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ORIGINAL ARTICLE

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Pyogenic infections of the central nervous system secondary to dental affections—a report of six cases

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Abstract Pyogenic infections of the central nervous system of dental origin are quite uncommon in industrialized countries. We report six cases with intracerebral (n=4) and intraspinal (n=2) infections treated in our hospital. The microbial pathogen was successfully isolated in all patients. *Fusobacterium nucleatum* as well as *Streptococcus* species were found in three cases. *Bacillus* species were identified in two patients. *Actinomyces* was the etiologic agent in one case. All patients suffered from dental pathologies, so that after clinical and radiological exclusion of other sources an oral focus was presumed. Therapeutic management consisted of an operative procedure in order to obtain decompression, as well as evacuation of the pus on the one hand, followed by targeted antibiotics on the other. Clinical improvement was achieved in all patients, with one patient lost to follow-up. On magnetic resonance tomography, the inflammatory changes also disappeared in all cases. We recommend that oral infection with recurrent bacteraemia should always be considered in the pathogenesis of the so-called "cryptic" intracerebral and intraspinal infections.

Keywords Intracerebral abscess · Intraspinal abscess · Oral infection · Peridental ostitis

Introduction

Intracerebral and intraspinal accumulation of pus is nowadays a rare neurosurgical entity in industrialized countries. Depending on the source, incidence of brain abscess is reported to be between one and eight patients in 100,000 per year [2, 14]. Due to improved diagnostic and therapeutic possibilities, mortality could be reduced from about 50% at the beginning of the 1970s to under 10% today [1, 2, 11, 17]. Nevertheless, a pyogenic central nervous system (CNS) infection is still a life-threatening situation, which always requires rapid action. Open contamination of the brain tissue, direct spread from neighbouring structures and metastatic seeding from a distant focus are possible pathophysiogical mechanisms. Therefore, odontogenic infections or oral manipulations represent a possible source of bacteraemia, triggering off neurological complications in the intracerebral as well as in the intraspinal compartment. Only a small number of cases concerning this kind of complication have been published up to now [3–6, 12, 18].

We present six more cases, in which the isolated microbial flora and the clinical and radiological signs lead to an oral focus. We describe clinical and radiological follow-up and discuss our findings with respect to the current literature.

Patients and methods

We report retrospectively the cases of six patients between 49 and 65 years old who had been suffering from pyogenic infections of the CNS, their origin being still unknown at that time. They were treated in our institution from January 2000 to December 2004. The patient's history had lasted less than two weeks in all cases. Table 1 provides a complete summary of preoperative symptoms, therapy and follow-up. In five of the six patients there was no reason to suppose an immunodeficiency; only one patient suffered from diabetes mellitus as potential immunocompromising co-morbidity.

Before their operations, none of the patients complained of having any trouble with their teeth. Neither was there any report about preceding dental treatment or other manipulations.

The cerebral or spinal pathology was diagnosed by using magnetic resonance imaging (MRI) in all cases, showing

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Table 1 History, clinical, radiological and microbiological findings in six patients with pyogenic infections of the CNS

Patient	Age	History, clinical findings	Diagnosis	Isolated microbe	Dental pathology	Therapy	Course of disease
1	65	Headache over 2 weeks, hemianopsia	Brain abscess in the right occipital lobe	*Fusobacterium nucleatum*, *Veillonella* species, *Bacillus circulans*, saprophytic staphlococci, *Streptococcus angionosus*	Periapical ostitis 36, retained tooth 48	Abscess excision, imipenem, vancomycin, metronidazole, doxycycline, levofloxacin over 6 months	Six months post-OP: hemianopsia improved
2	58	Progressive back pain over 1 week, incomplete paraparesis sub T12	Intraspinal epidural empyema T7–9	Haemolytic B streptococci	Caries 27, 28; root rests teeth 22, 25, 26, 35	Laminectomy T7-9, irrigation of the empyema, amoxicillin with clavulanate over three months	Four months post-OP: paraparesis improved
3	49	Over some weeks progressive paresis of the right arm and the left leg, epilepsy	Multiple cerebral abscesses	*Fusobacterium nucleatum*	Caries teeth 14, 25, 27, 34, 35, 43, 44; periodontitis 21, 47	Open biopsy, clindamycin, metronidazole, cefuroxim over 1 year	One year post-OP: no ictus with anticonvulsive therapy, no neurological deficit
4	50	Acute weakness of the left arm	Single abscess in the right precentral area	*Fusobacterium nucleatum*, *Actinomyces meyeri*	Gingivitis; caries teeth 16, 17, 18, 26	Abscess excision, amoxicillin with clavulanate, metronidazole over 3 months	Four months post-OP: no neurological deficit
5	64	Headache over 2 weeks	Single abscess in the left parietal lobe	*Bacillus subtilis*, *Streptococcus oralis*	Gingivitis	Abscess excision, penicillin, ceftriaxon, metronidazole	Patient lost to follow-up
6	52	Neck pain, monoparesis of the left arm lasting a few hours	Epidural and prevertebral abscess at C5 to C7	*Staphylococcus aureus*	Periapical ostitis teeth 34; caries in all remaining teeth	Nucleotomy C5/6, abscess irrigation, clindamycin, metronidazole	Three months post-OP: no pain, no neurological deficit

one single lesion located in the occipital lobe (Fig. 1), in the parietal lobe in two patients and an abscess situated in the right precentral region in another patient. In one case, multiple lesions were scattered throughout the whole brain.

Intraspinal pus was detected in two patients, at levels C5/6 and T7–9. No patient had a temperature. Concerning laboratory findings, C-reactive protein was elevated in five patients, with values between 8.3 and 214.1 mg/l, with the highest values found in patients with spinal infection (140 mg/l and 214.1 mg/l).

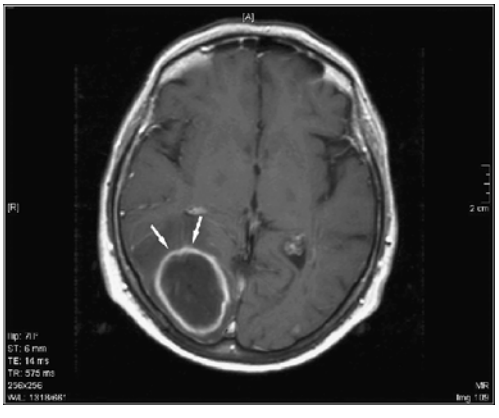

Fig. 1 Abscess formation (*arrows*) in the right occipital area triggered by *Fusobacterium nucleatum*

In all cases, treatment was simultaneously initiated via a combined operative and medical approach, with the diagnosis being confirmed by histological examination of the specimen taken during the operation.

Postoperatively, an HIV test and a computer tomographic examination of the thorax and the abdomen were done in all patients, as well as a dental pantomogram and an X-ray of the paranasal sinuses followed by an examination by a dentist and an otolaryngologist. A cardiac anomaly was excluded by means of transthoracal echocardiography in three cases and transesophageal echocardiography in one patient. A scintigraphic leukocyte scan was performed in three cases.

Antibiotic therapy was continuously performed on all patients for more than 3 months. It was stopped when symptoms improved and, above all, when there was no more contrast enhancing lesion in MRI. Dental treatment was initiated in all patients during the first month after the operation.

Results

No perioperative morbidity occurred. In one patient, a recraniotomy had to be done 4 days after the first intervention because of a recurrence of the space-occupying lesion visible on MRI.

The isolation of the pathogenic microbe from the material obtained during operation was successful in all cases. Table 1 also summarizes the cultivated microbial species and the initiated medical therapy. Concerning the postoperative evaluation, there were oral pathologies detectable in all patients—clinically as well as radiographically (Table 1). Leukocyte scans showed increased tracer uptake in the mandible area in one of three examined patients as a sign of acute local infection.

One patient remains lost to follow-up. In all other patients, there was a continuous clinical improvement during the course of disease, with a follow-up of between 2 and 12 months. After 4–12 months, inflammatory changes in MRI vanished completely in all remaining patients.

Discussion

Cerebral or intraspinal pyogenic infections of the CNS are rare in industrialized countries, due to improved diagnostic and therapeutic options in neurosurgical routine. On the other hand, there is a slightly increasing incidence in organ transplant recipients and other immunocompromised patients [13]. An odontogenic focus is often taken into consideration, but only a few cases have been described in the literature up to now [5], especially concerning intraspinal infection [3, 4, 6], although a big part of the middle European population is supposed to have “bad teeth”.

Pathogenesis

There are three different ways for a microorganism to translocate into the intracranial space. The direct contamination caused for example by penetrating injuries, the continued infection originating from oral or paranasal foci or metastatic spread of microbes during transient bacteraemia caused by distant inflammations somewhere else in the body, especially in immunodeficient subjects. In immunocompetent individuals, intruding microbes are intercepted by the reticuloendothelial system within minutes, so that only a few bacteria enter the bloodstream. In general, metastatic lesions are supposed to be caused by acute infections only, with a large number of intruding pathogens and a highly virulent microorganism or by chronic infection with recurrent bacteraemia, which breaks through the endogenous immunity mechanisms.

According to the general meaning, there is no definable origin for intracerebral or intraspinal infection in up to 25% of cases [13]. These are the so-called “cryptic abscesses”. Apart from pulmonal and cardiac abnormalities, an oral focus has often been discussed [5, 10, 18]. The oral cavity is an ideal entry point for microorganisms. There are more than 350 species that have been isolated, with streptococci and bacteriodacae as the most important species. The microbiological data of our patients represent the flora of the oral cavity described in the relevant literature [5, 10, 15].

The paradental tissue, with its anatomic specialities, is an excellent environment for microbes, which can trigger off local infections, which, for their part, are the origin of recurrent bacteraemia, possibly leading to a metastatic spread in immunocompetent individuals as well. Thus, it could be demonstrated that bacteraemia has been found in 38.5% during tooth brushing, but lasting for a few seconds only [16]. After other oral manipulations, especially tooth extraction or intraoral surgery, the rate is much higher [18, 19], with *Streptococcus viridans* being the most isolated organism. In our patients, the most frequently diagnosed oral pathologies were periapical ostitis and caries, both described in the literature as possible sources of a systemic spread of microorganisms [8–10, 12].

Evaluation

Due to the wide availability of MRI, rapid evaluation of the inflammatory changes is nowadays no problem, so that an operation can be initiated as soon as possible to evacuate the pus, to collect some specimens for microbiological examination and to confirm the presumed diagnosis histologically. The basis of the subsequent search for the origin of the abscess is the isolation and cultivation of the triggering microbe. With correct transport and treatment of the specimens, isolation and cultivation of the triggering microbe is possible in up to 100% of cases [13]. Recently, 16S rDNA sequential analysis has been described to allow identification of the bacterium in up to one day, which is especially useful in slowly growing or fastidious organisms [20]. This technique was performed on one of our patients. *Fusobacterium nucleatum* could be identified 5 days after the operation and after a preoperative antimicrobial treatment for over 14 days. According to the relevant literature, this method does not provide information on antibacterial susceptibilities, so that it has always to be accompanied by conventional identification.

Against the background of the microbiological data, identification of the source of the bacteraemia has to be started. This includes computer tomographic examinations of the thorax and the abdomen to exclude pulmonal diseases, such as bronchiectasia and arteriovenous malformation, which could be found in 0.8% of all patients [7]. In addition to this, an echocardiography is also helpful.

Further, 99 m technetium granulocyte scintigraphy may also be helpful if positive, but a negative result, especially under antibiotic covering therapy, does not automatically exclude an oral source.

In our opinion, three conditions have to be fulfilled to confirm dental origin, always considering that “bad teeth” are a widespread problem. The first and most important condition is that no other source has been found; secondly, the microbiological spectrum should represent the oral microflora; and thirdly, there have to be clinical and

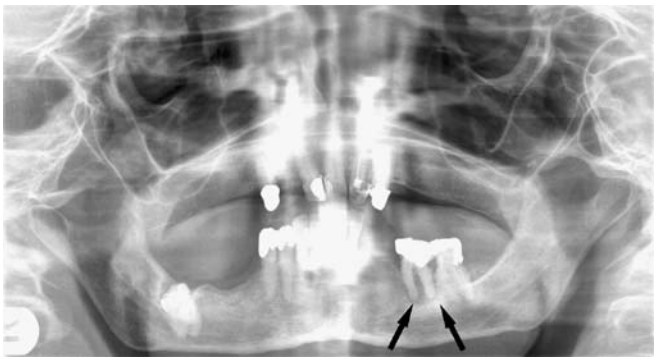

Fig. 2 Oral pantomogram of this patient reveals signs of periapical ostitis at 36 (*arrows*)

radiographical signs of an acute or chronic dental or paradental infection. A clinical evaluation by a dentist and an oral pantomogram are useful here (see Fig. 2).

Therapy

The therapeutic concept in brain or intraspinal abscess of dental origin is the same as in every pyogenic infection of any other source. In the first place, it is most important to treat the CNS process as a possible life-threatening entity, consisting of an operation on the one hand and an antimicrobial therapy on the other, which should be applied for a longer period. In the literature, the opinions differ about how long these antibiotics should be administered. Recommendations differ between weeks and months [2, 13]. In our opinion, normalization of C-reactive protein and white blood cells, and a complete resolution of the inflammatory changes on MRI, are mandatory before stopping the antibiotic therapy. Initially, there should be broad antibiotic coverage, always including anaerobic pathogens, depending on the suspected source of the infection and the individual experience of the treating physician. After changing antibiotic therapy to a more selective one, the microbial data obtained from the operation and the potential co-morbidity of the patient should be considered.

Especially concerning the dental origin of the infection, prophylaxis is of the highest importance, so that we, as neurologists and neurosurgeons, should also recommend consequent dental hygiene.

Conclusion

Dental or paradental infections seem to be a rare cause of intracerebral or intraspinal infections in otherwise healthy individuals. The oral source is ascertainable often only after exclusion of other sources. Nevertheless, a dental focus should always be considered in the evaluation and the treatment of so called “cryptic” infections of the CNS. It remains a severe entity, but with appropriate prophylaxis an avoidable one.

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Comment

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The current challenges in the management of intracranial abscess for the neurosurgeon are chiefly as follows. First is maintaining a high level of suspicion in appropriate patients so that catastrophic delays in diagnosis do not occur. Second is choosing an appropriate

antibiotic regimen and a suitable surgical method. Third is attentive postoperative follow-up, so that recurrences are dealt with decisively.

Ewald et al. have reported six cases with cryptic infection of the CNS that occurred secondary to dental and paradental infection. It is interesting that before an operation was employed no case complained of having any trouble with his/her teeth and there was no report about preceding dental treatment or manipulation because of dental disorder. Dental or paradental infection was diagnosed with investigation by dental pantomogram.

It is impossible to disagree with the necessity that dental and paradental infection should be proven clinically or radiologically, the determined agent microorganism should be harmonious with the oral flora, and no etiological causes should have been shown except for dental or paradental source.

Although brain abscess and its causes are mentioned in detail in the textbook, this paper could be beneficial for readers because of the authors' distinct outlook on the subject, as described above.