima *et al*., 2022).

Ferreira *et al*. (2021) investigated the efficacy of different antibiotic regimens and concluded that the early administration of appropriate antibiotic therapy can significantly reduce the duration and severity of odontogenic infections. The study stresses that the choice of antibacterial medication should be based on the microbiological profile of the infection (Ferreira *et al*., 2021). According to Santos *et al*. (2023), metronidazole is often used in combination with other antibiotics to treat severe odontogenic infections, especially those with significant anaerobic components. The study suggests that this combination is highly effective in reducing the complications associated with these infections (Santos *et al*., 2023).

The articles reviewed indicate that the pharmacological treatment of odontogenic infections should be well-targeted and based on precise microbiological assessment. Amoxicillin, often in combination with clavulanate, is the antibiotic of choice due to its broad spectrum of action. However, alternatives such as clindamycin and metronidazole are essential for specific cases, such as in penicillin-allergic patients or resistant infections (Souza *et al*., 2023; Lima *et al*., 2022; Ferreira *et al*.., 2021; Santos *et al*., 2023).

The literature review demonstrates that the appropriate selection of antibiotics is crucial for the effective treatment of odontogenic infections. Amoxicillin, clindamycin, and metronidazole are all important in the therapeutic arsenal against these infections, and the choice of antibiotic regimen should be guided by detailed microbiological and clinical evaluation.

8 SURGICAL TREATMENT OF DENTAL INFECTIONS

The surgical treatment of infections, particularly severe conditions such as Ludwig's angina and cervical necrotizing fasciitis, is a critical area in medicine due to its direct impact on patient survival. Ludwig's angina is a rapidly progressing and often fatal gangrenous cellulitis affecting the neck and floor of the mouth. The management

of this condition requires a team trained in surgery, antibiotic therapy, and resuscitative measures (Vallée, M. *et al*., 2020). Early identification and immediate surgical debridement are crucial for the prognosis of these patients.

The typical treatment for Ludwig's angina involves surgical decompression of the sublingual, submental, and submandibular regions, often necessitating a tracheostomy to ensure airway patency. The technique includes external incisions and drainage, with nasotracheal intubation under flexible endoscopy in seated patients, anticipating the possible need for an emergency surgical airway (Sonar *et al*., 2023). The administration of broad-spectrum antibiotics is essential to combat polymicrobial infections, typically involving streptococci and anaerobic bacteria (Sonar *et al*., 2023).

Cervical necrotizing fasciitis, also associated with Ludwig's angina, requires multiple surgical interventions for drainage and excision of necrotic tissues, which is essential for the efficacy of antibiotics and eventual recovery (Vallée, M. *et al*., 2020). Studies indicate that optimal surgery, which drains all collections and removes all necrotic tissues, is necessary for the effectiveness of antibiotics (Medeiros *et al*., 2020).

Managing these conditions depends not only on surgery but also on interdisciplinary coordination among physicians, emergency teams, and dentists, particularly in cases involving odontogenic infections. Integration among these professionals is crucial to providing comprehensive and effective patient care (Perez *et al*., 2020).

Both Ludwig's angina and cervical necrotizing fasciitis are severe surgical emergencies that require prompt and multidisciplinary treatment. Success in managing these conditions is directly related to early surgical intervention, appropriate antibiotic use, and the experience of the medical team involved (Vallée, M. *et al*., 2020; Sonar *et al*., 2023; Medeiros *et al*., 2020; Perez *et al*., 2020).

9 CONCLUSION

The treatment of periodontal diseases and odontogenic infections is a crucial area within dentistry, particularly due to the potential systemic complications, such as cardiovascular and respiratory diseases. The reviewed literature demonstrates that both pharmacological and non-pharmacological approaches play key roles in managing these conditions.

Photodynamic Therapy (PDT) and Photobiomodulation Therapy (PBMT) have shown great potential as adjunctive therapies in the treatment of periodontitis, by promoting the reduction of periodontal pathogens and modulating the inflammatory response, contributing to the recovery of periodontal tissue and improvement of clinical parameters. Both therapies have shown significant benefits, such as reducing probing depth and gingivitis, and provide a non-invasive approach without inducing bacterial resistance.

In the pharmacological realm, the use of antibiotics like amoxicillin, clindamycin, and metronidazole remains essential in treating odontogenic infections. The combination of amoxicillin with clavulanate, in particular, has proven highly effective due to its broad spectrum of action, and alternatives like clindamycin are highlighted for penicillin-allergic patients or resistant cases. The careful selection of antibiotic regimens, based on microbiological and clinical evaluation, is crucial to ensuring effective treatment and minimizing complications.

Surgical treatment, especially in severe cases of odontogenic infections such as Ludwig's angina and cervical necrotizing fasciitis, requires a multidisciplinary approach. Early intervention and immediate surgical debridement are critical for prognosis, emphasizing the importance of coordination between dentists, physicians, and emergency teams.

In conclusion, the combination of pharmacological therapies, such as the proper use of antibiotics, with innovative non-pharmacological strategies like PDT and PBMT, offers a more effective and safer treatment for periodontal diseases and odontogenic infections. Advancements in the understanding of these approaches and their clinical application are essential to optimizing therapeutic outcomes and reducing the risk of systemic complications associated with these conditions. Continued research and development of new therapeutic protocols will undoubtedly contribute to the evolution of these treatments, providing patients with improved quality of life and satisfactory clinical results.

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