

Brain abscesses – the Groote Schuur experience, 1993 - 2003

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Summary

Objective. To review management and outcome of patients with brain abscess treated at Groote Schuur Hospital (GSH) between 1993 and 2003.

Patients and methods. Case notes, radiological results and laboratory records were reviewed retrospectively for 121 patients at GSH who underwent a neurosurgical procedure for treatment of a brain abscess between 1993 and 2003. Patients not treated surgically were excluded. Follow-up with serial computed tomography (CT) scans, erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) levels and the temperature chart were used to determine the duration of parenteral antibiotic treatment and the need for repeat surgical evacuation of pus by either aspiration or excision of the capsule.

Results. The mean patient age was 33 years, with a male-to-female ratio of 5:1. Headache, depressed level of consciousness and pyrexia were the commonest presenting symptoms. Other symptoms included seizures and hemiparesis. The frontal lobe was the commonest site (44%); the majority of abscesses occurred as a result of infection following trauma. Mastoiditis (21%) and sinusitis

(8%) were the second and third most common causes. Organisms were identified in 81% of cases; polymicrobial infections occurred in half of these. Thirty-three different organisms were identified, the majority of which were Gram-positive bacteria. Anaerobes were present in 23%, while methicillin-resistant *Staphylococcus aureus* was identified in 1 patient. *Nocardia* was seen in 3 patients, 2 of whom were diabetic. The average duration of parenteral antibiotic therapy was 15 and 19 days for excision and aspiration respectively. Accurate ESR records were available in 75% of cases, with a positive predictive value in 81%, while CRP (in use since 1999) was helpful in 92% of cases.

Outcome. Sixteen patients (13%) died, 12 of whom had been admitted with a Glasgow Coma Score (GCS) of less than 4T/15. Thirteen patients developed epilepsy. On discharge, patients continued to take oral antibiotics for another 4 weeks, at the end of which they were reviewed at the neurosurgery outpatient department.

Conclusion. Compared with previous studies from this hospital, mortality and morbidity have been diminishing progressively. GCS at the time of admission remains the most important prognostic factor.

Despite the advent of modern imaging technologies, better surgical techniques and newer antibiotics, brain abscesses and other forms of intracranial sepsis remain serious and life-threatening conditions. Delay in diagnosis and treatment can have deleterious and even fatal outcomes.

This study reviews the management and outcome of brain abscesses during the last decade at Groote Schuur Hospital. A comparison is made to previous studies and the outcomes are compared.

Patients and methods

All patients admitted to GSH between 1993 and 2003 with a proven brain abscess were included in the study. The case records were reviewed retrospectively.

In accordance with our protocol, all patients in whom there was clinical suspicion of intracranial sepsis had a brain computed tomography (CT) scan done on admission. All patients with brain lesions showing 'characteristic' ring-lesion appearance of a brain abscess (diameter 3 cm or more) on CT scan underwent at least one surgical procedure, were

started on triple antibiotics (ceftriaxone, cloxacillin and metronidazole), and had blood taken for determination of the erythrocyte sedimentation rate (ESR) and C-reactive protein (CRP) level. Ultimately, the choice of antibiotic therapy was guided by the final culture results.

There were 121 patients, with a mean age of 33 years; 101 patients were male and 20 female.

Patients were grouped according to aetiology: implantation (traumatic); otogenic and rhinogenic; metastatic from pulmonary, cardiac and dental sepsis; iatrogenic following procedures on the brain for other reasons; and cryptogenic, where the source of the sepsis could not be identified (Fig. 1).

Results

Location, source and predisposing conditions

There were 121 patients, with a mean age of 33 years; 101 patients were male and 20 female.

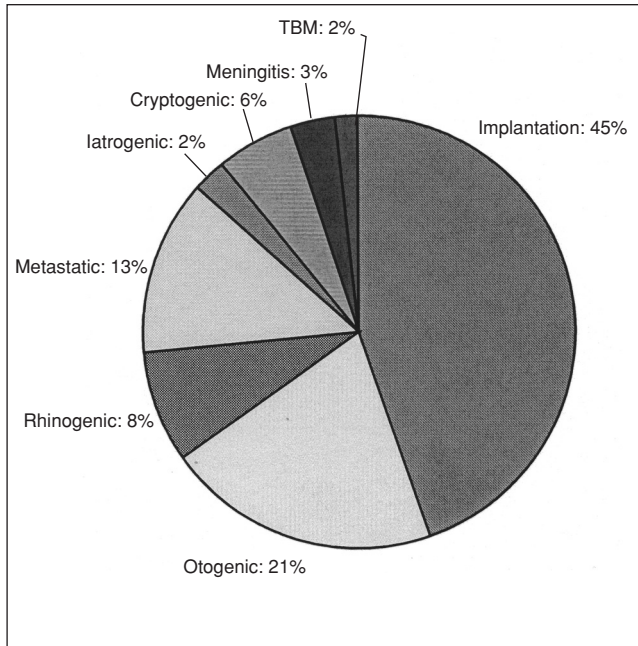


Fig. 1. Sources of infection.

The location of abscesses was supratentorial in 110 patients (91%) and infratentorial in 11 patients (9%) (Fig. 2). The frontal lobe accounted for the majority of the supratentorial abscesses (53 patients, 44%). A large proportion of the frontal lobe abscesses (30 out of 53 patients, 57%) arose from implantation secondary to trauma (mostly sharp assault), while in 10 patients (19%) the source was rhinogenic (Fig. 3). Parietal lobe abscesses accounted for 31 cases (26%), 14 of them due to implantation by trauma. Five patients (4%) had occipital lobe abscesses, 4 of which were caused by trauma. Most temporal and cerebellar lobe abscesses were of direct otogenic origin (Figs 2 and 3). Iatrogenic abscesses occurred in 3 patients, while metastatic abscesses accounted for 16 cases, 12 (10%) from pulmonary sepsis, 1 (1%) from the Ebstein cardiac anomaly and 3 (2%) from dental infections. Concomitant bacterial meningitis occurred in 4 patients (3%) while 2 patients with TB meningitis had a concurrent bacterial abscess. Cryptogenic abscesses occurred in 7 patients (6%).

Potential predisposing immune-compromising illnesses were identified in 9 cases.

Presenting features

The majority of the patients presented with multiple symptoms. Headache (81 patients) was the most common, followed by depressed level of consciousness (74 patients), pyrexia (47 patients), seizures (33 patients) and nausea and vomiting (21 patients). Twelve patients presented with a Glasgow Coma Score (GCS) of less than of 4T/15. Other presenting symptoms included cranial nerve palsies, ataxia and visual symptoms. The average duration of symptoms at the time of presentation was 12 days (range 3 - 56 days). CT scan was the primary mode of diagnosis in all 121 patients. An average of 6 CT scans were done per patient during treatment.

Operative drainage procedures

All 121 patients underwent a surgical procedure. Free-hand needle aspiration through a burrhole or craniectomy was

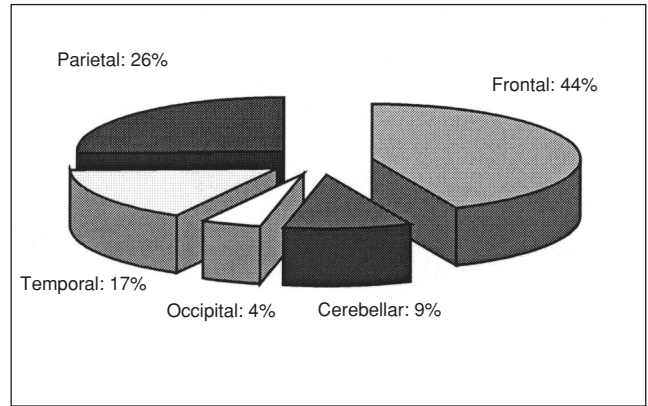


Fig. 2. Abscess location.

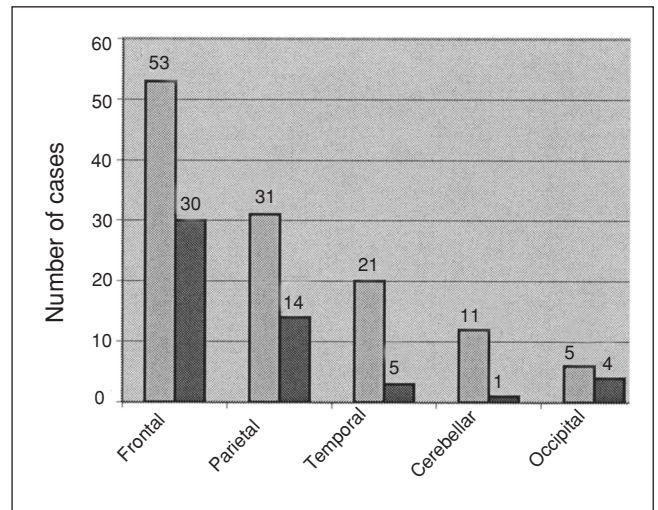


Fig. 3. Relationships of abscess location to history of trauma.

done 253 times, while stereotactic aspiration was used in 4 cases. Craniotomy and excision of the abscess capsule was done in 16 patients. Eighteen mastoidectomy and 11 sinus trephination procedures were also performed. Considering aspiration and excision procedures alone, an average of 2.3 operations were performed per patient with a brain abscess.

Microbiology

All the micro-organisms cultured from the pus are listed in Table I.

Despite the fact that many patients started antibiotic treatment before surgery, positive cultures were identified in 98 patients (81%). However, no organisms were cultured in patients who had been on antibiotics for more than 1 week before surgery.

Gram-positive bacteria were the most common group of bacteria isolated. Polymicrobial infections occurred in 42 of the 98 patients (43%).

Anaerobes were identified in 23 cases (14%).

Nocardia was identified in 3 patients, 2 of whom were diabetic. One patient had multiple amoebic brain abscesses related to a liver abscess which had ruptured into the pleural cavity.

In this study, *Staphylococcus aureus*, coagulase-negative staphylococcus and beta-haemolytic streptococci were the three most prevalent pathogens associated with implantation

by trauma. *Proteus* and *Streptococcus milleri* were the two most common pathogens of otogenic origin, while *S. milleri* was the most common pathogen of rhinogenic origin.

Antimicrobial therapy

The patients in the study received an average of 15 and 19 days of parenteral antibiotics for excision and aspiration respectively. The duration of antibiotic therapy was determined by the following factors: (i) decrease in the level of ESR and CRP (before 1999 only ESR was available); (ii) diameter of the abscess lesion on follow-up CT scans; and (iii) the temperature chart of the patient.

CRP was positively predictive in 23 of the 25 patients (92%), while ESR was positively predictive in 73 of 90 patients (81%). In these cases the levels of the septic markers were initially elevated and reduced with response to treatment. This was evidenced by the return of temperature to normal and the size of the abscess on follow-up CT scan.

Before 1996 the broad-spectrum antibiotics given on admission to cover Gram-positive, Gram-negative and anaerobic bacteria were benzylpenicillin, chloramphenicol and metronidazole. With the advent of third-generation

cephalosporins, ceftriaxone together with cloxacillin and metronidazole have become the mainstay of initial therapy. This treatment is continued until a positive culture and sensitivity result are available.

Follow-up and outcome

Once the temperature had settled and there was a decrease in ESR and CRP to normal levels and a good surgical result on follow-up CT scan, the regimen was converted to oral antibiotics and the patient discharged to continue the medication at home for another 4 weeks. Flucloxacillin and cotrimoxazole were the most commonly used oral agents. The patient was then reviewed at the neurosurgical outpatient clinic. ESR and CRP measurement and CT scan were repeated at this time, and depending on the results, the oral antibiotics were either stopped or continued for another 2 weeks pending a review. The patients were followed up as outpatients for at least 24 months, those developing epilepsy needing a longer period of follow-up.

The outcome of our patients was classified according to the Glasgow Outcome Score (GOS), with a score of 5 being a return to normal productive life without any deficit and a score of 1 being death. Seventy-four patients (61%) had a GOS of 5, 28 (23%) had a GOS of 4, 3 (2.5%) had a GOS of 3 and 16 patients died (GOS of 1) (13%). Twelve (75%) of the deaths occurred in patients who had a GOS of less than 4T/15 on admission. Six of 7 patients who had intraventricular rupture of abscess died, while 4 of 5 patients with metastatic abscesses from the lungs also died. Thirteen patients (11%) developed epilepsy, while 6 patients (5%) developed hemiparesis.

Discussion

Successful treatment of brain abscesses requires not only appropriate antimicrobial therapy, surgical intervention and eradication of the primary source, but also a high index of suspicion to enable early referral for CT scanning and prompt surgical intervention.^{1,2} Before the CT scan era, diagnosis by angiography, air studies, pyelograms and isotope scans added to the delay in surgical intervention, with most patients already compromised by delayed presentation to hospital.³ The CT scan has made possible early diagnosis and urgent surgical intervention and is probably the most important factor in the improvement in mortality rates.⁴ The availability of efficient laboratory facilities for bacteriological analysis of the pus, and the introduction of the cephalosporins are added factors in the improved outcomes.

The average duration of symptoms in this study was 12 days (median 12 days). A mortality rate of 13% shows a significant improvement from studies done previously at GSH. Mortality for the period 1952 - 1965 was 45%, for 1966 - 1976 it was 27%, and for 1977 - 1986, 17%.⁷ Most of the deaths in our study occurred in patients who presented with a GOS of less than 4T/15. Of the 16 deaths, 10 occurred between 1993 and 1997, while only 6 deaths were recorded between 1998 and 2003. It was noticed that patients were referred with a shorter duration of symptoms in the second half of the study than in the first. Lower mortality rates have been recorded in studies where the duration of symptoms was shorter. Tattevin and Regnier⁵ noticed a significant improvement in mortality from more than 30% during 1980-

Table I. Microbial pathogens isolated from brain abscesses

Isolate	No. of isolates
Gram-positive bacteria	
<i>Streptococcus milleri</i>	24
<i>Streptococcus pneumoniae</i>	2
Beta-haemolytic <i>Streptococcus A</i>	19
Group G <i>Streptococcus</i>	1
<i>Staphylococcus aureus</i> (methicillin-sensitive)	23
<i>Staphylococcus aureus</i> (MRSA)	1
Coagulase-negative <i>Staphylococcus</i>	14
Other Gram-positive bacteria	
<i>Enterococcus</i>	6
Gram-negative bacteria	
Enterobacteriaceae	
<i>Proteus mirabilis</i>	13
<i>Enterobacter cloacae</i>	7
<i>Escherichia coli</i>	5
<i>Escherichia faecalis</i>	1
<i>Klebsiella species</i>	4
<i>Citrobacter</i>	3
<i>Morganella morganii</i>	1
<i>Pseudomonas aeruginosa</i>	3
<i>Haemophilus influenzae</i>	3
<i>Providentia</i>	1
<i>Stenotrophomonas</i>	1
<i>Serratia</i>	1
<i>Diphtheroides</i>	1
<i>Acinetobacter</i>	4
Anaerobes	
Clostridia	8
<i>Bacteroides</i>	7
<i>Propionibacterium</i>	4
<i>Peptostreptococcus</i>	4
<i>Nocardia</i>	3

MRSA = methicillin-resistant *Staphylococcus aureus*.

1992 to 8% in 1993 - 1999 when patients were admitted a median of 2 days (range 0 - 7 days) after neurological symptoms appeared. Alderson *et al.*⁶ noticed a decrease in mortality from 42% in 1964 - 1968, to 21% in 1969 - 1973, and to 10% in 1974 - 1978. This improvement may have reflected early surgical intervention and treatment with metronidazole. Compared with the study by Domingo and Peter,⁷ morbidity also improved, with a reduction in the prevalence of epilepsy from 20 - 55% to 13%. Hemiparesis occurred in 5% of the patients. Tattevin and Regnier⁵ reported epilepsy in 7.5% and sensory and motor changes in 20%.

Implantation was the major cause of intracranial abscesses in this study, which correlates with the levels of violence in the Western Cape. A study by Mwang'ombe⁸ at the Kenyatta National Hospital, Nairobi, also reports trauma as the commonest cause of brain abscess. In most studies worldwide, the majority of the intracranial abscesses are otogenic in origin, followed by rhinogenic. In this study implantation abscesses accounted for 45%, followed by otogenic (21%). Metastatic abscesses accounted for 13%, while rhinogenic abscesses were fourth (8%). In the study by Keet³ done previously at GSH, otogenic causes were responsible for 40%, implantation for 22%, metastatic for 31% and rhinogenic for 10%. The study by Domingo and Peter⁷ reported an otogenic cause in 33% of cases followed by implantation in 26%. Reduction in the prevalence of metastatic abscesses could probably be a result of aggressive treatment of dental, pulmonary and cardiac infections.

Gram-positive bacteria accounted for the majority of the microbial pathogens (55%), while Gram-negative and anaerobic organisms were found in 29% and 14% of the cases respectively. The two most common Gram-positive organisms were *S. milleri* and *S. aureus* (14% each). The finding with regard to *S. aureus* is similar to that reported by Domingo and Peter,⁷ Lu and Wu⁹ and Roche *et al.*¹⁰ *S. aureus* was identified in 11% of the implantation cases.

Antibiotic therapy has undergone major changes. In the period between 1952 and 1965 at GSH, penicillin, streptomycin and later chloramphenicol and Polybactrin were instilled into the abscess cavity together with a capsule marker (Thorotrast or later a sterile microsuspension of barium).³ The introduction of CT scans and metronidazole and better microbiological analysis in the period between 1977 and 1986 improved the outcome of brain abscess patients.³ It is apparent, however, that the introduction of the cephalosporins produced even better outcomes.

CRP and ESR have proved to be effective tools in the process of patient follow-up and antibiotic management.¹⁰ CRP and ESR levels correlated with the patient's response to antibiotic therapy in 92% and 81% of cases respectively. On admission patients had high levels of the septic markers, and with treatment these levels gradually decreased. This decrease correlated with a reduction in temperature, reduction in the size of the abscess on follow-up CT scan and also improvement in the general condition of the patient.

Consequently, the duration of antibiotic therapy was tailored in line with the levels of the septic markers. Increasing levels of the septic markers also correlated well with the size of the brain abscess.

Recent reviews of antibiotic therapy have shown a preference for a shorter duration of parenteral antibiotics. In this review, the mean duration of parenteral antibiotic therapy was 15 and 19 days for excision and aspiration respectively, which correlates well with reviews by Jansson *et al.*¹¹ and Jamjoom.¹²

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