

Efstathios J. Boviatsis · Andreas T. Kouyialis ·  
George Stranjalis · Stefanos Korfiatis ·  
Damianos E. Sakas

## CT-guided stereotactic aspiration of brain abscesses

Received: 23 November 2002 / Accepted: 21 January 2003 / Published online: 27 March 2003  
© Springer-Verlag 2003

**Abstract** The effective treatment of intracranial abscess remains controversial. Progress in technology, linked with the development of neuronavigational systems, has made stereotactic aspiration and drainage of intracerebral abscesses effective and valid alternatives to traditional methods, namely, conservative medical treatment or open surgical excision. Between 1995 and 2002, 12 patients at our hospital underwent drainage of intracerebral abscesses under stereotactic guidance. Ten patients had solitary lesions and two had multiple abscesses. The appropriate antibiotic schemes were administered following culture of the aspirated material. The size of the abscess, the mass effect, and response to antibiotic treatment were followed up by repeated CT scans. All patients showed improvement and, at the end of treatment, returned to their previous activities. There were neither deaths nor any postoperative complication. A second aspiration was required in one patient due to recurrence of the abscess. The CT-guided stereotactic aspiration of brain abscesses helps achieve all treatment goals. It drains the contents of the abscess, reduces mass effect, and confirms diagnosis. It is minimally invasive, carries minimal morbidity and mortality, and can be performed on compromised patients under local anesthesia.

**Keywords** Brain abscess · Stereotactic aspiration · Stereotaxy

### Introduction

According to the international literature, despite the widespread use of modern antibiotics, treatment of

predisposing factors leading to its formation, and improvements in living conditions even in underdeveloped countries, brain abscess has not shown reduced incidence. Possible reasons include an increasingly immunocompromised population (patients receiving chemotherapy or steroids, HIV-positive patients, and transplant recipients) and the high diagnostic ability of modern neuroimaging techniques that help diagnose nonsymptomatic and small abscesses in early stages of formation.

Even to the present day, the correct management of intracranial abscesses remains disputed, due to the limited results and serious clinical burden these patients represent [1, 2]. The administration of a combination of antibiotics alone has not yielded the anticipated results and is nowadays used as an adjuvant treatment to surgical decompression or when surgery has failed [3]. Conservative treatment of brain abscesses can give satisfactory results only in certain cases and only if certain criteria are met.

Surgical treatment, although successful in a good number of cases, presents the disadvantage of creating an excess surgical trauma in an already edematous brain; this is inexpedient, especially when the abscess is in a critical structure of the brain. Moreover, it is poorly applicable in cases of multiple abscesses [4], abscesses deeply seated in eloquent regions, and poor surgical candidates who are too debilitated to undergo general anesthesia.

As an alternative treatment, stereotactic aspiration of brain abscesses under both CT and MRI guidance is of great therapeutic value. It is becoming more and more accepted because it carries no mortality and little morbidity, causes only slight trauma to the brain tissue, and is better than other methods in cases of multiple and deeply seated abscesses.

### Patients and methods

Twelve patients with clinical and laboratory diagnoses of brain abscess confirmed by brain CT or MRI were treated from 1995 to 2002. There were seven male and five female patients. Ten had solitary lesions and two presented with multiple abscesses.

E. J. Boviatsis (✉) · A. T. Kouyialis · G. Stranjalis · S. Korfiatis ·  
D. E. Sakas

Department of Neurosurgery,  
Evangelismos General Hospital,  
61 Ipsilantou Street, 115 21 Athens, Greece  
e-mail: eboviats@med.uoa.gr  
Tel.: +30-210-7201654  
Fax: +30-210-7215281

**Table 1** Location of the abscesses in the cerebral hemispheres

Location	No. of abscesses
Thalamus	3
Cerebral hemispheres (cortex)	5
Basic ganglia	3
Deep white matter	4

**Table 2** Symptoms and signs

	No. of patients
Headache	9
Mental status changes	8
Focal neurologic deficit	8
Hemiparesis	4
Aphasia	13
Visual defects	1
Seizures	6
Fever	6
Papilledema	4
Nuchal rigidity	1

Localizations of the abscesses, which were all supratentorial, are seen in Table 1. The clinical picture was characterized by symptoms of intracranial hypertension in all patients, while eight presented with focal kinetic or sensorial symptoms. Six had seizure crises of generalized or local type, and nuchal rigidity was observed in one patient (Table 2).

Preoperative evaluation of the patients included a wide variety of exams and had two main components:

1. Assessment of general medical status, including potentially complicating conditions. General medical evaluation emphasized the renal, cardiovascular, hepatic, and blood coagulation systems.
2. The attempt to recognize the predisposing factor or the initial source of infection.

All patients were evaluated with complete blood count, erythrocyte sedimentation rate, clotting screen, urinalysis, and chest, skull, and paranasal sinus X-rays. Moreover, blood, urine, and sputum cultures were obtained, and all patients were checked for HIV infection. Finally, they were all submitted to heart ultrasound and ear, nose, and throat examination. The size and location of the abscesses were assessed with gadolinium-enhanced CT and MRI. Predisposing factors were identified in seven cases and are seen in Table 3.

Five of the patients had already received antibiotics prior to the aspiration. Three of them were treated in a pathology department for fever of unknown origin; one was treated for a pulmonary infection and one in a cardiology department for infective endocarditis. They were all referred to our department after deterioration of their general condition and mental status or after they had presented with neurologic deficits or seizures. Six patients had initial diagnoses of brain abscess and were started on antibiotics after the stereotactic procedure. There was finally a single patient diagnosed with glioblastoma multiforme and who received corticosteroids prior to the aspiration. She was submitted to stereotactic biopsy of her lesion, but purulent material was aspirated instead. After evacuation of the abscess, steroids were tapered for 2 days and she was immediately started on antibiotics. None of the other patients received steroids and, in case of clinical signs of elevated intracranial pressure, they received 20% mannitol as antiedematous treatment.

Indications for stereotactic aspiration in our series of patients included: small, deep-seated abscesses located near or within

**Table 3** Predisposing factors for the development of cerebral abscess

	No. of patients
Otitis media	3
Paranasal sinus infection	2
Infective endocarditis	1
Interatrial septum defect	1
Head trauma	1
Pulmonary infection	1
Unknown	3

**Table 4** Results of cultures of the aspirated pus

Isolated organism	No. of patients
<i>Peptostreptococcus</i>	3
<i>Staphylococcus aureus</i>	2
<i>Streptococcus viridans</i>	1
B-hemolytic streptococcus	1
Mixed infection ( <i>Bacteroides fragilis</i> , <i>Peptostreptococcus</i> )	1
No culture	4

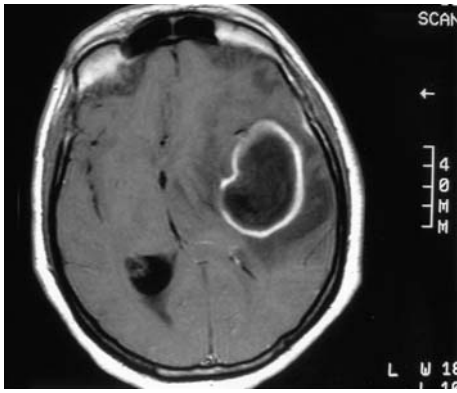
eloquent structures (seven patients), compromised patients with poor general condition considered to be poor candidates for surgery under general anesthesia (three patients), abscess in the stage of early cerebritis (two patients), presence of mass effect (three patients), and biopsy/differential diagnosis (one patient).

All patients were subjected to stereotactic aspiration and draining of the abscess using the Cosman-Roberts-Well stereotactic system (Radionics, Burlington, Mass., USA). Targeting of the lesion was performed by CT scan with simultaneous i.v. administration of contrast medium. A burr hole was then carried out in the precoronal area, 3 cm from the midline, under local anesthesia using 2% xylocaine and mild analgesics i.v.. Valproate sodium (Depakine, Sanofi Winthrop, France) was administered to all patients intraoperatively at a dose of 800 mg. Perforation of the abscess capsule was carried out and, via a 2.7-mm Nashold biopsy needle, the pus was drained in a quantity equal to or smaller than the total volume of the abscess, which had been calculated preoperatively. Lavage of the abscess cavity using normal saline solution and broad-spectrum antibiotics was performed in all cases. In the two patients with multiple abscesses, the larger one was initially approached in each case (3.0 cm and 2.5 cm, respectively) and in one, the second largest in the other hemisphere was evacuated 24 h later. The aspirated material was sent for microbiological screening and culture; the results of laboratory examinations are shown in Table 4. In four cases, even though Gram's stain was positive, no micro-organisms were cultured. These sterile cultures were correlated with patients who had received antibiotics preoperatively.

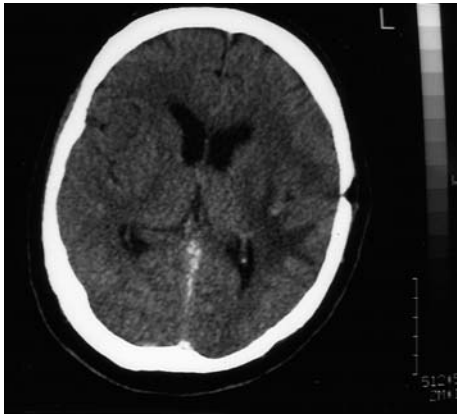
Following the procedure and prior to receiving the culture results, all patients were started on empirical antibiotics. Intravenous crystalline penicillin, metronidazole, and a third-generation cephalosporin were the first to be administered and later changed according to the results of the cultures, antibiography, and sensitivity tests. All patients received i.v. antibiotics for 4 weeks, followed by oral ampicillin (150 mg/kg per day) and trimethoprim sulphamethoxazole for another 4 weeks.

## Results

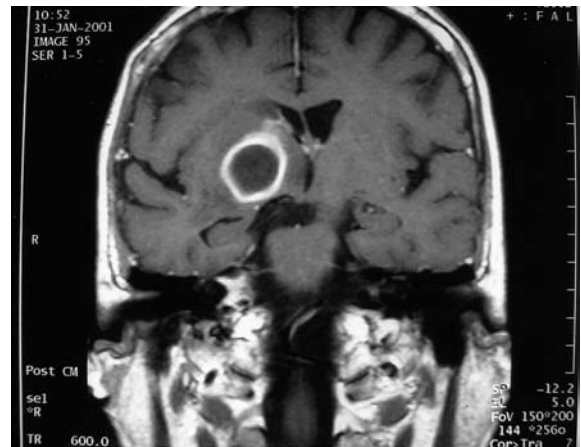
There were no deaths in our series. The postoperative course in all patients was normal, with no complications. Gradual improvement of the clinical picture was observed



**Fig. 1** MRI scan in a 37-year-old male showing a large brain abscess located in the left temporoparietal area



**Fig. 2** CT scan performed on the same patient 1 week later shows complete disappearance of the abscess. There was also dramatic improvement in clinical status



**Fig. 3** MRI scan in a 65-year-old female showing a brain abscess in the right basal ganglia



**Fig. 4** CT scan performed on the same patient 1 week after aspiration of the abscess shows the residual cavity

in all 12 patients. The immediate postoperative course in two patients with large abscesses (Fig. 1) was spectacular. Preoperatively, they were both lethargic, with a fall in the level of consciousness due to the large size of the abscess, but presented immediate postoperative amelioration (Fig. 2) with a normal level of consciousness (Glasgow coma scale 15/15). Repeated CT scans in all patients exhibited gradual decreases in abscess size, reaching total obliteration of edema and the abscess cavities (Fig. 3, Fig. 4). There was abscess relapse in one patient 7 days after the first aspiration, and he was thus submitted to repeated stereotactic aspiration.

The postoperative course was followed for periods ranging between 3 months and 3.5 years. All patients had normal courses and returned to their previous activities (Glasgow Outcome Scale 5). The duration of hospitalization fluctuated from 3 to 5 weeks, and mobilization started on the 2nd postoperative day. All patients were subjected to CT scan on the first postoperative day and then once every week to check the course of the disease. Following discharge from hospital, they all received anticonvulsants (Depakine) at a dose of 1,000 mg/day for a period of at least 1 year.

## Discussion

The management of brain abscesses aims to (1) reduce the space-occupying activity, (2) reduce the intracranial pressure, and (3) eradicate the pathogenic micro-organism. There is still debate as to the most appropriate therapeutic approach. The available forms of treatment are conservative medical management [2, 5] and the open surgical approach (free-hand needle aspiration or surgical excision) [6, 7, 8, 9]. In recent years, image-guided stereotactic aspiration has been added to these existing forms of treatment.

Wise and Gleason, in 1979, were the first to report CT-guided aspiration of a deeply seated abscess [9]. In 1985, Broggi et al. [10] presented their experience in the treatment of deep brain abscess by stereotactic implantation of an intracavity device for evacuation and local application of antibiotics. There followed reports [4, 11, 12, 13, 14, 15] supporting the value of stereotactic techniques. This paper deals with the first 12 cases of intracranial abscesses reported in Greece that were treated using stereotactic aspiration.

One of the main problems caused by brain abscesses is the space-occupying influence exerted on the brain parenchyma and the resulting increase in intracranial pressure. The aim of any therapeutic effort is reduce the size of the lesion and eradicate the pathogenic micro-organism. The cause of intracranial hypertension is the formation of an abscess cavity due to the collection of purulent material. Stereotactic aspiration permits immediate, fast, and safe removal of the contents of the abscess, resulting in decreased intracranial pressure, even in emergency settings.

Stereotactic aspiration is carried out under local anesthesia, which permits application in compromised patients with disturbed levels of consciousness and having the danger of herniation due to the lesion. Because of its technique, it creates the smallest possible injury to the brain surrounding the abscess, thus causing minimal retrogression of the already existing edema. Stereotactic aspiration can be repeated safely and is considered the procedure of choice in cases of multiple and/or deeply seated abscesses, for which open surgical approach is impossible, and when the damage is situated in eloquent areas of the brain.

In our series, 12 patients with 15 supratentorial abscesses underwent stereotactically guided aspiration of the lesions. Follow-up was performed with clinical evaluation and repeated CT scans for periods between 3 months and 3.5 years. All patients had normal courses, and no recurrence was observed. One of the female patients, who presented with multiple abscesses, had another operation for an interatrial septum defect 6 months after discharge from our department. All patients returned to their previous activities (Glasgow Outcome Scale 5) within a median of 4 months after the operation. Additional proof of the superiority of this method is the possibility of later (or subsequent) open surgical excision in case of failure of the aspiration. In our series, there was no need for this procedure.

Reports of the abscess "capsule" in the literature and the need for its removal stand in contrast to our observations of reabsorption of the abscess walls following removal of its contents. The literature also refers to the possibility of placing a catheter in the cavity and leaving it in situ for 3 to 4 days in order to continue drainage and for infusion of antibiotics. The authors did not pursue this method, with similar results [10, 16]. As already mentioned, antibiotic treatment was started as soon as the procedure was concluded, unless the patient was already on a therapeutic scheme. The initial combination was later adjusted according to the results of cultures and sensitivity tests. When isolation of the pathogenic micro-organism was unsuccessful, the initial combination was altered according to the identified predisposing factor.

## Conclusions

Review of the literature shows various series of brain abscesses managed by stereotactic aspiration, however, with small numbers of patients. Although the number in our series is also small and requires further development, our results are in agreement with data of the international literature and support the view that stereotactic aspiration of brain abscesses has advantages over other methods. We thus believe that, in the future, this surgical procedure will predominate internationally as the first-line treatment for brain abscesses.

## References

1. Bidzinski J, Koszewski W (1990) The value of different methods of treatment of brain abscess in the CT era. *Acta Neurochir* 105:117-120
2. Kammin M, Bibble D (1981) Conservative management of focal intracerebral infection. *Neurology* 31:103-106
3. Dyste GN, Dias PS, Uttley D (1988) CT scanning in the management of intracranial abscess: a review of 100 cases. *Br J Neurosurg* 21:439-446
4. Nauta HJW, Contreras FL, Weiner RL, Crofford MJ (1987) Brainstem abscess managed with computer tomography-guided stereotactic aspiration. *Neurosurgery* 20:476-480
5. Berg B, Franklin G, Guneo R, Boldrey E (1978) Non-surgical cure of brain abscess: early diagnosis and follow up with CT scan. *Ann Neurol* 3:474-478
6. Maurice-Williams RS (1987) Experience with "open evacuation of pus" in the treatment of intracranial abscess. *Br J Neurosurg* 1:343-351
7. Stephanov S, Jonberg MJ (1982) Large brain abscess treated by aspiration alone. *Surg Neurol* 17:338-340
8. Maurice-Williams RS (1983) Open evacuation of pus: a satisfactory approach to the problem of abscess? *J Neurol Neurosurg Psychiatry* 46:697-703
9. Wise BI, Gleason CA (1979) CT-directed stereotactic surgery in the management of brain abscess. *Ann Neurol* 6:467-471
10. Broggi G, Franzini A, Peluchetti P, Servello P (1985) Treatment of deep brain abscess by stereotactic implantation of an intracavity device for evacuation and local application of antibiotics. *Acta Neurochir* 76:94-98
11. Stapleton SR, Bell BA, Uttley D (1993) Stereotactic aspiration of brain abscess. Is it the treatment of choice? *Acta Neurochir* 121:15-19
12. Apuzzo ML, Chandrasoma PT, Cohen D, Chi-Shing Z, Zelman V (1987) Computed imaging stereotaxy: experience and perspective related to 500 procedures applied to brain masses. *Neurosurgery* 20:930-937
13. Lunsford LD (1987) Stereotactic drainage of brain abscess. *Neurol Res* 9:270-274
14. Rajshekhar V, Chandy MJ (1994) Successful stereotactic management of a large cardiogenic brainstem abscess. *Neurosurgery* 34:368-371
15. Dyste GN, Hitchon RW, Menzes AH (1988) Stereotactic surgery in the treatment of multiple brain abscesses. *J Neurosurg* 69:188-191
16. Hasdermir MG, Ebbeling U (1993) CT-guided stereotactic aspiration and treatment of brain abscess. *Acta Neurochir* 125:58-63