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Case Report

Parvimonas micra: A potential causative pathogen to consider when diagnosing odontogenic brain abscesses

Ruth Prieto[1], Alejandro Callejas-Díaz[2], Rasha Hassan[1], Alberto Pérez de Vargas[3], Luis Fernando López-Pájaro[3]

Departments of [1]Neurosurgery, [2]Internal Medicine, [3]Neurophysiology, Puerta de Hierro University Hospital, Madrid, Spain.

E-mail: *Ruth Prieto - rprieto29@hotmail.com; Alejandro Callejas-Díaz - alejandro.callejasdiaz@gmail.com; Rasha Hassan - rashahn8@gmail.com; Alberto Pérez de Vargas - albertoperezdv@hotmail.com; Luis Fernando López-Pájaro - drzucco70@hotmail.com

***Corresponding author:**
Ruth Prieto,
Department of Neurosurgery,
Puerta de Hierro University Hospital, Madrid, Spain,
C/Manuel de Falla 1,
Majadahonda, Madrid - 28222,
Madrid, Spain.

rprieto29@hotmail.com

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ABSTRACT

Background: Brain abscess is a life-threatening entity which requires prompt and long-term antibiotic therapy, generally associated with surgical drainage, and eradicating the primary source of infection. *Parvimonas micra* (*Pm*) has only been reported once before as the lone infecting organism of an orally originated, solitary brain abscess. Diagnosing brain abscesses caused by this Gram-positive anaerobic coccus, constituent of the oral cavity flora, is challenging, and an optimal treatment regimen has not been well established. We report the diagnosis and successful treatment of a *Pm* caused odontogenic brain abscess.

Case Description: A 62-year-old immunocompetent male with a right-parietal brain abscess presented with headache and seizures. He was started on empirical antibiotic therapy and subsequently underwent surgical drainage. The only source of infection found was severe periodontitis with infected mandibular cysts. Thus, tooth extraction and cyst curettage were performed 1 week after brain surgery. Cultures of brain abscess fluid were negative, but amplification of bacterial 16S ribosomal RNA (rRNA) with polymerase chain reaction demonstrated *Pm*. After 3 weeks of intravenous ceftriaxone and metronidazole, the patient was switched to oral metronidazole and moxifloxacin for 6 weeks.

Conclusions: This case highlights the potential risk of untreated dental infections causing brain abscesses. *Pm* should be considered as a possible pathogen of odontogenic brain abscesses despite its presence usually not being detected by standard bacterial cultures. Therefore, 16S rRNA gene sequencing analysis is strongly recommended for bacterial identification before defining brain abscesses as cryptogenic.

Keywords: 16S rRNA analysis, Brain abscess, Dental infection, Odontogenic abscess, *Parvimonas micra*

INTRODUCTION

Brain abscess is one of the most serious infections of the central nervous system. It consists of a focal purulent collection of the brain parenchyma.[2,15] Despite notable improvement in outcome since the introduction of more powerful diagnostic methods and targeted antibiotics, currently the mortality rate is as high as 10%.[2,5,12,15] The most common source of infection is the contiguous otorhinogenic area, while a dental origin is rather rare. Dissemination of microorganisms from the oral cavity microbiota is thought to be the underlying cause of infection in <10% of brain abscesses.[4,5,15,16,19] Moazzam *et al.* have recently published the largest review of orally originated intracranial infections, a total of 60 cases.[12] The most common pathogens found were *Streptococcus viridans* (55%) and *Fusobacterium* spp. (20%). Conversely, *Parvimonas micra* (*Pm*) was involved in <5% of these cases.[12]

Pm, formerly known as *Peptostreptococcus micros* and *Micromonas micros*, is a Gram-positive anaerobic coccus that is normally found in the human flora of the oral cavity and gastrointestinal tract.[6,20,21] This bacterium has generally been associated with polymicrobial infections of the oral cavity, whereas infections outside this area are rare, particularly in healthy people. Most such infections involve the spine (45%), followed by the joints, heart valves, and pleura. Brain abscesses caused by *Pm* are extremely rare.[3] Through a systematic PubMed literature review using the search terms "brain abscess" combined with "odontogenic" or "dental" or "anaerobic" or "*Pm*" or "*P. micros*" or "*M. micros*" and by studying the reference lists of the articles collected, we have found only one similar case to ours in this report.[10] Our patient, as well as one reported 10 years ago by Kwon *et al.*, had a solitary brain abscess in which orally originated *Pm* was identified as the lone causative microorganism. We discuss the diagnostic and treatment strategies of these two cases in addition to those of nine patients with either multiple brain abscesses due to *Pm* monomicrobial infection,[8,18] or polymicrobial brain abscess including *Pm*.[1,13,14,23] Odontogenic brain abscesses caused by *Pm* are life-threatening unless correctly managed by a multidisciplinary team including neurosurgeons, infectious-disease specialists, and maxillofacial surgeons.

CASE DESCRIPTION

A 62-year-old male presented to the hospital with a 1-week history of headache and an episode of transitory paresthesia in the left upper limb followed by a 2-min lapse in awareness and a claw-like left hand position highly suggestive of an atypical absence seizure. He had no history of fever, malignancy, diabetes mellitus, or corticosteroid use. Laboratory results revealed a normal white blood cell count and a moderately elevated C-reactive protein (63.6 mg/L–normal levels are below 10 mg/L–). The patient was alert and presented neither neurological deficits nor signs of meningeal irritation. An urgent brain computed tomography (CT) scan demonstrated an expansive process in the right parietal lobe [Figure 1a]. For better characterization a magnetic resonance imaging (MRI) was also performed, revealing a cystic cortico-subcortical lesion [Figure 1b]. Gadolinium injection demonstrated an irregular rim enhancement of the lesion that spread to the subarachnoid space. Restricted diffusion-weighted imaging (DWI) and diminished apparent diffusion coefficient (ADC) along with high lipids and low N-acetylaspartate levels in MR spectroscopy led to the diagnosis of a brain abscess. Therefore, the patient was immediately placed on triple empiric intravenous antibiotic therapy (vancomycin, ceftriaxone, and metronidazole). The workup to identify the infection source included a thoracoabdominal CT scan, transthoracic cardiac ultrasound, and fundoscopy. All of these were unremarkable, but direct visualization of the oral cavity showed very poor oral health.

On day 3, the patient underwent craniotomy with neurophysiological monitoring given the proximity of the lesion to the motor cortex. After opening the dura mater, a swollen brain was found [Figure 2]. A catheter was first used to drain purulent fluid and reduce brain swelling. Then, the adjacent cortex was opened to wash the cavity with saline, antibiotics (vancomycin, and gentamicin), and hydrogen peroxide. Several tissue samples from the cavity were also taken for pathological study, which revealed acute inflammatory changes but no malignant cells. The blood cultures were negative. Likewise, Gram staining of the abscess

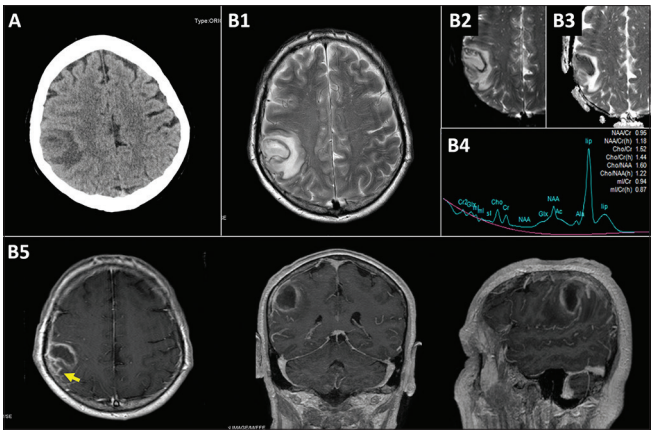

Figure 1: Preoperative neuroradiological studies. (A) Computed tomography scan showing an isodense 3-cm-parietal mass with surrounding digitiform edema, (B) preoperative magnetic resonance imaging (MRI). (B1) T2-weighted MRI showing a hyperintense lesion with significant perilesional edema, (B2) diffusion-weighted imaging MRI showing a bright signal within the lesion (restriction of water diffusion), (B3) low apparent diffusion coefficient value within the lesion fluid. (B4) MR spectroscopy showing a high lipid level (lip) and decreased N-acetylaspartate, (B5) gadolinium-enhanced T1-weighted MRI showing a low-intensity lesion with rim enhancement which extended to the subarachnoid space (arrow).

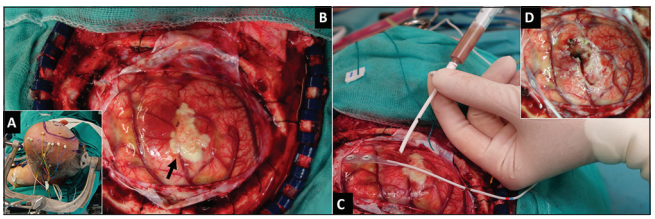

Figure 2: Intraoperative photographs. (A) The patient was placed in the lateral position, (B) following dura opening, a swollen brain was found with a whitish subarachnoid area (arrow), (C) a catheter was inserted at the point where the abscess capsule was closest to the cortex. Brownish liquid pus was aspirated for mass decompression and later microbiological study. (D) Surgical view following removal of the whitish subarachnoid area and cavity washing.

fluid exhibited no organisms, and routine aerobic/anaerobic cultures revealed no bacterial growth. Therefore, abscess samples were sent to another hospital for the amplification of bacterial 16S ribosomal RNA (rRNA) with polymerase chain reaction. When *Pm* was demonstrated as the causative agent of the infection, vancomycin was discontinued.

The patient was also assessed by maxillofacial surgeons who detected severe periodontitis with infected mandibular cysts. This condition was considered the primary source of brain infection, and 1 week after craniotomy the patient underwent extraction of the lower teeth and curettage of mandibular cysts. Unfortunately, the material of the extracted teeth was not sent for microbiological studies. The patient was discharged in excellent conditions after 3 weeks of intravenous antibiotics, followed by 1 week of oral metronidazole and moxifloxacine. Oral antibiotics were maintained for 5 additional weeks. Follow-up MRIs demonstrated favorable progress without any radiological suspicion of recurrence [Figure 3].

DISCUSSION

The seriousness of brain abscesses requires prompt joint action by neurosurgeons and infectious-disease specialists. Merely focusing on the focal suppurative process of the brain parenchyma is not enough for a successful treatment. It is paramount to identify and eradicate the primary source of infection and the specific causative microorganism. In the case presented, *Pm* isolated in the brain abscess was assumed to have an oral origin based on the evident signs of dental infection. Abscess location in the parietal lobe supports that hematogenous dissemination is the major pathophysiological mechanism of brain abscess of odontogenic origin.[12] Our case highlights the importance of careful clinical and radiological examination of the maxillofacial area whenever other infective sources are not detected before defining as unknown the origin of intracerebral abscesses.[5] When obvious signs of dental disease such as periodontitis or caries are lacking, a history of dental procedures, particularly tooth extraction performed 1–4 weeks before the onset of intracranial infection, should also be considered.[3,7,9] Even poor oral hygiene alone has proven enough to lead to brain abscesses.[8]

After a thorough literature review, we found only ten previous cases of brain abscesses in which *Pm*, an organism typically found in the human oral flora, was isolated [Table 1]. Among the cases with a known source of infection, a dental origin was reported for all but one case with esophageal pleural fistula.[1,8,10,13] It is remarkable that all the patients in this series were in good general health, except for one with an esophageal carcinoma. In agreement with a recent systemic review of infections caused by *Pm*, this case series of brain abscesses sustains that most *Pm* infections occur in a polymicrobial environment.[3] Nevertheless, in our patient and three others in this series, *Pm* was the only isolated microorganism [Table 1]. It is worth mentioning that standard bacterial culturing was ineffective to detect *Pm* in these four cases, and the authors had to use gene amplification of bacterial samples and sequencing technologies to identify the pathogen.[8,10,18] Our report supports the diagnostic value of 16S rRNA to detect *Pm* in patients with culture-negative brain abscesses.[8,10,21] The application of matrix-assisted laser desorption/ionization-time-of-flight mass spectrometry has also proven useful to detect *Pm*.[7] The challenging identification of this strict anaerobe, particularly when antibiotic therapy was started before collecting the specimen, might have contributed to the infrequent reporting of brain abscesses caused by *Pm*.[9,12-14]

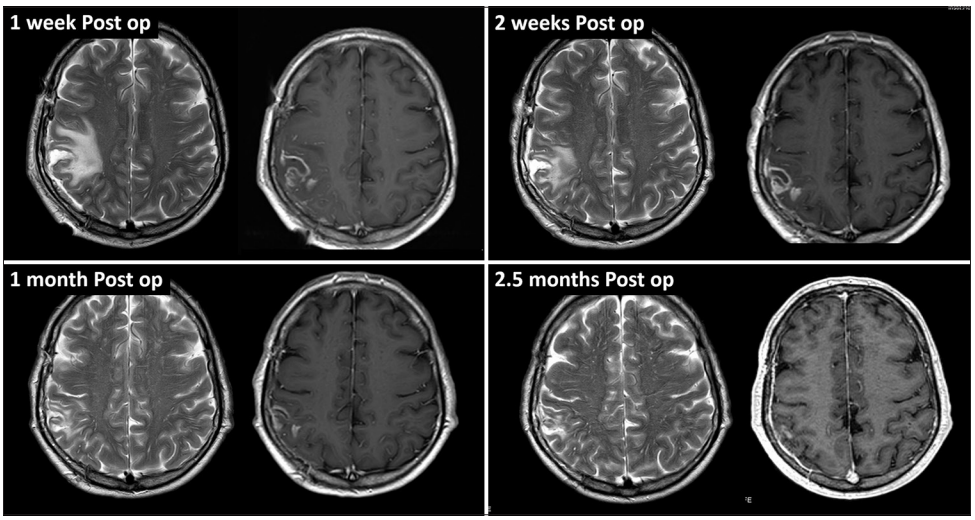

Figure 3: Postoperative magnetic resonance imaging (MRI) studies. Follow-up T2-weighted and gadolinium-enhanced T1-weighted MRI demonstrated progressive brain edema reduction, shrinkage of the residual cavity, and disappearance of contrast enhancement areas.

Table 1: Summary of demographic, clinical, bacteriological, and treatment features of the patients with brain abscesses caused by *Parvimonas micra**.

No.	Author, year[Reference]	Age, sex	Source of infection	Predisposing factors	Symptoms	Consciousness impairment	Surgical drainage	Isolated bacteria	Method of bacterial identification	Antibiotic therapy (route, duration)	Outcome (Follow-up)
1.	Murdoch *et al.*, 1988[14]	41 M	Not found	NA	Headache, vomiting	No	Yes	*Peptostreptococcus micros, Bacteroides ureolyticus, Fusobacterium, Streptococcus milleri*	Abscess cultures	NA	NA
2.		6 M	Not found	NA	Vomiting	No	Yes	*Peptostreptococcus micros, Streptococcus milleri, Bacteroides melaninogenicus, Fusobacterium*	Abscess cultures	NA	NA
3.		32 F	NA	NA	Headache	No	Yes	*Peptostreptococcus micros, Streptococcus milleri*	Abscess cultures	NA	NA
4.	Mueller *et al.*, 2009[13]	50 M	Tooth extraction	None	Weakness	Yes (GCS 13/15)	Yes	*Fusobacterium nucleatum, Micromonas micros, Actinomyces meieri*	Abscess cultures	Ceftriaxone, Rifampicin (IV, NA)	NA
5.		66 F	Not found	Esophageal carcinoma	Fever, headache, meningism	Yes (GCS 11/15)	Yes	*Fusobacterium nucleatum, Micromonas micros, Streptococcus oralis, Actinomyces turicensis*	Abscess cultures	Ceftriaxone, Rifampicin (IV, NA)	NA
6.	Kwon *et al.*, 2009[10]	49 F	Periodontitis	None	Fever, headache	No	Yes	*Parvimonas micra*	16 S rRNA (brain abscess)	Ceftriaxone, Isepamicin, Metronidazole (IV, 4 wk)+Ceftriaxone (IV, 3 wk)	Good (2 m)
7.	Vishwanath *et al.*, 2016[23]	30 M	NA	None	Headache	Yes (drowsiness)	Yes (stereotactic aspiration)	*Streptococcus* spp., *Fusobacterium nucleatum, Parvimonas micra*	Abscess cultures	Vancomycin, Metronidazole, Amikacin (IV, NA)	Good (hospital stay)
8.	Akashi *et al.*, 2017[1]	68 M	Periodontitis	None	Fever, weakness	No	Yes (stereotactic aspiration)	*Streptococcus constellatus, Fusobacterium nucleatum, Parvimonas micra*	Abscess cultures	Ampicillin and Metronidazole (IV, 6 wk)	Good (1.5 m)

(Contd...)

Table 1: *(Continued)*

No.	Author, year[Reference]	Age, sex	Source of infection	Predisposing factors	Symptoms	Consciousness impairment	Surgical drainage	Isolated bacteria	Method of bacterial identification	Antibiotic therapy (route, duration)	Outcome (Follow-up)
9.	Shtaya *et al.*, 2001[18]†	65 M	Esophageal pleural fistula	None	Fever, vomiting, weakness	No	No	*Parvimonas micra*	16S rDNA (spinal pus)	Ceftriaxone and Metronidazole (IV, 12 wk)	Good (3 m)
10.	Kim *et al.*, 2019[8]††	65 F	Poor oral hygiene	None	Nausea, general weakness	Yes (GCS 9/15)	No	*Parvimonas micra*	16S rRNA (blood)	Cefotaxime and Metronidazole (IV, 2 wk)	Poor
11.	Present case	62 M	Periodontitis	None	Headache, seizures	No	Yes (craniotomy)	*Parvimonas micra*	16S rRNA (brain abscess)	Ceftriaxone and Metronidazole (IV 3 wk)+Moxifloxacine and Metronidazole (Oral 6 wk)	Good (4 m)

*Or under its former classification (*Peptostreptococcus micros* and *Micromonas micros*), †patient with concomitant cervical and multiple brain abscess who underwent spine surgery, ††patient with concomitant liver abscess and multiple brain abscesses who discontinued treatment after 2 weeks due to financial difficulties. IV: Intravenous, m: Months, NA: No available information, wk: Weeks, rRNA: Ribosomal RNA

Optimal treatment of intracranial *Pm* infections remains uncertain.[3,12] Our patient, as well as all cases with a solitary brain abscess, underwent prompt surgical drainage [Table 1]. Nevertheless, antibiotic therapy alone might be a safe and suitable option for patients with small lesions, particularly when they are multiple and located deep within the brain.[17,18] There are even more doubts regarding the most appropriate antibiotic regimen. Penicillin, amoxicillin (±clavulanic acid), piperacillin (±tazobactam), cefoxitin, ceftriaxone, imipenem, meropenem, ciprofloxacin, clindamycin, and metronidazole have all been found effective for treating *Pm*.[9,11] Despite some *Pm* strains being resistant to metronidazole,[22] antibiotic therapy for most *Pm* brain abscess cases involved the simultaneous use of ceftriaxone and metronidazole [Table 1]. All cases had a favorable outcome except a patient who discontinued antibiotic treatment after 2 weeks due to financial difficulties.[8] Nonetheless, the simultaneous use of more than one antibiotic precludes ascertaining which one played the most determinant role in the favorable response. Finally, the greatest difference among the cases reported is the duration of the antibiotic therapy, which ranged from 6 to 12 weeks [Table 1]. Bearing in mind that successful patient outcome depends on long-term antibiotic treatment; its final duration should be individually based on strict clinical and neuroimaging follow-ups.

CONCLUSIONS

We report the successful diagnosis and treatment of a solitary brain abscess caused by *Pm* in a patient with severe periodontal infection. This case highlights the potential risk of untreated dental infections, which may lead to life-threating brain abscesses even in healthy patients. This report also supports that 16S rRNA analysis is a valuable technique to detect *Pm* in cases with culture-negative brain abscesses.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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