

## Medical-dental considerations in the care of children with facial cellulitis of odontogenic origin. A disease of interest for pediatricians and pediatric dentists

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### ABSTRACT

An odontogenic infection is a polymicrobial, mixed infection (aerobic and anaerobic bacteria). It comprises various clinical conditions, whose importance varies depending on their frequency and potential severity. It is the most common type of oral infection and its treatment involves up to 10% of all antibiotic prescriptions. Facial cellulitis is a diffuse inflammation of soft tissue that is not confined or limited to a specific region and tends to spread. The objective of this review is to update the aspects considered in the care of children with facial cellulitis of odontogenic origin and the multidisciplinary management between dentists and pediatricians.

**Key words:** facial cellulitis of odontogenic origin, care, child.

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### INTRODUCTION

Most oral infections are usually of odontogenic origin and take place at a local, confined level, but they may sometimes spread by direct continuity and access deep tissue or, more rarely, spread via hematogenous or lymphatic routes and reach distant organs, which results in more severe processes.<sup>1</sup>

Cellulitis of odontogenic origin is an acute, deep, and diffuse inflammation of the subcutaneous tissue that spreads through the spaces between the tissue cells to several anatomic regions, tissue spaces, and throughout the aponeurotic plane because of the infection of one or several teeth or due to dental

or supportive tissue-associated pathologies.<sup>2</sup>

It has various clinical presentations, from a harmless, isolated process to a progressive, diffuse clinical condition that may cause complications. If cellulitis is detected at an early stage, it usually has a soft and smooth consistency with inflammatory signs, its edges are poorly-defined and, sometimes, the underlying epidermis is not raised up. In the advanced stage, the area is indurated.<sup>2</sup>

The intraoral examination includes assessing the level of mouth opening, which may be restricted by the presence of pain and trismus. The clinical characteristics include cleft effacement and tooth mobility or extrusion.<sup>2</sup>

The general symptoms of head and neck infections vary. Sepsis presents with apathy, weakness, discomfort, fever spikes, sweating, thready pulse, leukocytosis and, sometimes, marked secondary anemia. Muscle spasm or immobilization of adjacent muscles causes trismus, torticollis, and stiffness. Neural involvement causes pain in the affected sensory nerve and motor nerve paralysis. Dysphagia, dysphonia, and aphonia may also occur, depending on the site of infection.<sup>1</sup>

The treatment of facial cellulitis of odontogenic origin in children depends on the patient's general status and the course of the clinical condition. The main objective is to control and eliminate the causative agent, which, in some cases, requires the specialized care of a pediatrician and hospital management.<sup>3</sup>

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## ETIOLOGY

The etiopathogenesis of facial cellulitis of odontogenic origin is an illness in the dental and periodontal structures. The main cause is a dental cavity that was not treated in time, which compromises the pulp, in general, pulp necrosis of the affected dental structure.<sup>2</sup> It is conditioned by two factors: the great virulence of the causative agent and the immunocompromised status of the patient.<sup>3</sup>

Odontogenic infections are frequent in the pediatric population, especially among children younger than 6 years and, most commonly, boys. In this regard, the prevalence of facial cellulitis has increased in the past decades. Establishing the primary infection site and the causative agents may be challenging due to the proximity of the intimal layer, teeth, salivary glands, sinuses, and ear canal. The microbial flora and the site of origin of the infection may vary and should be determined so that the most effective treatment regimen may be instituted. Facial cellulitis of odontogenic origin in children is similar to that in adults; however, pediatric patients deserve special considerations due to their acute course resulting from the easy dissemination to deep spaces.<sup>4</sup>

The local immune system of the oral mucosa plays a key role in the body's defense mechanisms. A large number of immunocompetent mononuclear cells have been found on the surface of oral mucosa. B and plasma cells, with the help of some T cells, are responsible for immunoglobulin synthesis at a local level: IgA, IgE, and small amounts of IgG and IgM, regardless of the systemic immune system. These immunoglobulins are part of the first line of defense of the oral mucosa.<sup>5</sup>

In the case of microbial aggression against the tissue, non-specific mechanisms react by causing an inflammatory response. These include the release of mediators, vascular changes (vasodilation and vasopermeability), cell exudate, and leukocyte activation, mainly polymorphs. If such inflammatory reaction continues, mononuclear cells (monocytes and lymphocytes) develop and granulation tissue forms subsequently.<sup>5,6</sup>

In the inflammatory process, the condition may be complicated depending on the relevance of the microbial aggression and the body's defense ability. This may cause a systemic inflammatory response which, sometimes, leads to septic shock, multiple organ failure, and finally, death.<sup>6</sup>

## Microorganisms involved in facial cellulitis of odontogenic origin

If conditions are favorable (certain metabolic circumstances, mucosal injury, immunocompromise, microbial ecosystem imbalance, etc.), oral commensal microorganisms may turn into opportunistic pathogens. Therefore, the bacteria isolated in an odontogenic infection are the same that make up the microbiota.<sup>6</sup>

Oral infections may be bacterial, fungal, or viral. Odontogenic infections tend to be mixed (aerobic and anaerobic bacteria), although anaerobic microorganisms prevail.<sup>7-10</sup>

The most common microorganisms involved are *Streptococcus*-like facultative Gram-positive aerobic organisms and strict Gram-negative organisms such as *Prevotella*, *Porphyromonas* and *Fusobacterium*.<sup>11</sup>

The most common bacterial agents involved in odontogenic infections are *Streptococcus mutans* (24.5%), *Porphyromonas gingivalis* (23.6%), and *Porphyromonas endodontalis* (18.2%). Depending on virulence factors, bacterial metabolism, and the patient's nutritional requirements, the most relevant causative agents are *Streptococcus salivarius* (10.1%) and *Streptococcus sanguis* (8.2%).<sup>12,13</sup>

On their side, Leitao, Pedemonte, and Basili, in their study on microbial action in children and adults, found differences in orofacial infections caused by pulp necrosis in both groups. They reported that aerobic infections were significantly more common in children (20%) compared to adults (10%), that anaerobic infections were significantly more frequent in adults (40%) and nonexistent in children (0%), and that mixed infections predominated in both groups (children: 75%; adults: 45%).<sup>12-14</sup>

Another microorganism involved in facial cellulitis of odontogenic origin in children is *Streptococcus pyogenes*, sometimes in association with other microorganisms present in the oral bacterial flora.<sup>15</sup>

The following factors contribute to infection dissemination:

### General factors

- Reduced immunity: bacterial growth and dissemination are faster in the case of systemically compromised patients (e.g., those with uncontrolled diabetes), whose resistance is reduced, even if the number of microorganisms is not high and their virulence, insignificant.<sup>16</sup>

- Virulence: it depends on the microorganism's qualities, which favor invasiveness through the production of lytic enzymes, endotoxins, and exotoxins.<sup>16</sup>
- Number of bacteria: it is important because, in the primary source of infection, it affects the size of the infection; at the same time, it increases the ability to defeat the host's defense mechanisms and the level of toxic substances.<sup>16-18</sup>

#### Local factors

- The alveolar bone is the primary local barrier. The infection spreads radially and subsequently relates to the periosteum, which is more developed in the mandible than in the maxilla. In most cases, the infection spreads to the underlying soft tissue; the anatomical disposition of muscles and aponeuroses determines the next infection site.<sup>16</sup>

#### Potential complications if facial cellulitis of odontogenic origin is not treated adequately

Most odontogenic infections are usually managed adequately with few complications; however, if they disseminate, they may cause severe complications, including death.<sup>8</sup>

These include odontogenic sinusitis, periorbital infections, cavernous sinus thrombosis, bacterial endocarditis, Ludwig's angina, cervicofacial necrotizing fasciitis, brain abscess, meningitis, mediastinitis, septicemia, gangrenous encephalitis, gangrenous pneumonia, thrombophlebitis of the jugular veins, edema of glottis.<sup>17,18</sup>

The complications of this pathology will directly depend on the patient's general status and immune system, and the presence or absence of a systemic disease, which may worsen the process. Facial cellulitis of odontogenic origin in children is characterized by the speed of the septic process induced by the extent of the medullary spaces, which is life-threatening. It may cause seizures and high fever with brain damage. The child may have dehydration depending on his/her own characteristics. In addition, skeletal growth centers may be affected.<sup>18</sup>

Patients may be referred to a hospital for specialized medical-surgical care if any of the following criteria is observed: rapidly progressing cellulitis, dyspnea, dysphagia, dissemination to deep spaces, fever higher than 38 °C, severe trismus of the temporomandibular joint (TMJ), patients who do not collaborate or are unable

to follow an outpatient treatment on their own, initial treatment failure, severe general status compromise, and immunocompromised patients.<sup>12,19</sup>

Some patients have been reported to have diffuse odontogenic infections, which leads to sepsis, including the mediastinum, and liver disease in those with immunocompromising conditions.<sup>20,21</sup>

In a pediatric patient, the infection may not be confined to the local tissues and spread through the less resistant route, therefore affecting the superficial maxillofacial spaces in the first place and even compromising deep anatomical spaces. For this reason, it is necessary for health care providers and dentists to know how to manage odontogenic infections in children so as to avoid complications, if possible.<sup>22</sup>

Some of the complications account for a higher life threatening risk for the patient, such as cavernous sinus thrombosis, which may be caused by an infectious or non-infectious process.<sup>22</sup>

In severe infections of the mediastinum, only a timely diagnosis and treatment may reduce the high mortality rate of this disease. Necrotizing mediastinitis is mostly caused by oropharyngeal infections, especially those of odontogenic origin.<sup>23-26</sup>

Another severe complication is *Streptococcus pyogenes* necrotizing fasciitis, which implies a surgical emergency with a higher mortality rate among children due to its rapid progression to shock and multiple organ failure. The challenge posed by this disease is making an early diagnosis, since it is usually confused with a mild soft tissue infection.<sup>27</sup>

Last, but not least, other severe complications include periorbital infections, which may result from an infection of the maxilla that spreads directly, although the hematogenous route is also a possibility. The orbit is a partially closed anatomical structure with thin walls, no deep lymphatic system, and valveless veins. An orbital infection that is misdiagnosed and inadequately treated may lead to cavernous sinus thrombosis and spread and cause thrombophlebitis of adjacent veins, leading to eyeball tenderness, hyperthermia, eye pain, ptosis, etc.<sup>28-30</sup>

#### Multidisciplinary management of facial cellulitis of odontogenic origin in children

The treatment of facial cellulitis of odontogenic origin in children depends on the patient's general

status and the course of the clinical condition. To treat and resolve the infection, it is necessary to take the patient's history, make an adequate diagnosis, recognize the causative agent, and, in this case, identify the tooth that is considered the main source of infection. The corresponding diagnostic methods should be used, including periapical and panoramic X-rays, an extraoral and intraoral clinical examination of the patient, assessment of the patient's general condition and, in some cases, a computed tomography and soft tissue ultrasound.<sup>1,31</sup>

Not all odontogenic infections require antibiotic therapy; it depends on the infection characteristics. In general, if a child has odontogenic cellulitis, most parents are unaware of its etiology, and for this reason, the child is referred to a health care center for the corresponding diagnostic tests to look for the cause of infection.<sup>11</sup>

Treatment is based on two essential principles: elimination of the underlying cause and local draining or debridement together with the use of oral or parenteral antibiotics.<sup>12</sup>

If a local infection remains untreated, it may spread to the upper or lower regions of the face.<sup>32-34</sup> Children have special characteristics that increase their chances of this occurring. Their general anatomical and physiological characteristics are highly variable due to the wide age range of patients seen in pediatric dentistry.<sup>35</sup>

From a local perspective, the maxillae of children also display different anatomical characteristics. The presence of tooth germs, the larger amount of cancellous bone with wider medullary spaces, and the presence of bone growth centers make infections spread more rapidly in children than in adults. The pediatric dentist should consider the patient's clinical course and pay attention to the warning signs that may indicate the need for hospitalization.<sup>36</sup>

Hospital management is indicated for patients who have more than two aponeurotic spaces affected, those who cannot tolerate oral therapy, and those whose infection cannot be managed in the outpatient clinic.<sup>1,35</sup>

The following are the hospitalization criteria for a child or adolescent with odontogenic cellulitis:

- General status compromise and/or immunocompromised patient, e.g., a subject with diabetes, malnutrition, human immunodeficiency virus (HIV), etc.
- Rapidly progressing cellulitis.

- Time elapsed, in general, more than 24 hours.
- Cellulitis spreading to deep facial spaces.
- Upper airway involvement (parapharyngeal, pretracheal, retropharyngeal spaces).
- Fever higher than 38 °C, dyspnea and/or dysphagia and/or severe trismus restricting mouth opening to less than 10 mm.
- A patient or family who do not collaborate or are unable to follow the prescribed outpatient treatment.
- Initial treatment failure.

If during the dental examination, it is determined that the patient meets the criteria for hospitalization, a pediatrician should be consulted for an assessment, to stabilize the patient and reinstate medical and nutritional support, administer fluids and electrolytes, and start antibiotic therapy and analgesia depending on the affected tissue.<sup>36</sup>

From a dental perspective, priority should be given to local treatment in the case of odontogenic infections that affect either the primary teeth of children or the permanent teeth of adolescents. This consists in opening the affected tooth for dental drainage, with or without root canal cleaning, to allow pus content, if any, to drain. If no local treatment is implemented and only antibiotics are given, the infection virulence will be reduced but it may flare-up once the medication is discontinued.<sup>37</sup>

Once the acute odontogenic infection is resolved, definite treatment should be decided: either keep the tooth with a non-vital pulpectomy plus definite restoration or dental extraction; this will depend on X-ray findings.<sup>37</sup>

Historically, beta-lactam antibiotics have been the first line treatment for odontogenic infections. Crystalline penicillin G (parenteral) and penicillin V (oral) are highly effective because most bacteria are sensitive to them; however, *Prevotella*, *Bacteroides*, and other microorganisms produce penicillin-resistant enzymes. In this setting, inhibitor-associated aminopenicillins (amoxicillin/clavulanic acid and ampicillin/sulbactam) are the first therapeutic option in most dental infections and related complications, as long as the patient does not have penicillin hypersensitivity.<sup>3</sup>

There is another classification for the hospitalization of children and adolescents with odontogenic infections:

1. Mild odontogenic infections: oral amoxicillin + clavulanic acid.<sup>38</sup>
2. Cellulitis and parulides: oral amoxicillin +

clavulanic acid (if oral treatment shows no response or the infection progresses rapidly, intravenous clindamycin is an alternative for treatment).<sup>38</sup>

3. Severe facial cellulitis: intravenous amoxicillin + clavulanic acid at 100 mg/kg/day.

In some countries, clindamycin is not available as oral solution, which is a problem in the setting of pediatrics and pediatric dentistry; for this reason, parenteral clindamycin could be administered to patients with penicillin hypersensitivity.<sup>37,38</sup>

## CONCLUSIONS

An early and adequate diagnosis of facial infections of odontogenic origin by the primary care pediatrician, an appropriate antibiotic use, and dental treatment are key for the rapid resolution of this condition. Essentially, patients with rapidly progressing facial cellulitis of odontogenic origin, trismus, general status compromise or oral antibiotic therapy failure should be referred for hospitalization. A timely diagnosis and hospital management may prevent severe complications.

It is imperative to have a pediatric dentist available at the hospital due to the high prevalence of this type of conditions and the complications that may develop if not managed adequately.

Further studies on this topic are required and it is necessary to insist on oral hygiene and periodic dental exams, which are essential to prevent and treat dental cavities and periodontal disease and avoid their progression. ■

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