The year 1993 marked the centennial of the publication of Sir William Macewen’s monograph, *Pyogenic Infective Diseases of the Brain and Spinal Cord*, and its accompanying volume, *Atlas of Head Sections*. As Harvey Cushing noted, the text on pyogenic diseases of the brain was a landmark in surgery of the nervous system. At the time of its publication, Macewen’s work was the most comprehensive study of pyogenic brain diseases.

In this paper the author reviews the state of knowledge of brain abscess existing in the 19th and 20th centuries, with particular emphasis on the late 19th century, and elucidates factors contributing to Macewen’s remarkable success. His thorough knowledge of the natural history of pyogenic diseases of the temporal bone and nasal sinuses, in addition to his clear description of cranial anatomy, as illustrated in his *Atlas of Head Sections*, were especially important in developing his successful treatment of brain abscess. The x-ray had not yet been discovered; Macewen’s diagnosis was based on clinical findings superbly illustrated by his three clinical stages of brain abscess development. His clinical observations are as relevant today as when he described them 100 years ago.

Macewen recorded 25 cases of brain abscess. Nineteen of these patients came to his attention in time to undergo surgery, resulting in 18 recoveries. All five of his patients with extradural abscess recovered. These results were achieved in the era known as “the most glorious period in British surgery.” Neurosurgery was in its infancy; nevertheless, even as the 20th century closes, Macewen’s results still have not been surpassed.

**Keywords** • William Macewen • brain abscess • neurosurgical history • early diagnosis • surgical outcome

Macewen made his greatest contribution in the field of neurological surgery, which led to his being proclaimed one of the founders of this field together with Sir Victor Horsley.

In his Macewen Memorial Lecture of 1927, Harvey Cushing stated that Macewen’s monograph on pyogenic diseases of the brain and spinal cord was a landmark in surgery of the nervous system; it was also one of the first medical books that Cushing purchased.

**Brief Biography of Sir William Macewen**

Born on June 22, 1848, on the Isle of Bute off the west coast of Scotland, William Macewen was the youngest of 12 children. He entered Glasgow University in 1865, and graduated in 1869 at the age of 21 with his bachelor’s degrees in medicine and surgery. While Macewen was a student Joseph Lister was formulating his antiseptic methods for the treatments of wounds. Inspired early by Lister, Macewen became one of the leading proponents of listerism and was probably the first to use moist heat as a rou-
tine method of sterilizing surgical instruments and dressings. By 1879, he had abandoned the use of carbolic spray and was boiling the gauze used for dressings. He thus played an active role in developing the practical application of the listerian doctrine.

Macewen was appointed to the Glasgow Royal Infirmary in 1877 at the age of 29. This was the beginning of a long and productive career, which later included becoming Regius Professor of Surgery at Glasgow in 1892 and being knighted in 1902 (Fig. 1).

Described as a rather slow and deliberate surgeon, Macewen was authoritative, demanding obedience and loyalty from nurses, house surgeons, and assistants. He was a tireless worker, spending most of his days and many of his nights at the hospital and in the laboratory. All conduct of affairs, both on the wards and in the operating room, was orchestrated strictly according to his direction.

Although he was not a great teacher of systematic surgery and never developed a great school of clinical surgery like Theodore Kocher of Berne, Macewen was a particularly strong proponent of the teaching of operative surgery. He kindled a spirit of investigation and would encourage his assistants to think for themselves.

In 1889, Macewen was invited to become the first Professor of Surgery at the newly established Johns Hopkins Medical School. He was very busy with other activities in Glasgow at that time, including writing his text on pyogenic diseases of the brain. The American school was willing to give Macewen complete authority over the surgical department and would have had the surgical wards built to suit his wishes. However, it appears that the Board would not give assurance that supervision and training of the nursing staff would be wholly in Macwen’s hands.

Surgery for Brain Abscess in the 19th Century

Pre-Lister Period of Surgery

Until the last quarter of the 19th century, successful surgery for a brain abscess, usually caused by trauma, was quite rare and probably related more to pure chance than anything else.

The French surgeon S.F. Morand is said to have been the first to operate successfully on a temporoethmoidal abscess of otic origin, performing that surgery in 1752.6 Celebrated cases operated on by Baron Guillaume Dupuytren in 1823 and Delmold in 1850 involved incising the brain parenchyma and draining a brain abscess; unfortunately, both patients died.86

A review of a publication by the U.S. Surgeon General’s Office for reports of brain abscess reveals several cases that were described at autopsy secondary to penetrating gunshot wounds to the head. Subdural abscess was a common cause of death in gunshot wounds in which there was a fracture of the inner table of the skull. Of 196 cases of trephination for gunshot wounds to the head, 56% resulted in fatality. Indeed, no single case of posttraumatic brain abscess diagnosed preoperatively and successfully cured with surgery is described.

There were occasional successes. An oft-cited case was that of a cavalry lieutenant operated on by Dr. J. F. Weeds, a frontier army surgeon. The lieutenant had been shot in the right frontal area of the head in July 1868, while on his way to Fort Stanton, New Mexico. He apparently developed meningitis and recovered, only to develop additional symptoms approximately 10 days later consisting of papilledema, focal convulsions, and hemiparesis. Weeds trephined in the area of the original gunshot wound and found a spicule of bone protruding from the inner table. He incised the dura, and “plunged [his] knife into the cerebral substance,”90 following which a half ounce of dark green, fetid pus flowed from the wound. Remarkably, the lieutenant recovered.

Weeds reported this case in 1872.90 On reviewing the American and European medical literature, he had found 214 cases of brain abscess. Of these, only four cases resulted in recovery and one of them was doubtful. As Weeds noted, “Not a single case recovered without the abscess being opened and its contents evacuated, either by nature or by the knife of the surgeon.”90

Post-Lister Period of Aseptic Surgery

In the first edition of Sir William Gowers’ work,99 pub-
William Macewen and the treatment of brain abscesses

lished in 1888 and soon to become the late 19th century’s bible of neurology, the author states, “Although almost beyond the range of direct treatment, abscess of the brain is not altogether beyond the range of prevention when due to its most frequent cause, local bone disease.” He wrote that surgical treatment was almost never successful in cases of traumatic abscess in which treatment involved passing a needle or trocar into the brain. He stated further, “I am aware of no case in which the indication of cerebral localization alone guided the operator successfully.” He noted that only recently had the feasibility of surgical treatment of abscesses arising from middle ear infection been proven, citing his own case operated on by A.E. Barker at University College Hospital, London.

The case reported by Gowers and Barker in 1886 was “the first case in which a cerebral abscess due to otic suppuration, had been correctly diagnosed, localized and evacuated by operation with complete success.” The following year, Thomas Barr, a surgeon affiliated with the Glasgow Ear Hospital who worked with Macewen, showed that purulent inflammation of the middle ear was “distinctly the most frequent cause of cerebral abscess,” the majority (73%) of which occurred in the temporal lobe.

In his famous address delivered at the annual meeting of the British Medical Association in 1888, Macewen cited two factors necessary for the introduction of cerebral surgery: the development of aseptic surgery based on Lister’s principles and the development of the principles of cerebral localization.

Macewen’s first case of cerebral abscess occurred in 1876. The young patient had suffered an injury to the skull in the left frontal region overlying Broca’s area and had later developed focal seizures and aphasia. On examination, Macewen made a diagnosis of a left frontal lobe abscess. The parents of the young man refused surgery and he died. Postmortem examination revealed an abscess the size of a pigeon’s egg in the left second and third frontal convolutions, confirming Macewen’s diagnosis. His second case was one of a large temporal lobe abscess operated on in 1881. The patient came to him late in the course of the disease and the abscess had apparently ruptured into the lateral ventricle. Even though the patient was “in extremis,” an operation was performed. Postmortem examination revealed a large temporal lobe abscess. These two frustrating cases must have stimulated Macewen’s scientific interest in the subject of brain abscess and made him realize the need for early diagnosis and surgery for this condition. A subsequent case of temporal lobe abscess in a 9-year-old boy with obvious chronic otitis media was successfully operated by Macewen in 1887. Despite early disappointments, Macewen recognized that brain abscesses occurred more frequently than was usually supposed, and he refused to accept the view of some prominent neurologists concerning the hopelessness of surgical treatment. This determination culminated in the publication of his monograph in 1893 (Fig. 2).

Macewen’s Monograph

The uniqueness of Macewen’s monograph deserves mention. Most surgical texts published in the early period following the introduction of aseptic surgery were general in nature, providing superficial descriptions for the surgical treatment of various conditions (tumors, brain abscesses, and hematomas) in the form of anecdotal case reports. Rarely could the reader discern any scientific approach or standardization of treatment with tabulation of surgical results. Harvey Cushing greatly admired the work of Macewen, and it seems apparent that he patterned his own works after Macewen’s beginning with his (Cushing’s) pituitary monograph published in 1912.

Macewen subdivided the monograph into six chapters, discussing in order: surgical anatomy, pathology of cerebral abscess and meningitis, symptoms of abscess of brain and meningitis, thrombosis of intracranial sinuses, treatment, and results.

Chapter I: Surgical Anatomy. Macewen opened the monograph with a thorough discussion of the anatomy of the mastoid and petrous portions of the temporal bone. He was thoroughly familiar with the circulation of spinal fluid, particularly as shown in the work of Key and Retzius. Most importantly, he demonstrated a schematic diagram of the intra- and extracranial venous anastomoses and, of course, referred to his own marvelous atlas.

Chapter II: Pathology of Cerebral Abscesses and Meningitis. In this chapter, Macewen discussed the relationship of meningitis to brain abscesses, noting that infection commonly spreads from the infected bone through the dura to the leptomeninges. According to the author, if the inflammation results in a “soldering” of the lep.
tomeninges, the infection tends to be localized; if not, meningitis occurs. He noted that infection can also be spread directly by means of an infected thrombus propagated through communicating veins, as well as in the perivascular spaces. Macewen had observed that inflammation of the middle ear, worsening and spreading intracranially, results in the majority of the pathological processes. In addition, he found that it is not acute middle ear infections, but rather chronic middle ear infections that are prone to cause brain abscesses. Macewen pointed out that chronic draining ears were too often were ignored, sometimes for years and that one could not predict when an abscess might develop. He strongly recommended exenteration of the infected areas in the middle ear and mastoid process. He noted that temporal lobe abscesses tended to be approximately four times as common as cerebellar abscesses.

Basic pathological studies began in the 18th century, notably with Morgagni's work published in 1761; however, neuropathology had its formal beginning in the 19th century and was largely anatomical and descriptive of gross lesions, such as those shown in the beautiful atlases of Hooper, Cruveilhier, Carswell, and Bright. John Abercrombie of Edinburgh, a fellow Scotsman, whose book was first published in 1828, originated the field of neuropathology. In the first part of this monograph, "Inflammatory infections of the brain," Abercrombie clearly presented meningeal infections, abscesses, and infections of various parts of the brain with examples of clinical cases and pathological findings, along with his personal comments.

The development of the germ theory, however, was the principal factor leading to the successful surgical treatment of diseases of the brain. In Macewen’s cases, Streptococcus and Staphylococcus aureus were the most frequent causative organisms.

Chapter III: Symptoms of Abscess of Brain and Meningitis. Macewen divided the course of brain abscess into three stages. In the "initiatory stage," he noted that the majority of patients with brain abscess, other than traumatic or septic, have a history of chronic purulent discharge from the middle ear, often dating from childhood. The patient becomes ill somewhat suddenly, with pain residing initially in the ear, then radiating into the frontal and occipital regions. The pain may be exacerbating, with frequent vomiting and rigors. Temperature is usually slightly above normal, and drainage of pus from the middle ear may lessen during this stage, which lasts 12 to 72 hours.

Most cases, according to Macewen, are brought to the surgeon’s notice in the "second stage," during which pain lessens and percussion over the affected mastoid area causes the pain. Cerebration has slowed, attention span is short and the patient is often somnolent. Temperature is generally normal; the pulse is slow and full. The patient usually needs to be catheterized. Vomiting is not usual, except in cerebellar abscesses, and convulsions are also not common. Optic neuritis (papilledema) is frequent.

The "third" or "terminal stage" occurs when the disease is allowed to pursue its course; this stage ultimately ends in death, usually by rupture of the abscess to the surface of the brain or into the lateral ventricle. The temperature rises suddenly, the pulse increases, and the patient commonly develops a dilated pupil on the ipsilateral side. Other localizing symptoms are only found occasionally.

Chapter IV: Thrombosis of Intracranial Sinuses. The fourth chapter offers a discussion of the mechanisms of thrombosis of intracranial dural sinuses. Macewen noted that the infected cavernous sinus thrombosis is almost uniformly fatal.

Chapter V: Treatment. Macewen emphasized prophylaxis in his treatment to prevent intracranial infections, including both abscesses and meningitis. He gave detailed instructions for operating on chronic purulent otitis media with extension of the infection to the mastoid antrum and cells. He advised opening into the antrum through the "suprameatal triangle," allowing the surgeon to avoid injury to the sigmoid sinus, the floor of the middle fossa, and the fallopian canal containing the facial nerve. Macewen used a motor-driven rotary Burr to perform his bone work, rather than relying on a chisel. He would have his assistant observe the facial muscles to note if he got close to the facial nerve. In this chapter Macewen provided instructions on how to obliterate the sigmoid sinus if it is occluded with infective thrombi and also how to ligate the jugular vein. He warned against allowing air to enter the venous sinuses and for technical reasons advised against ligating the sigmoid sinus.

In preparing the patient for surgery, Macewen used a meticulous regime of shaving, washing the scalp with soap and water, and applying an aqueous solution of boric acid to the skin. He used chloroform anesthesia, never ether, and premedicated his patients with morphine suppositories. When an abscess had been localized, Macewen would trephine the area over the suspected abscess in the temporal lobe, usually over the posterior aspect of the zygoma. He would open the dura and insert a cannula or trocar into the abscess. In acute cases, the opening through the brain to the abscess sometimes had to be enlarged so that sloughing brain tissue could be removed. Macewen would irrigate the abscess cavity with a boric acid or weak phenol solution (1:100). In the case of middle ear disease, he would sometimes drain the abscess into the tegmen. For chronic abscesses that he felt needed draining, an absorbable decalcified chicken bone was used.

### Table 1

<table>
<thead>
<tr>
<th>Disease</th>
<th>No. of Cases</th>
<th>No. Operated</th>
<th>No. Cured</th>
<th>No. Died</th>
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<tr>
<td>cerebral abscess</td>
<td></td>
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<td></td>
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<td>1</td>
<td>1</td>
<td>0</td>
</tr>
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<td>4</td>
<td>4</td>
<td>0</td>
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<tr>
<td>of the brain</td>
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<td>4</td>
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<td>7</td>
</tr>
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<td>5</td>
<td>0</td>
</tr>
<tr>
<td>total</td>
<td>30</td>
<td>24</td>
<td>23</td>
<td>7</td>
</tr>
</tbody>
</table>

introduced into the abscess cavity and sutured to the skin. At other times, he would use an India rubber, glass, or other nonabsorbable drain, but he always liked to remove the drain within 24 to 48 hours. He did not close the dura and, usually, the skull bone that had been removed was not replaced. A layer of iodoform and boric acid powder was dusted over the brain and an iodoform gauze dressing was applied. Cerebellar abscesses were evacuated in the same fashion.

Chapter VI: Results. After consulting the scattered literature on the subject, Macewen found that cases of intracranial pyogenic infective diseases recorded prior to “the last few years” were, for the most part, fragmentary and defective. Hence, he undertook what he described as an intensive recording of his own cases (Table 1).

Macewen’s monograph provides reports of 94 cases of “infective intracranial lesions.” Of these, 30 cases represented intracranial abscesses. The cerebral and cerebellar abscesses totaled 25 cases; the extradural abscesses totaled five. Nineteen of the cerebral and cerebellar abscesses were treated by surgery with 18 recoveries. All five of the patients operated on for extradural abscesses recovered. Macewen stated, “One might almost conclude that in uncomplicated abscesses of the brain operated on at a fairly early period, recovery ought to be the rule.”

Macewen’s Atlas of Head Sections

The atlas consists of 53 engraved copper plates displaying frozen sections of the head and 53 key plates with descriptive text. This work was published in 1893, concurrently with Macewen’s monograph. The cost of publication of the atlas was considerable and, apparently, only a limited number of copies were published. The plates include a series of sections: coronal, sagittal, and horizontal. The sections obtained from an adult are supplemented by those from a child. The collection was intended to serve as an aid to surgeons operating on the brain, illustrating the relationship of the brain to the external markings and especially to the nasal sinuses and temporal bone. To appreciate the usefulness of the atlas, one only has to remember that x-ray had not been discovered at that time (Figs. 3 and 4).

Impact of Macewen’s Work

The importance of Macewen’s monograph can be seen in Sir Geoffrey Jefferson’s statement that “it fairly shook
the medical world when published." In 1893, M. Allen Starr, the well-known New York neurologist, recognized the importance of early diagnosis and surgical drainage of cerebral abscesses. He was aware of earlier publications by Mac ewen and others on the treatment of brain abscesses. Two years later in 1895, William Osler and Francis X. Dercum both recognized the importance of Mac ewen's contribution; as Osler pointed out, "a most important, one might almost say essential factor in the successful treatment of intracranial suppuration is an intelligent knowledge on the part of the surgeon of the work and works of William Mac ewen."

It is somewhat ironic that L. Emmett Holt, one of the foremost New York pediatricians at the turn of the century, erroneously recommended not operating on infants suspected of harboring brain abscesses unless "localizing symptoms were present." This advice was given in spite of Holt's awareness of Mac ewen's work and his (Holt's) own high mortality rate.

**Surgery for Brain Abscess in the 20th Century**

As neurosurgery moved into the 20th century, surgical drainage of brain abscess was almost universally recognized as the treatment of choice. After reading reports from the leading neurological centers of the time, both in the United States and abroad, one cannot help but be aware of the sense of frustration felt by surgeons dealing with the problems encountered in treatment over the next six decades, caused in part by difficulties in early diagnosis, sepsis, and the complications of the operation itself. It was predictable that various surgical techniques that evolved would extend from the conservative to the quite radical, each having its proponents.

On the Continent, two surgeons in particular, Ernest von Bergmann and Fedor Krause, were early disciples of Lister's aseptic surgical principles and treated abscesses in a similar fashion, with cortical incision and gauze packing. Herman Oppenheim, the leading neuropathologist in Berlin working with Krause, reported a mortality rate of approximately 50% for cerebral abscesses and 55% for cerebellar abscesses.

In England, Charles Ballance, Bath Rawling, and Victor Horsley treated brain abscesses similarly by making a small incision in the cortex and draining the abscess with tube drains. Horsley and Rawling used Horsley's pus evacuator (a long, narrow-billed speculum) to locate and drain the abscess. Horsley introduced concentric rubber drains with an outer drain sutured to the dura and a removable inner drain. Rawling reported occasional primary excision of thick-walled abscesses.

It is interesting to note that Harvey Cushing and Victor Horsley were both of the opinion that the principles of treatment of brain abscesses were basically the same as those for treating abscesses elsewhere in the body; it was "only a question of adequate drainage." The drains used varied considerably in type. Cushing used gauze, whereas Horsley was strongly opposed to gauze. Mosher introduced a unique, cone-shaped wire mesh drain that could be sutured to the dura, but it did not gain acceptance. During this same period (the first two decades of the 20th century), Sharpe introduced concentric glass drains, but also recommended a separate subtemporal decompression to control intracranial pressure.

During the 1920s, the most radical operations became commonplace. Large osteoplastic flaps with wide dural openings were used in some procedures. Others involved craniotomies with large areas of cortical excision to "unroof" the abscess, which was then packed with gauze and allowed to herniate gradually so as to extrude the remaining abscess wall.

Dandy emphasized the conservative approach to surgical treatment of brain abscesses. Confronting the customary drainage of chronic brain abscesses, he noted that many patients undergoing radical operations succumbed from the effects of treatment, rather than from the abscess itself. Dandy proposed delaying treatment for 10 days to 2 weeks, until the abscess had become "walled off," and then treating the abscess by tapping it with a ventricular needle one or more times to drain the pus through a small perforator in the bone. He felt the infection was much less likely to spread by this method and that the results of this procedure were better than those involving the more radical open operation. Twenty years later, Dandy had not changed his method of tapping the abscess after encapsulation. In the presence of increased intracranial pressure, however, he did not hesitate to perform a subtemporal decompression on the side of the lesion. Others would recommend a combination of both techniques, depending on the degree of encapsulation of the abscess capsule.

In 1927, Semmes described his technique, a modification of that reported by Dowman and Bagley for operating on brain abscesses. Doctor Semmes noted that there was a "radical difference in opinion as to the best treatment." Like Dandy, his lifelong friend and correspondent, he felt that the high mortality following surgery for brain abscesses was principally caused by meningitis from soiling of the meninges and frequent occurrence of cerebral hernia and fungus formation after a large osteoplastic flap had been turned. The need for meticulous attention to detail in this preantibiotic era can be well illustrated by Dr. Semmes' technique, which consisted of operating under local anesthesia using 1% novocaine. He would make a 1-in incision through the scalp down to the skull and insert a mastoid retractor. The skull was then opened with a small perforator. A nick was carefully made in the dura to avoid damage to cortical vessels. He then passed a Cushing ventricular needle through carefully until the abscess wall was encountered. He inserted the needle into the abscess and as soon as a drop of pus appeared, he withdrew the needle slightly, measuring the depth of the abscess cavity. Following this, he completely removed the needle without emptying the abscess. Through a small opening in the bone, he stuffed a piece of gauze a short distance into the cortex. After waiting 24 to 48 hours for adhesions to form, the needle was then reinserted into the abscess cavity. A small catheter was then passed into the needle tract. The end of the catheter was slit and strapped to the scalp. The catheter drain was left in place until there was no longer any drainage, and then the drain was gradually shortened each day.

McKenzie also noted the "many controversial points" raised in the treatment of brain abscesses in 1929. Faced with patients who had abscesses of the brain, he believed...
that the following aphorism of Hippocrates was particularly applicable:

Life is short
And the art long,
The occasion instant,
Experiment perilous
Decision difficult.65

The importance of allowing 2 to 4 weeks for an abscess to become walled off was recognized; nevertheless, surgeons too often faced the necessity “of performing eleventh hour operations in obviously hopeless cases.”67 Frazier emphasized that the stage of encapsulation of an abscess was not always discernible early, noting that “an operation premature usually spells disaster. Procrastination may lead to disaster by rupture of the abscess into the ventricle or by foraminial hernia.”70

In 1936, King classified in a general way the types of operations for brain abscesses as open method; closed method; extirpation of the abscess in toto; and tapping. The open method, in which a large cortical excision was performed with iodoform gauze packing, continued to have advocates despite the high incidence of postoperative seizures secondary to cortical scarring.50,64 A form of open operation using the technique of “marsupialization” was attributed to Cushing.45 The results of the closed method were equally good, as shown by Adson and others.2,3,41 Complete excision of an encapsulated abscess was occasionally successful.88 Large abscesses were commonly found to lie in proximity to the wall of the lateral ventricle. Hence attempts at enucleation carried a significant risk of abscess rupture into the ventricle with uniformly fatal results. Total extirpation was not widely performed as a primary procedure prior to the introduction of antibiotic therapy.

The introduction of ventriculography by Dandy in 1918 was a significant aid in the diagnosis and localization of brain abscesses, as well as tumors and other intracranial mass lesions. Angiography subsequently proved to be superior to ventriculography in the localization of brain abscesses.86

A very useful adjunct in following the size and resolution of brain abscess was first addressed by Kahn in 1938 with the introduction of thorium oxide (Thorotrast) injected into the abscess cavity. Because of the risk associated with the long-term effects of this radioactive substance, Thorotrast was eventually taken off the market. The search for other agents included tantalum powder, which caused an intense inflammatory reaction and thus was never widely accepted. However, micropaque barium in suspension was found to be very useful, and replaced Thorotrast at the University of Michigan, where Thorotrast had first been used, as well as at other centers.63 Radionuclide brain scans were of some value in the diagnosis of brain abscesses before the introduction of the computerized tomography (CT) scan.

The introduction of chemotherapeutic agents, beginning with sulfanilamide in the 1930s, was an important adjunct to the treatment of brain abscesses; however, the mortality rate still remained distressingly high. In 1938, Bucy reported on the first case of brain abscess caused by hemolytic Streptococcus in which sulfanilamide was used while draining a cerebellar abscess. The patient made an excellent recovery. Bucy and later others,41 believed that sulfanilamide played a significant role in the treatment of brain abscesses.

Penicillin, which was soon to be introduced, was an even more important chemotherapeutic agent because of its antistaphylococcal action. The successful isolation of penicillin and the proof of its clinical usefulness were credited to Howard Florey of Oxford, who was later joined by Ernst Chain. They first successfully extracted penicillin in 1938. Two years later, they reported proof of the in vivo therapeutic action of penicillin against Staphylococcus and other bacterial infections.19

In February 1941, the first patient was treated with penicillin. Florey and Florey reported on the remarkable clinical effectiveness of systemic penicillin in the treatment of 15 cases of serious illness in 1943, including a “fulminating case” of cavernous sinus thrombosis and the first successful treatment of a case of streptococcal meningitis using intramuscular and intrathecal penicillin. The meningitis case (Alexander Fleming’s patient) was reported in detail in October, 1943.36,37 Pilcher and Meacham confirmed the effectiveness of intrathecal penicillin therapy in the treatment of experimental streptococcal meningitis in the same year. The manufacturing process was perfected, and penicillin became available before the end of World War II. Fulton,36,37 a friend of Howard Florey and a fellow Rhodes Scholar, played an important role in the wartime effort of getting penicillin into production in the United States.27

Cairns, the first neurosurgeon to use penicillin to treat contaminated head injuries, did so in North Africa and Italy in 1943. He also reported instilling penicillin solution (1000 U/cc) into the abscess cavity twice a day for 3 to 5 days. Hamilton, et al in 1944, reported six cases of brain abscess treated with both penicillin and surgery, with only one death. They concluded that penicillin was effective in the cerebritis stage of abscess formation and also in sterilizing the abscess contents when penicillin was injected directly into the abscess, once encapsulated. The use of penicillin, however, did not replace the need for drainage or enucleation of the abscess.42

The occurrence of brain abscess in children with congenital heart disease was recognized with increasing frequency beginning in the late 1940s. These children often had tetralogy of Fallot or septal defects. Because of improved medical care and eventually because their defects could be operated more successfully using the new heart/lung machine, these children were living longer. The symptom of persistent headaches, with or without focal neurological signs, suggested the presence of a brain abscess in a child with congenital heart disease. Recognition of this association led to successful surgical treatment of the brain abscess in many cases.86,87

The overall mortality rate for the treatment of abscesses fell in the two decades following the introduction of antibiotic drugs, but it still remained distressingly high. Antibiotic administration had proved to be a significant aid in the treatment of the cerebritis stage of an abscess and in the encapsulation of an abscess, allowing safe surgical excision of brain abscesses that did not resolve with repeated aspirations.79,80 Postoperative seizures in patients...
with supratentorial abscesses, however, continued to be a significant source of morbidity. The mortality rate for brain abscesses treated surgically remained significant through 1973. This was shown graphically in two consecutive series of 60 cases at the Mayo Clinic. The mortality rates for the two series were identical (17%). Multiple brain abscesses and anaerobic streptococci were associated with higher mortality.67,68

Modern Diagnostic and Surgical Techniques

Rosenblum and coworkers at the University of California in San Francisco, were among the first to point out the remarkable decrease in mortality in the treatment of intraparenchymal pyogenic brain abscesses after the introduction of the CT scan. At their institution, their overall mortality rate dropped from 44% during the 3 years prior to CT scanning in 1974 to 0% for the 3 years following the introduction of CT scanning in 1977. The lower mortality rate was principally related to two factors: early diagnosis and accurate method of postoperative follow up. Differentiation between brain abscess and cerebritis was often possible with contrast enhancement. Carey noted an overall worldwide mortality in the range of 14% after CT scanning became available (Table 2).

The modern treatment of brain abscesses now consists of needle aspiration followed by treatment with appropriate antibiotic drugs for 4 to 8 weeks. Despite penetration of systemically administered antibiotic into the abscess contents in therapeutic levels, needle aspiration is still necessary. Stereotactic techniques have aided greatly, especially in the treatment of multiple and deep-seated cerebral abscesses. Surgical resection is still needed in certain cases, particularly in patients with large superficial abscesses and/or abscesses associated with the presence of a foreign body, and in those patients who do not respond to aspiration alone. Steroids have been shown to be beneficial in reducing brain edema. Nonsurgical or “medical” treatment of brain abscesses with antibiotic drugs alone has been reported, but is somewhat controversial.

Regardless of the operative mode or the use of antibiotic drugs, the mortality rate for patients with brain abscess is directly related to the patient’s neurological status when first seen, just as Macewen originally emphasized 100 years ago.

Summary

Macewen’s treatise on the diagnosis and treatment of pyogenic disease of the central nervous system laid the foundation for treatment of brain abscesses. Sir Geoffrey Jefferson suggested two reasons for Macewen’s success: he performed the surgeries himself, both on the mastoid area and on the abscess, and he was quite familiar with operating on both skull and brain.

Macewen’s astonishing results in the early period of aseptic surgery prior to the introduction of x-ray has hardly been surpassed. More than once it has been pointed out that he could not have continued to obtain a low surgical mortality without rejecting a significant number of potential surgical patients. In the years following Macewen’s treatise, the mortality of brain abscesses remained high, despite a variety of different operative procedures, and even the discovery of antibiotic drugs. The introduction of ventriculography, angiography, and the use of Thorotrast, which made it possible to follow and observe the stages of resolution of the abscess cavity, aided in lowering mortality rates.

Macewen’s principles of early diagnosis and localization, the most important factors in the cure of pyogenic brain abscesses, eventually were proved with the introduction of CT. He clearly showed that brain abscess, a not infrequent but often fatal condition occurring in young individuals, could be treated surgically with a high degree of success if the diagnosis was made early.

The genius of this pioneer surgeon cannot be disputed, and his monograph remains a landmark 100 years after its publication.

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