Journal of Neurology, Neurosurgery, and Psychiatry, 1978, **41**, 1043–1047

Brain abscesses in Northern Ireland: a 30 year community review

CHARLES J. McCLELLAND, BARRY F. CRAIG, AND H. ALAN CROCKARD

From the University Departments of Orthopaedics and Neurosurgery, Royal Victoria Hospital, Belfast

SUMMARY One hundred and seventy-two cases of intracranial abscesses, obtained from Neurosurgical and Centralised Autopsy Records for Northern Ireland for the 30 years, 1947–1976, have been reviewed. The incidence of the disease has fallen from five to three per million of population per year over the past three decades. Intracranial abscesses were three times as common in males as in females. Twenty-nine per cent of the abscesses were in the temporal lobe, 25% frontal, 10% parietal, 6% cerebellar, 3% occipital, and 7% were either subdural or in deep sites such as the thalamus; the remainder (20%) were multiple. Multiple and occipital abscesses were all fatal, temporal and parietal abscesses were associated with a 65% mortality, and 45% of patients with frontal abscesses died. Chronic suppurative otitis media was the single largest cause, and it was the only aetiological factor to have shown a progressive decline over 30 years. For those seen and treated in the neurosurgical unit the mortality was 53%, but if those obtained from the necropsy records were included the overall mortality was 70%.

MacEwen (1893) was the first to show that cerebral abscesses could be treated and that a reduction in mortality followed adequate surgical intervention. The introduction of antibiotics further improved the treatment of this condition (Jooma *et al.*, 1951). However, the mortality remains high, and the obscure presentation of the disease still gives rise to concern. The prevalence of the disease in the community has not been well documented. Most reports deal with the surgical treatment of relatively few cases. The one very large series (Garfield, 1969) deals exclusively with those referred to a neurosurgical unit, and while the mortality rate of 40% underlines the importance of early and accurate diagnosis, it does not represent the true mortality in the community from this condition. This paper deals with the incidence, presentation, and mortality of brain abscesses over 30 years in a community of one and a half million people. We have attempted to highlight those features of the disease which are of significance in the prognosis, and to establish whether there has been any change in the aetiological factors.

Address for reprint requests: Dr C. J. McClelland, Department of Orthopaedics, Musgrave Park Hospital, Stockman's Lane, Belfast BT9 7JB, Northern Ireland.

Accepted 19 June 1978

Patients and methods

This retrospective study was based on the case records of the Regional Neurosurgical Unit and the Centralised Pathology Records of Northern Ireland. The study included all macroscopic intracranial abscesses either single or multiple, of at least 15 mm diameter, regardless of other pathology. All microscopic abscesses were excluded. Some of the cases obtained from the Pathology Records were suffering from other terminal conditions or serious multiple organ disease—for example, leukaemia, carcinoma of the lung, or renal failure—but there was a large group in whom the brain abscess was the cause of death and was not detected during life.

Results

WHOLE SERIES

Altogether there were 172 cases: 113 had been admitted to the Neurosurgical Unit, and the records of a further 59, who had died in hospitals, were obtained from the Pathology Records. One hundred and twenty patients died, an overall mortality of 70%. Of the 113 cases seen or treated by a neurosurgeon 61 died, a mortality of

53%. There were 135 men and 37 women, a male preponderance of 3 to 1. There has been a steady decline in the number of cases presenting each year. The average incidence in the 1950s was about eight cases per annum or five per million of population; by the 1970s this had dropped to four cases per annum (Fig. 1), and there were fewer detected at necropsy.

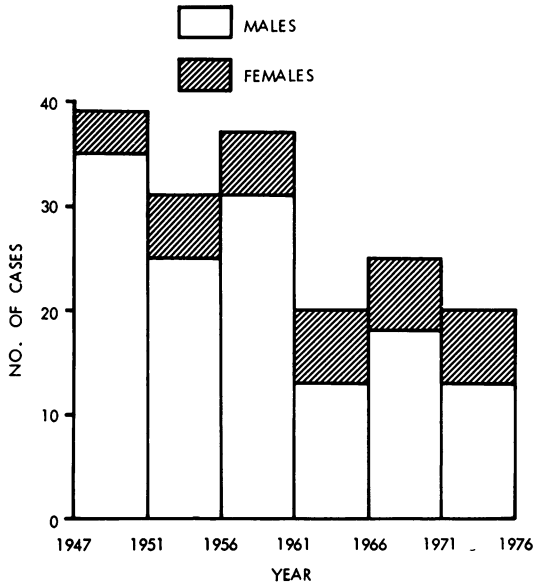

Fig. 1 *Histogram of number of all cases of cerebral abscess during the 30 years (1947–1976). There is a 3 : 1 male preponderance.*

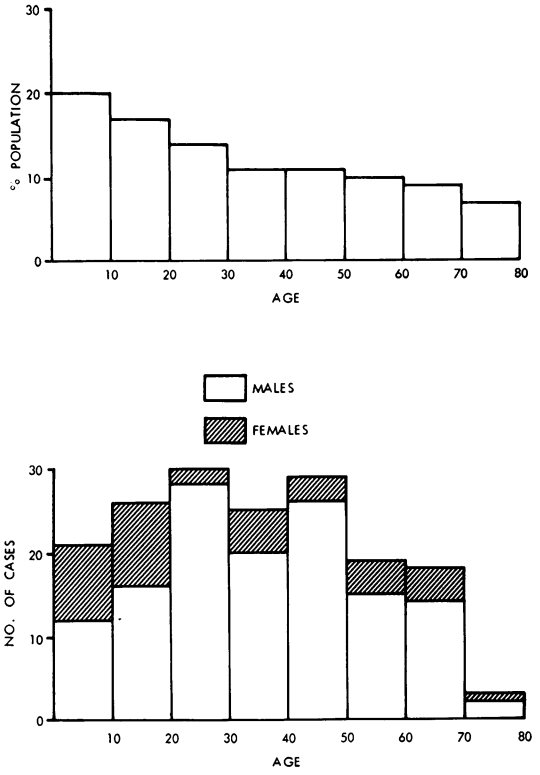

Fig. 2. *Top: age distribution for population of Northern Ireland obtained from Registrar General Census 1976. Bottom: age distribution of patients with brain abscesses.*

A comparison of the age distributions of the population and of the cases in the series (Fig. 2) demonstrates that the disease occurs most often in the middle decades of life, though the community population is weighted to the younger age groups.

The geographical distribution of the cases was studied, and there was a marked urban preponderance—47% of the cases were from urban areas, while only one-third of the population are urban dwellers according to the Registrar General's figures. We could not detect an urban preponderance for any single aetiological category.

A probable source of infection was demonstrated at the time of presentation or at necropsy in 154 cases. No primary site of infection was found in the other 19. We classified the site of primary infection (Table 1) into groups: (1) ENT causes, namely middle ear disease and sinus infection; (2) metastatic infections, which included sepsis, pulmonary disease, and heart disease; (3) trauma, either accidental or surgical; (4) miscellaneous and unknown.

Table 1 *Aetiology of intracranial abscesses in 172 cases*

Aetiology	*Number of cases*	*Totals*	*Mortality (%)*
Chronic suppurative otitis media	44	57	58
Sinusitis	13		
Metastatic infection			
Sepsis	29		
Pulmonary	29		
Heart disease	6	64	85
Trauma			
Direct trauma	9		
Postoperative infection	15	24	54
Miscellaneous	8	8	
Unknown	19	19	67

Chronic suppurative otitis media (CSOM) was the most common single disease causing intracranial suppuration. However, metastatic infections as a group arising from a wide variety of

disease remain the largest cause of the brain abscesses. Direct trauma accounted for only nine cases of intracranial abscess in 30 years. Three of these cases were compound depressed fractures (one a penetrating pitchfork injury), and five others were considered to have been closed head injuries. There were 15 abscesses resulting from postoperative infection, 8.5% of the total. Those with "metastatic infection" as the source of their intracranial abscess had by far the highest mortality (85%), while the other major causes (Table 1) had a mortality of 50–60%, the lowest being in the group associated with trauma.

The site of the abscesses is shown in Fig. 3. Just over a quarter of the abscesses were in the temporal lobe, and a further quarter in the frontal

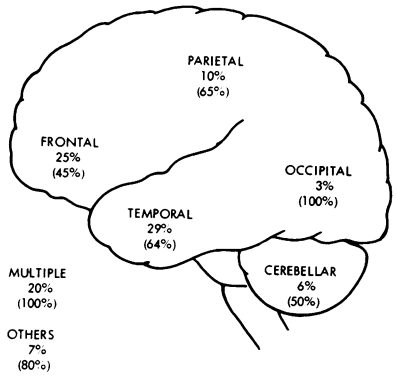

Fig. 3 *Incidence of abscesses by site in the present series. The figures in brackets are the mortality rates of abscesses at these sites.*

lobe. Parietal, occipital, and cerebellar abscesses were relatively rare. Deep sites such as the thalamus were also rare, and there were only nine subdural abscesses. These latter sites together account for the 7% "other" in Fig. 3. Multiple abscesses occurred in 20% of the patients. Frontal lobe abscesses had a mortality of 45% and cerebellar abscesses 50%. Those in the parietal and temporal lobes were more sinister (65% mortality) while occipital lobe abscesses were all fatal.

NEUROSURGICAL SERIES

The presentation, the signs and symptoms, and level of consciousness of the 113 cases managed by the neurosurgical department are now considered in more detail. The mortality of these cases was 53%. Aetiologically, this group was comparable to the whole series.

The level of consciousness at the time of presentation was divided into four grades as suggested by Garfield (1969): (a) fully alert and orientated, (b) drowsy and disorientated but responding to commands, (c) responding only to painful stimulation, and (d) no response to stimulation. Those who presented fully alert had a mortality of 28%. Any clouding of consciousness was associated with a large increase in death rate to over 50%. There was little or no increase in mortality with further obtundation (Table 2).

Table 2 *Presenting level of consciousness and mortality in 113 cases seen by a neurosurgeon. Note that any clouding of consciousness resulted in a twofold increase in mortality*

Level of consciousness	*Number of cases*	*Mortality (%)*
A	18	28
B	74	56
C	8	62.5
D	13	54

Patients who had symptoms and signs for less than two weeks had a mortality of 68%. When symptoms were present for more than two weeks the mortality was 42%, and there was no death when the history exceeded two months.

The presenting level of consciousness and mortality were related to the site of the abscess, and there was a significant difference between frontal and temporal lobe abscesses. Any clouding of consciousness (group b) in a temporal lobe abscess was associated with an increase in mortality (50%), and all temporal lobe abscesses in group d (that is—coma, no response to stimulation) were fatal. In contrast, patients with frontal lobe abscesses had a 25% mortality when drowsy (group b) and recovery was possible when deeply unconscious (group d mortality 60%).

Standard neuroradiological investigations were undertaken in those cases admitted to the neurosurgical unit. In difficult diagnostic cases angiography was preferred to pneumoventriculography (Pennybacker, 1951). The introduction of radioisotope brain scans in the last decade has been very successful in the localisation of frontal and temporal lobe abscesses but has been less helpful in the localisation of parietal lobe abscesses, as judged by our clinical experience.

Of the 113 patients seen by a neurosurgeon 100 had an operation. The usual operation was aspiration through a burrhole. Positive contrast medium was usually injected into the abscess cavity at the initial operation along with antibiotics. Where possible the abscess cavity was excised at a subsequent operation.

Bacteriological examination of pus was carried

out in all patients who had an operation in which the abscess was located, in 53 cases Gram-positive cocci were cultured, 20 grew Gram-negative bacilli, and there were four others (Table 3). Patients with Gram-positive coccal infections had an overall mortality of 40%, those with Gram-negative bacilli had a mortality of 50%. Where the Gram-positive coccal infection was secondary to CSOM the mortality was 50%. However, if the infecting organism was *Proteus* the mortality rose to 80%.

Table 3 *Results of bacteriological studies in 113 patients with brain abscess*

Infecting organism	*Number of cases*	*Total*
Staphylococcus	23	53
Streptococcus	15	
Diplococcus	2	
Gram-positive Cocci	13	
Proteus	8	20
E. coli	11	
Haemophilus inf.	1	
Sterile	16	40
No result	20	
Others	4	

Of the 52 survivors, 32 made a good recovery and were able to resume their original employment. Ten patients had epileptic seizures severe enough to prohibit their original employment, and 10 others were severely disabled and required either institutional management or other assisted help in the home.

Discussion

In the study we have collected material from all the possible clinical and pathology records, and considered the incidence reported here to approximate closely to the true incidence reported in Northern Ireland which has an unchanging population of one and a half million over a prolonged period of time. Our estimate of about four brain abscesses annually per million population may be lower than the true incidence, for some patients may die with inaccurate clinical diagnosis and not have a necropsy examination. The relatively few unsuspected abscesses detected at necropsy in the last decade, when the frequency of postmortem examinations has increased, would suggest that the figure is fairly accurate.

Our results fell into two groups. The first included all patients in whom a cerebral abscess had been diagnosed either during life or at necropsy, and this provided useful guidelines to the major aetiological factors involved. The second group comprised those patients managed by the neurosurgical unit, and it included both early and late referrals—these represent optimally treated patients without any selection. There was a significant difference in mortality between the two groups, 70% as compared with 53%, the latter figure being similar to other neurosurgical series, (Gregory, 1967).

This series shows a steady fall in the incidence of brain abscesses over 30 years without any alteration in mortality rate. The most common aetiological factor has been CSOM, and the decreased incidence of abscesses in the last three decades has been caused primarily by a decrease in those from an otological cause. There were 23 cases during the first decade, 12 during the second, and nine during the third, and there was also a small reduction in the number of abscesses caused by sinusitis, though this was a rare cause of brain or subdural abscess in our series. The high incidence of ENT disease is seen also in Garfield's (1969) study of 200 cases but is not reflected in papers outside the UK (Gregory *et al.*, 1967).

Like most other authors we found that metastatic infections as a group were the chief source of brain abscesses. Chest disease accounts in a large measure for the marked male to female distribution and, being a disease of middle and old age, it accounted to some extent for the age distribution of brain abscesses compared with that of the population at large. The mortality associated with the various aetiological factors is shown in Table 1, and the high mortality associated with metastatic infections could be accounted for largely by the fact that most of the multiple abscesses in the series occurred in this group. It is interesting to note that direct trauma, whether from penetrating injuries or compound depressed fractures, forms a small group (Jennett and Miller, 1972). The postoperative infection group is similar to that of other series (Samson and Clark, 1973) as is the number of cases of unknown aetiology.

There was an inverse relationship between the length of history and the mortality. Those with symptoms and signs of less than two weeks had a mortality of 68%, while no one with a history of longer than two months died. Krayenbuhl (1967) seems to have been dealing with abscesses which had a relatively long history when he said that he was often surprised at operation for a suspected tumour to find an abscess and that these were invariably well encapsulated. Similarly MacEwen's (1893) patients had long histories, which explains, to some extent, the better survival rates in their patients.

It is almost as though we are dealing with two different pathophysiological mechanisms. In

patients with short histories there is intense brain oedema associated with cerebritis whereas in the more chronic cases the abscess acts as an encapsulated space-occupying lesion causing little local irritation.

The level of consciousness at presentation has been shown by other authors to be of great prognostic value (Karandanis and Shulman, 1975). We found that the mortality rate was fairly uniformly increased once there was any appreciable deterioration in the level of consciousness, that is, grade b (Table 2), and this was also seen in the relationship between the level of consciousness and prognosis in missile injuries to the head (Byrnes *et al.*, 1967). There was an interesting relationship between the level of consciousness and prognosis in varying sites of the abscesses. Reduction in the level of consciousness, even to a comatose state in frontal lobe abscesses, was less sinister than a comparable reduction in the level of consciousness with temporal lobe abscesses. This would indicate that the space-occupying aspect of abscesses in strategic positions is perhaps as important as the infective or toxic components of the lesion, the temporal lobe abscess being more likely to cause uncal herniation and brainstem pressure effects at an earlier stage.

Concerning the organisms involved in brain abscesses, it was noted that *Proteus* infections were associated with a high mortality, 83%. This may have been due in some part to the pathogenicity of the organisms, but it is more likely to have been caused by the use of inappropriate antibiotics in their presence (in most cases penicillin, streptomycin, and chloramphenicol were used). In this series only 77% of culture material grew organisms. Recently it has been shown that careful aerobic and anaerobic culture techniques can yield results in all cases (De Louvois *et al.*, 1977a). They also showed a high incidence of *Proteus* infection. It might be appropriate, therefore, in all cases of brain abscess secondary to CSOM to add an antibiotic capable of combating *Proteus*, until such time as a culture result is available (De Louvois *et al.*, 1977b). More recently it has also been shown that with careful culture a high yield of bacteroides could be obtained from these abscesses and that metronidazole can reduce this mortality (Ingham *et al.*, 1977). With the advent of noninvasive procedures, such as radioisotope brain scans and computerised axial tomography, it is hoped that abscesses will be detected at an early stage in their evolution. However, a high index of clinical suspicion must remain the motivating factor if our advances in techniques of abscess location are to be used to the full in curtailing death from this disease.

In conclusion, we would like to point out that the duration of symptoms, the level of consciousness, the site of the abscess, and the type of infecting organism each contribute to the mortality of brain abscesses, and that little we have done in the past 30 years has succeeded in changing this mortality.

We wish to thank Mr I. C. Bailey, Mr C. A. Gleadhill, Mr D. S. Gordon, and Mr A. A. Taylor for permission to study their cases and for their constructive criticism. We are also indebted to Dr I. V. Allen for assistance with the Centralised Pathology Records.

References

Byrnes, D. P., Crockard, H. A., Gordon, D. S., and Gleadhill, C. A. (1976). Penetrating craniocerebral missile injuries in civil disturbances in Northern Ireland. *British Journal of Surgery*, **61**, 196–175.

De Louvois, J., Gortvai, P., and Hurley, R. (1977a). Bacteriology of abscesses of the central nervous system—a multicentre prospective study. *British Medical Journal*, **2**, 981–984.

De Louvois, J., Gortvai, P., and Hurley, R. (1977b). Antibiotic treatment of abscesses of the central nervous system. *British Medical Journal*, **2**, 985–987.

Garfield, J. (1969). Management of supratentorial intracranial abscess—a review of 200 cases. *British Medical Journal*, **2**, 7–11.

Gregory, D. H., Messner, R., and Zinnerman, H. H. (1967). Metastatic brain abscesses. *Archives of Internal Medicine*, **11**, 25.

Ingham, H. R., Selkon, B. J., and Roxby, C. M. (1977). Bacteriological study of otogenic cerebral abscesses. Chemotherapeutic role of metronidazole. *British Medical Journal*, **2**, 991–993.

Jennett, B., and Miller, J. D. (1972). Infection after depressed fracture of the skull. *Journal of Neurosurgery*, **36**, 333–339.

Jooma, O. V., Pennybacker, J. B., and Tutton, G. K. (1951). Brain abscess, aspiration drainage or excision. *Journal of Neurology, Neurosurgery, and Psychiatry*, **14**, 308–313.

Karandanis, D., and Shulman, J. A. (1975). Factors associated with mortality in brain abscess. *Archives of Internal Medicine*, **125**, 1145–1150.

Krayenbuhl, H. A. (1967). Abscess of the brain. *Clinical Neurosurgery*, **14**, 25–44.

MacEwen, W. (1893). *Pyogenic Infective Diseases of the Brain and Spinal Cord*. Maclehose: Glasgow.

Pennybacker, J. (1951). Abscesses of the brain. In *Modern Trends in Neurology*, Series 1, pp. 257–290. Edited by A. Feiling. Butterworths: London.

Samson, D. S., and Clark, K. (1973). A current review of brain abscesses. *American Journal of Medicine*, **54**, 301–210.