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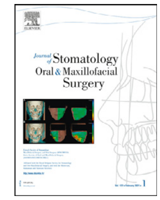

Review

Brain complications from odontogenic infections: A systematic review

Luis Felipe Burgos-Larraín[a,b], Álvaro Vázquez-Portela[a,c], Carlos M. Cobo-Vázquez[d,e,*], Luis Miguel Sáez-Alcaide[e], Luis Sánchez-Labrador[e], Cristina Meniz-García[d]

[a] Department of Clinical Specialities, Faculty of Dentistry, Complutense University of Madrid, Spain
[b] Concepción University, Chil
[c] San Pablo-CEU University, Madrid, Spain
[d] Department of Clinical Specialities, Faculty of Dentistry, Complutense University of Madrid, Plaza Ramón y Cajal, 3, Madrid 28040, Spain
[e] Department of Dentistry and Stomatology, Gregorio Marañón University General Hospital, Madrid, Spain

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Purpose: Odontogenic infections can spread through different routes to more remote anatomical areas, such as the brain. Brain abscesses have an incidence of 0.3−1.3 / 100,000 population and only 2−5% are of dental origin. The main objective is to research brain complications derived from odontogenic infections. Secondary objectives were to identify the most common symptoms in brain abscess, to describe the microbiology involved in these infectious processes, report which parts of the brain complex are most commonly affected and report the sequelae of this patients.
Methods: A systematic review following the PRISMA Guide and the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Reports was carried out in PubMed, Scopus and Web of Science. The search terms were: Brain infection, brain abscess, oral health oral origin, odont* infect*.
Results: The database search identified a total of 1000 articles. A total of 18 publications were identified after applying inclusion and exclusion criteria. A total of 38 patients were analyzed. Mean age was 49.64± 18.80 years.
Conclusion: The most common symptoms of patients with brain abscess are neurological affectations first and then fever and headache second, without necessarily presenting as a symptomatological triad. Microbiological diagnosis is key to determining the origin of the infection. Anaerobic pathogens such as Streptococcus (F. Milleri), Fusobacterium Nucleatum and Porfiromonas Gingivalis families are common bacterial agents. The frontal lobe is the most frequently affected, followed by the parietal and temporal lobe. The most frequent brain complications are neurological disorders. However, most patients with brain abscesses recover without sequelae.

1. Introduction

Odontogenic infection origin occurs in one or more teeth, and or their supporting structures. It is one of the most common infectious processes in the oral cavity and the entire maxillofacial territory. The causes of an odontogenic infection are carious lesions, failure of conservative or endodontic treatment, pericoronitis, trauma and periodontal disease. Usually only the surrounding regions, like periodontium, and the tooth itself are affected [1].

If the infectious process is not treated early, the clinical picture will worsen to the point of be-ing life threatening for the patient. Most odontogenic infections penetrate the bone so that they become vestibular abscesses. However, if the spread occurs outside the muscle attachments, the infection spreads to the fascial spaces, leading to more serious infections that can lead to cavernous sinus thrombosis, airway obstruction, mediastinitis, and endocarditis. The infection can also run by hematogenous, lymphatic or direct venous drainage and generate a brain abscess [2−6].

One of the most common forms of infection of the brain complex is brain abscess. It is a life-threatening infectious process characterized by the presence of edema, swelling, and accumulation of pus. The affected area is the brain parenchyma. These infections usually always present with atriad of classic symptoms (fever, headache and neurological manifestations) [1,3,7,8]. Brain abscess has an incidence of 0.3−1.3/100,000 inhabitants each year. Mortality ranges from 8.3−16% annually.

It can have multiple causes such as sinusitis, otitis, bacteremia, endocarditis, pulmonary or urinary tract infection and It can also have

* Corresponding author at: Department of Clinical Specialities, Faculty of Dentistry, Complutense University of Madrid, Plaza Ramón y Cajal, 3, Madrid 28040, Spain.
E-mail address: cmcobo@ucm.es (C.M. Cobo-Vázquez).

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an odontogenic origin although it is less common. The fact that the dental origin is rare implies that clinicians often do not achieve an accurate diagnosis with the consequent delay in treatment. Despite the advancement of technology in diagnostic techniques like computer tomography (CT) and magnetic resonance (MRI), today it is still a challenge to diagnose a brain abscess of odontogenic origin [1–3,7].

A common factor in brain and odontogenic infections is that they are usually polymicrobial infectious processes in which several families of microorganisms intervene. Performing a bacterial culture to determine which pathogens are present is key to making an accurate diagnosis [5–7].

The objective of this review is to analyze the main brain complications derived from odontogenic infections described in the scientific literature. Seconday objectives are to identify the most common symptoms among patients who have suffered a brain abscess of odontogenic origin, to describe the microbiology involved in these infectious processes, to determine which parts of the brain complex are most commonly affected and finally report the sequelae described in the literature.

2. Material and methods

The authors independently searched the PubMed, Scopus, and Web of Science databases for articles following the PRISMA Guide and the Joanna Briggs Institute (JBI) Critical Appraisal Checklist for Case Reports to assess the methodological quality of the studies . Kappa Index was determined obtaining *K*=0,87 (near-perfect agreement).

The inclusion criteria used for this study were: humans, clinical cases or case reports and studies from the last 5 years. Exclusion criteria were established as language other than English or Spanish, brain conditions other than infectious, brain abscesses of non-dental origin, and studies with insufficient or unreported data. The search terms were: Brain infection, brain abscess, oral health oral origin, odont*, infect* (Table 1).

The data collected from the manuscripts included were author and year, study design, sex and age of the patient, lesion type, abscess location, symtoms, oral condition, microorganism detected and the outcome of the patient.

3. Results

The database search identified a total of 1000 articles. After removing duplicate articles (*n* = 44), 960 articles were chosen for review. After reading the abstracts and those that did not meet the exclusion criteria, were identified a total of 18 publications that met the inclusion criteria (Fig. 1).

The studies included in the present systematic review were mainly case reports. A total of 38 patients were included, 23 males and 15 females, with a mean age of 49.64±18.80 years. As shown, most patients were older of 40 years (Table 2).

The main symptom mentioned of brain abscess was neurological like vomiting, drowisiness or dizziness.

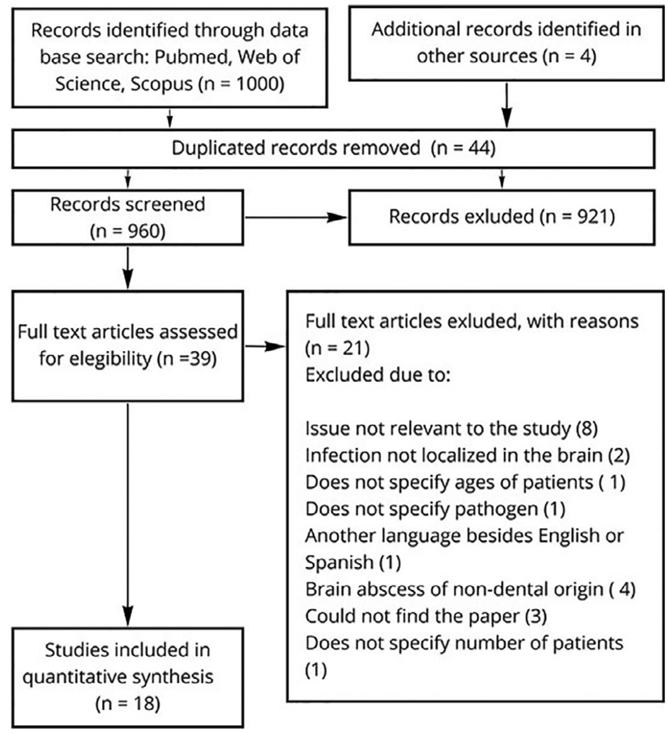

Fig. 1. PRISMA flow diagram.

Headache was reported in eleven cases, and nine cases reported fever (Fig. 2). However, there are 12 cases with no symtoms reported (Table 3). [1]

Microbiological diagnosis was key to determining the origin of the infection. Anaerobic pathogens such as Streptococcus (F. Milleri), Fusobacterium Nucleatum and Porfiromonas Gingivalis families are common bacterial agents diagnosed in brain abscess (Table 2).

The location of the abscess can vary widely. The frontal lobe was the most commonly affected lobe in 45.7% but it can also occur in other areas such as the parietal lobe 19.6% and the temporal and occipital lobes with a similar percentage 13% and 10.9% respectively (Fig. 3).

Computed tomography is a quick radiological technique for the diagnosis of brain abscesses. It provides a three-dimensional image that is useful to detect the size, number and location of abscesses. However, it must be complemented with magnetic resonance imaging (MRI) for the study of soft tissues and discard other pathologies such as neoplastic lesions.

Of the studies analyzed, almost half of the patients 46.5% recovered without sequelae after undergoing surgery and antibiotic therapy. The most common sequelae were neurological alterations in 27.9% of the affected patients, the most frequent among these were visual alterations, and 14% patients died (Fig. 4).

The etiology of the brain abscess was caused in most cases by dental infections, periodontal diseases or poor oral hygiene (Table 3).

Table 1
Search strategy. Represent the search terms used for the research in the data bases.

Pubmed	Web of Science	Scopus
(Brain abscess) AND (oral origin); (Brain abscess) AND (oral health); (Brain complications) AND (odont* infect*); (Brain infection) AND (oral origin); (Brain infection) AND (oral health).	(Brain abscess) AND (oral origin); (Brain abscess) AND (oral health); (Brain complications) AND (odont* infect*); (Brain infection) AND (oral origin); (Brain infection) AND (oral health).	(Brain abscess) AND (oral origin); (Brain abscess) AND (oral health); (Brain complications) AND (odont* infect*); (Brain infection) AND (oral origin); (Brain infection) AND (oral health).

Table 2
Data recorded from the studies included. Study type, gender and age of patients related to the species found in the cultures carried out of the brain lesions and the outcome of the clinical case after its treatment.

Author [Refs.] year	Study type	Sex	Age (years)	Lesion type	Microorganism	Outcome
Maraki et al. [9]	Case report	F	6	Brain abscess	*Haemophilus aphrophilus*	Good
Akashi et al. [5]	Case report	F	64	Brain abscess	*Staphylococcus aureus.*	Good
		M	68	Brain abscess	*Streptococcus constellatus* *Fusobacterium nucleatum* *Parvimonas micra*	Neurological sequelae
		F	64	Brain abscess	*Lactobacillus catenaeformis* *Porphyromonas gingivalis* *Fusobacterium nucleatum*	Good
Van der Cruyssen et al. [10]	Case report	M	65	Brain abscess	*Porphyromonas gingivalis*	Good
Pereira et al. [16]	Case report	F	23	Brain abscess	*Pseudomonas aeruginosa*	Good
Al Mousawi et al. [8]	Case report	F	56	Brain abscess	*Streptococcus intermedius*	Good
Jung et al. [4]	Case report	M	45	Multiple brain abscesses	*Streptococcus anginosus*	Good
Kawase et al. [21]	Case report	M	6	Brain abscess	*Streptococcus milleri group*	Good
Miyazaki et al. [19]	Case report	F	87	Brain abscess	*Actinomycetes*	Good
Pedersen et al. [20]	Case report	M	60	Multiple brain abscesses Ventriculitis	*Candida albicans* *Actinomyces oris* *Streptococcus mitis* *Streptococcus oralis* *parvimonas micra* *Porphyromonas gingivalis* *fusobacterium nucleatum*	Death
Kichenbrand et al. [3]	Case series	F	59	Brain abscess	*Streptococcus intermedius* *parvimonas micra*	Good
		F	57	Brain abscess	*Streptococcus intermedius*	Neurological sequelae
		M	52	Brain abscess	*Streptococcus intermedius*	Neurological sequelae
		M	37	Brain abscess	*Porphyromonas gingivalis* *Campylobacter rectus*	Death
		M	57	Brain abscess	*Streptococcus intermedius*	Death
		M	24	Emphysema	*Streptococcus constellatus* *Streptococcus anginosus*	Good
		M	50	Emphysema	*Streptococcus constellatus* *Streptococcus gordonii*	Good
Liao et al. [14]	Case report	M	44	Brain abscess	*Pseudoramibacter alactolyticus* *Mycobacterium tuberculosis*	Good
Gemelli et al. [18]	Case report	F	71	Multiple brain abscesses	Aggregatibacter aphrophilus	Good
Hsu et al. [1]	Retrospective Cohort Study	F	69	Brain abscess	*Staphylococcus epidermis, Fusobacterium*	Good
		M	44	Brain abscess	*Streptococcus milleri*	Encephalomalacia Neurological sequelae
		M	43	Brain abscess	*Staphylococcus aureus*	Sinusitis Neurological sequelae
		F	25	Brain abscess	*Anaerobes*	Sinusitis Neurological sequelae
		F	23	Brain abscess	*Streptococcus milleri*	Neurological sequelae
		M	23	Brain abscess	*Eikenella corrodens, Fusobacterium, Streptococcus constellatus*	Neurological sequelae Kidney injury
		M	59	Brain abscess	*Streptococcus anginosis, anaerobes*	Good
		M	53	Brain abscess	*Gram-positive cocci in chains*	Neurologic sequelae
		M	51	Brain abscess	*Streptococcus epidermis*	Neurologic sequelae
		F	58	Brain abscess	*Streptococcus milleri, Haemophilus aphrophilus*	Good
		F	66	Brain abscess	*Nocardia*	Encephalomalacia Neurological sequelae
		F	60	Brain abscess	*Propionibacterium acnes, Fusobacterium, Peptostreptococcus.*	Neurological sequelae
Xue et al. [6]	Case report	M	53	Ventricular and spinal emphysema	*Fusobacterium nucleatum, Fusobacterium hwasookii, Porphyromonas endodontalis, Solobacterium moorei, Prevotella intermedia, Dialister pneumosintes*	Death
Shibata et al. [7]	Case report	M	62	Multiple brain abscesses	*Streptococcus intermedius*	Death
		M	68	Multiple brain abscesses	*Streptococcus anginosus*	Death
Ma et al. [11]	Case report	M	75	Brain abscess	*Prevotella denticola Fusobacterium nucleatum*	Good
Sah et al. [12]	Case report	M	35	Brain abscess	*Actinomyces meyeri*	Good
Viviano et al. [13]	Case report	M	28	Multiple brain abscesses	*Streptococcus intermedius, Actinomyces*	Good

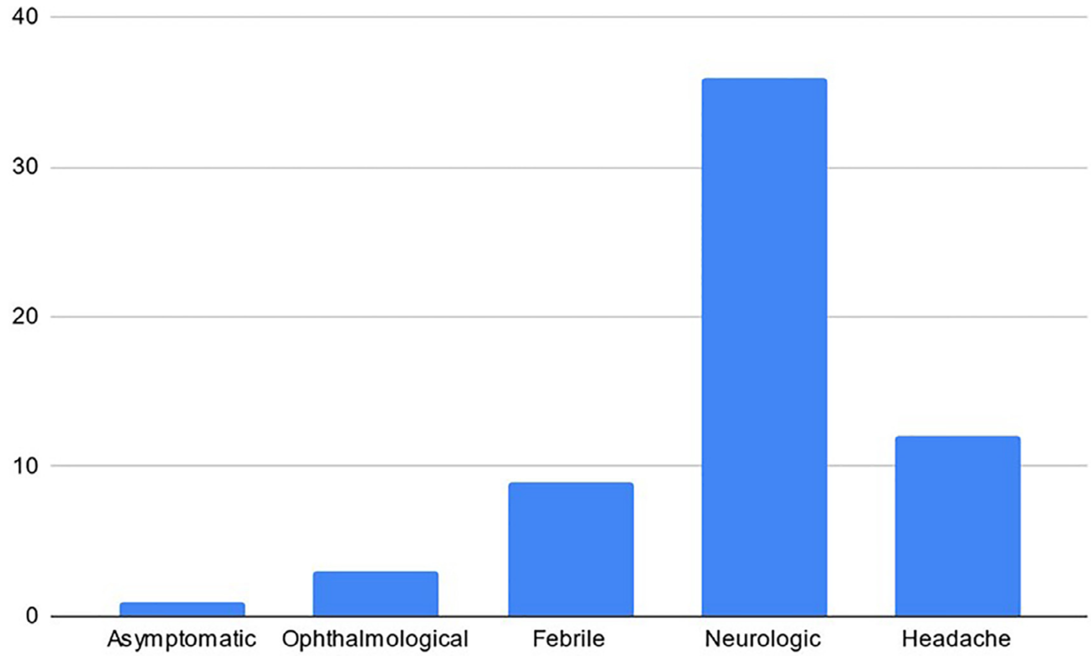

Fig. 2. Graphic representation of symptoms prior to admission to the associated hospital service by groups. Neurologis symptoms, headache, fever, ophtalmological symtoms or asymptomatic cases.

4. Discussion

Brain abscesses have an incidence of 0.3−1.3 / 100,000 inhabitants each year and only 2−5% are due to an odontogenic origin. The mortality of a brain abscess caused by an odontogenic infection reported in the studies is described between 8.3 and 16% (decades ago it was around 30%), which corresponds with the data obtained in our review with a mortality of 14% [1,3−7,9].

Regarding microbiology, the majority of bacteria involved in brain abscesses of odontogenic origin are anaerobic in a ratio of 3: 1 compared to aerobes. The most commonly found pathogenic species are Streptococci from the Milleri family (S.Anginosus, S. Constellatus and S.Intermedius). In our review we also identified this family as the most prevalent in brain abscesses, but only in 32.2%. Other recurrent pathogens are Fusobacterium Nucleatum 13.6% and Porfiromonas Gingivalis 6.8%.

As already mentioned, brain abscess of odontogenic origin has a low incidence (2−5% of all brain abscesses) and many times the clinician does not take into account that the oral cavity may be the primary cause of the infection. In the retrospective study carried out by Hsu et al, they postulate that these numbers may be underestimated since, according to their data, of 167 brain abscesses, 13.6% had an odontogenic origin. If an accurate and early diagnosis is not made, treatment will be delayed, and the abscess may become life-threatening for the patient [1,3,4,9].

These differences could be explained since, being a low prevalence pathology, the type of studies identified are mainly cases and controls, without there being a concordant methodology for the registration of cases and their follow-up among the authors, this being one of the reasons. for which there may be large differences in the results.

Computed tomography is an excellent radiological technique for the diagnosis of brain abscesses, although it must be complemented with magnetic resonance imaging (MRI).

MRI is useful to rule out other pathologies such as neoplastic lesions. The appearance of these diagnostic techniques has caused a decrease in the mortality rate from brain abscess over the years [8,10−13]. Regarding the literature, it could be adviced that computered tomography is useful for a quick diagnosis of the size, number and location of abscesses when patients manifest any symptom. However, complete diagnosis should include an MRI [10−13].

The pathogenesis of odontogenic infection is polymicrobial. Studies have shown that there is not a single group of pathogens, but rather a set of species, normally organized in biofilm communities [5,6].

The most abundant pathogens in the oral cavity (and most closely related to brain abscesses) are strict anaerobes such as Bacteroides (Prevotella spp and Porphyromonas Gingivalis) and Fusobacteria species such as Fusobacterium Nucleatum that are gram negative bacilli, which are described in percentages of 27.7% and Porfiromonas Gingivalis in 22.2% in cases of brain abscesses. Our data show that the reported percentage of these bacteria related to brain abscesses is less than 13.6% and 6.8% respectively.

Facultative anaerobes such as the Streptococci Milleri group (S. Anginosus, S. constellatus and S.Intermedius) are also very abundant, being described up to 50% in studies (they are gram positive cocci). In our review, 32.2% of the cases had this group in the description of the cultures. These data differ with the literature and with the data found by Darlow et al in a cohort study ($n = 47$), one of the largest identified. They describe that brain abscesses in which Milleri group streptococci is 61.7%. This study was not incorporated as it does not individualize patients for analysis.

There is a 3 times higher prevalence of anaerobic than aerobic pathogens. Anaerobic organisms are present in almost all dental infections, both periodontal and endodontic. Less than 5% of odontogenic infections are caused by aerobic organisms (these are Streptococcal species). Aerobic bacteria serve as initiators of infection, preparing the local environment for anaerobic bacterial invasion as the local tissue condition changes to a more hypoxemic state that favors anaerobic growth [5−7,11,14,15].

Detection of common bacteria in the patient's oral flora, blood, and brain abscess can be of great diagnostic aid in establishing a relationship between the oral cavity and the brain [12]. Bacterial culture is a process susceptible to errors since the sample to be analyzed has to be taken quickly to the laboratory, under strictly anaerobic conditions [5,6,11,15].

Table 3
Abscess location, symptoms and oral ethiology. Location of brain injury, symptoms of the patient at the time of entering the medical service and the status of oral quality at the time of examination.

Author [Ref] year	Abscess location	Sex	Age (years)	Symptoms	Oral condition
Maraki S. [9]	Left frontoparietal lobes	F	6	Drowsiness and vomiting	Poor oral hygiene, extraction of central incisor two weeks prior
Akashi M. [5]	Left temporal lobe	M	64	Difficulty speaking, unsteady gait, memory loss	Advanced periodontal disease
	Left Occipital lobe	M	68	Memory loss, imbalance, fever.	Advanced periodontal disease
	Right frontoparietal lobes	F	64	Seizures	Advanced periodontal disease
Van der Cruyssen F [10]	Right frontal lobe	M	65	Seizures, confusion.	Apical periodontitis: 1.6, 2.3 and 3.4
Pereira RS. [16]	Right frontal lobe	F	23	Headaches, right eye proptosis, subconjunctival hemorrhage, ophthalmoplegia.	1.6 Extensive caries lesion
Al Mousawi H. [8]	right cerebellum	F	56	Headaches and dizziness.	No infections
Jung KH. [4]	Right frontal lobe, Bilateral subcortical	M	45	Facial spasms, paresthesia, dysarthria, right arm tingling.	Chronic periodontitis, Periapical abscesses: 1.6, 1.7, 2.4 and 2.8
Kawase S. [21]	Right temporal lobe	M	6	Fever, vomiting, loss of consciousness, facial spasms.	Poor oral hygiene.
Miyazaki R. [19]	Right frontal lobe	F	87	Asymptomatic	Advanced periodontal disease
Pedersen T. [20]	Bilateral frontal lobe	M	60	Fever, headache.	Advanced periodontal disease
Kichenbrand C [3]	Frontal lobe	F	59	Headache.	Poor oral hygiene
	Cerebellum	F	57	Headache, vertigo, asthenia.	Poor oral hygiene
	Cerebellum	M	52	Cerebellar syndrome.	Poor oral hygiene
	Occipital lobe	M	37	Neurological deffect, comatose patient	-
	Parietal lobe	M	57	Headache.	-
	Frontal lobe	M	24	Headache.	Poor oral hygiene
	Frontal lobe	M	50	Aphasia, Hemiparesis.	Poor oral hygiene
Liao Y. [14]	Right frontal lobe	M	44	Fever, headache.	Recent tooth extraction
Gemelli N. [18]	Bilateral nodular lesions supra and infratentorial	F	71	Fever, disorientation, asthenia, adynamia, dyspnea.	Recent tooth extraction: 1.6, 1.7, 3.1, 3.2, 4.1 and 4.2.
Hsu G. [1]	Temporal lobe	F	69	-	Mandibular molar abscess
	Multifocal	M	44	-	1.6 Periapical abscess
	Frontal lobe	M	43	-	Left maxillary abscess
	Frontal lobe	F	25	-	1.8 Periapical abscess
	Frontal lobe, Parietal lobe	F	23	-	3.6 Periapical abscess
	Frontal lobe	M	23	-	2.3 Abscess
	Parietal lobe Occipital lobe	M	59	-	Mandibular infection
	Frontal lobe	M	53	-	Prophylaxis 2 weeks prior
	Temporal lobe	M	51	-	Full mouth restorations
	Frontal lobe, Temporal lobe	F	58	-	Dental restorations
	Parietal lobe, Occipital lobe	F	66	-	Oral prophylaxis
	Frontal lobe	F	60	-	Bilateral maxillary implants
Xue H. [6]	Ventricular, spinal canal	M	53	Intermittent fever, unconsciousness.	Dental cavities
Shibata T [7]	Right frontal lobe	M	62	Fever, headache, aphasia, and right hemiparesis.	1.7 and 1.5 periapical abscess
	Left frontal lobe Right parietal lobe	M	68	Fever, Hemiparesis.	No infections
Ma Z. [11]	Left temporal lobe	M	75	Fever, persistent month-long headache, dizziness.	Left sinus cyst posterior to dental extraction a month ago.
Sah. R [12]	Right parietal lobe	M	35	Headache, left adynamia.	-
Viviano M [13]	Left parietal lobe, Left occipital lobe	M	28	Severe headache, vomiting, pain.	Gingivitis

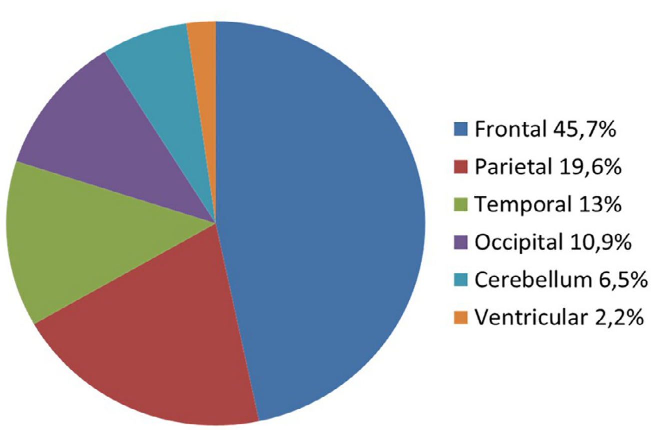

Fig. 3. Location of brain abscesses. The most frequent location of occurrence of brain abscess is in the frontal lobe (43.6%). The percentages not described correspond to abscesses located in the ventricular area and supra- and infratentorial areas with a prevalence of 1% respectively.

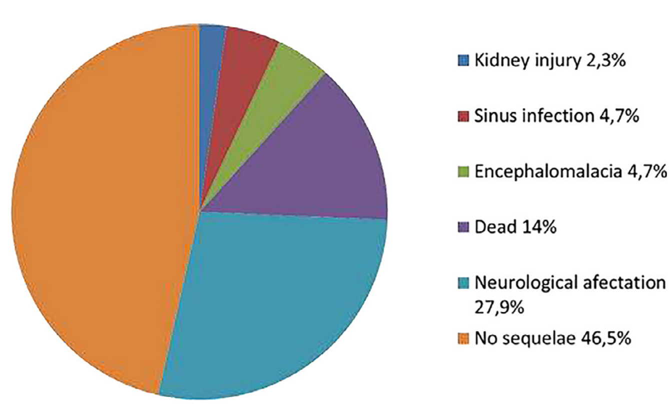

Fig. 4. Percentages of post-treatment sequelae of a brain abscess of odontogenic origin. The majority of people affected by brain abscesses of odontogenic origin do not have sequelae (46.5%). Of those sequelae, the majority are left with some degree of neurological involvement (27.9%)

It should be noted that the species Porfiromonas gingivalis is a gramnegative pathogen that is very closely related to periodontal disease. Its relationship with the formation of brain abscesses has been described in several articles and it is one of the 3 most prevalent pathogens in the development of brain abscesses [2,3,10,11,15].

Regarding the spread of the infection, it is logical to think that the brain abscess will have its origin in an infection of the maxillary area due to the proximity of the roots of the upper teeth (especially the 2nd premolar, 1st molar and 2nd molar) to the maxillary sinus. In the study by Pereira et al, the case of a patient who suffered a brain abscess caused by extensive caries of the upper right first molar was analyzed. The infection spread to the maxillary sinus, ethmoid sinus and orbital cavity, eventually forming the brain abscess. The proximity of the oral cavity to the frontal lobe and its greater area in proportion to the other lobes are the main reasons why this is the most affected lobe. There is a relationship between the frequency of appearance and the area of each lobe [7,16,17].

On the other hand, we must never rule out the jaw as a source, just because it is further away, since the infection usually runs through the hematogenous route and can also reach the brain. In several studies, among others, that of Akashi et al, the causative brain abscess was diagnosed as due to advanced periodontitis suffered by a mandibular canine and lateral incisor [5−7].

The clinical symptoms of a patient with a brain abscess caused by an odontogenic infection begin with fever and headache and are generally associated with some type of neurological manifestation, although this triad does not appear in all cases. In the study by Hsu et al (n = 12), previous symptoms were not described but it was incorporated into the review due to the contribution of data relevant to the objectives of the study.

Neurological alterations can be varied, the most common being confusion. In those cases, not accompanied by neurological alterations and due to the fact that they are very common symptoms, the patient often speculates that it is due to a common cold until over time it is seen that their condition does not improve. It can also occur with vomiting and seizures [1,3,7,9,14,18,19].

It is important to consider a headache with fever as a red flag warning of some serious problem, as well as a disabling headache reported as the most intense experienced.

Treatment of a brain abscess consists of draining it (by aspiration) and administering a broad-spectrum systemic antibiotic. In these cases, ampicillin, vancomycin, and 3rd generation cephalosporins (ceftriaxone) are administered intravenously. High doses are usually administered because the level of infection in these cases is very high. The time of antibiotic therapy depends on the evolution of the abscess itself. It will depend on its clinical, biochemical and radiological improvement. Normally, the antibiotic administration time ranges between 4 and 6 weeks [5,8,10,11,13,15].

Metronidazole is always given as an adjunct due to its efficacy in the treatment of periodontal disease, which is the cause of the spread of infection in many cases. The normal dose is 500 g every 8 ho [5,20]. Once the dental aethiology is diagnosed, dental treatment must be provided as soon as medical conditions of the patients allows. Tooth extraction is the most frequently required treatment. Dental extraction is also a risk of bacterial dissemination, however multidisciplinary medical team must determine the best moment to approach the treatment. In our practice, most oral surgeons extract the tooth after antibiotic therapy has effect on bacterial agents diagnosed to decrease the risk of bacterial dissemination. The effect on bacterial agents is usually determined by an improvement of blood test and after fever-stop. However, the present review did not found information about this issue.

In most of the studies found, the patient usually recovers without any condition, but this data may be overvalued since in many studies the report of the patient's departure from the hospital is poorly detailed and the follow-up described is almost non-existent.

The most common complication that the patient suffers when treated in these cases are neurological sequelae (episodes of vertigo, loss of memory and / or consciousness), although the type of neurological involvement in several studies is not specified.

In some studies, the existence of ocular complications (visual deficits), difficulty in speech and gait disturbances were confirmed [16].

The mortality rate (8.3−16%) has decreased in recent years due to new diagnostic techniques and more effective treatments. The mortality rate attributed to brain abscess in our review was 14%. Older age, immunosuppressed patients, and the presence of congenital heart abnormalities increase the risk of possible death from brain abscess. No direct relationship has been established between the type of microorganism and mortality (or any other complication) [8,15].

It is worth mentioning a study by Shibata et al, which highlights the importance of making a prior review of the patient's oral health before he undergoes cancer treatment. In this study, 2 cancer patients had to interrupt their chemotherapy treatment due to the presence of brain abscess secondary to an odontogenic infection. The time that the cancer treatment was stopped, caused a worsening of their general condition causing death in both patients [7].

In another study by Kawase et al, the formation of a brain abscess was described in a 6-year-old boy with previous rampant caries that triggered apical periodontitis of the 4 upper deciduous incisors [21].

Regular examinations of the oral cavity are key to not overlooking a possible source of infection. The presence of gingivitis, periodontitis, the presence of cavities, dental extractions and previous endodontic treatments have to make the clinician suspect that the oral cavity may be the cause of the abscess, no matter how low its prevalence is at present.

It is striking that the geographical distribution is mainly in the northern hemisphere and there are very few cases described in South America and none in Africa and Oceania [22,23].

Brain abscesses, as well as other brain pathologies, are treated clinically and their report to the scientific community is limited, this means that not only does there not exist a methodology and a unified protocol for treatment and data collection, but most cases are only reported as statistics of the general disease without specific origin diagnostic.

This review has a number of limitations. The reported cases are isolated and are not related to each other, so the reporting methodology as well as the diagnosis and treatment vary among the authors. In some studies, the pathogens were not specified as in the study by Hsu et al. One patient is reported only as anaerobic. Within our review, we excluded the study carried out by Darlow et al in the data analysis since it groups the patients for the description of pathogens and symptoms, although due to its good methodological design it was used for the comparison of results. Finally, authors did not find in the literature about the best moment described for tooth extraction in these cases.

5. Conclusions

The most frequent brain complications in brain abscesses derived from odontogenic infections are neurological disorders, although most of those who have suffered from brain abscesses recover without sequelae.

The most common symptoms of patients with brain abscess are neurological affectations first and then fever and headache second, without necessarily presenting as a symptomatological triad.

Microbiological diagnosis is key to determining the origin of the infection. Anaerobic pathogens such as Streptococcus (F. Milleri), Fusobacterium Nucleatum and Porfiromonas Gingivalis families are frequent bacterial agents in these clinical pictures.

The frontal lobe is the most frequently affected by the abscess, followed by the parietal and temporal lobe.

Tooth extraction is the most frequently required treatment. It must be provided as soon as medical conditions of the patients allows. Most oral surgeons extract the toothin a second step after antibiotic therapy has effect on bacterial agents diagnosed to decrease the risk of bacterial dissemination.

Ethics approval

Ethics approval was not required for this literature review.

Consent to participate

There is no patient recruitment. No consent to participate is needed.

Consent to publish

No images were taken from other papers. All tables and figures are original from the authors.

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Declaration of Competing Interest

All the authors declare that they present no conflict of interests in relation neither with the financing sources nor with the implications of the present work.

CRediT authorship contribution statement

Luis Felipe Burgos-Larraín: Conceptualization, Writing − review & editing, Data curation, Writing − review & editing, Writing − original draft. **Álvaro Vázquez-Portela:** Conceptualization, Writing − review & editing, Data curation, Writing − original draft. **Carlos M. Cobo-Vázquez:** Conceptualization, Visualization, Data curation, Writing − review & editing, Writing − original draft. **Luis Miguel Sáez-Alcaide:** Data curation, Formal analysis, Writing − original draft, Writing − review & editing. **Luis Sánchez-Labrador:** Data curation, Formal analysis, Writing − original draft, Writing − review & editing. **Cristina Meniz-García:** Conceptualization, Visualization, Data curation, Writing − review & editing, Writing − original draft.

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