CORRELATION OF NEUROLOGIC SEQUELAE WITH TYPES OF SURGICAL TREATMENT FOR BRAIN ABSCESSES: ASPIRATION AND CRANIOTOMY WITH EXCISION

A DISSERTATION SUBMITTED IN PART FULFILLMENT FOR AWARD OF THE DEGREE OF MASTER OF MEDICINE (MMED) IN NEUROSURGERY OF THE UNIVERSITY OF NAIROBI

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DECLARATIONS

Candidate's declaration

I hereby declare that this study is my original work and has not been presented at any other university.

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Supervisor's declaration

This dissertation has been submitted for examination with my approval as a university supervisor.

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DEDICATIONS

I dedicate this work to scholars who give their time for the training of future generations of African neurosurgeons through transmission of knowledge, example, and encouragements.

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ABBREVIATIONS

ANC: Absolute neutrophils count

CXCL : CXC (chemokine) ligand

CCL: CC chemokine ligands

CHD: Cyanotic heart disease

CRP: C- reactive proteins

CT: Computerized tomography

DNA: Deoxyribonucleic acid

EEG: Electroencephalography

ERC: Ethics research committee

ESR: Erythrocytes sedimentation rate

GCS: Glasgow coma scale

GOS: Glasgow outcome scale

HIV: Human immunodeficiency virus

IV: Intravenous

KNH: Kenyatta National Hospital

KNH-UON ERC: Kenyatta National Hospital - University of Nairobi Ethics research committee

MCL: Microlitre

MCP : Monocyte chemoattractant protein

MIP: Monocyte inflammatory protein

MRI: Magnetic resonance imaging

N.U.R: National University of Rwanda

PCR: Polymerase chain Reaction

PTBI: Penetrating Brain injury

TBI: Traumatic brain injury

TCA: T cell system A

TLR: Toll like receptor

U.O.N.: University of Nairobi

WBC: White blood cells

SUMMARY

Background: Pyogenic brain abscesses are life threatening conditions that require urgent surgical and medical treatment. Neurologic sequelae of pyogenic brain abscesses and or surgery include hemiplegia, monoplegia, visual defects, cognitive dysfunction, hydrocephalus and seizures. Currently the association of surgical techniques with neurologic sequelae is not clear; the goal of this study was to study a correlation between them.

Objective: Evaluate the correlation between neurologic sequelae among patients operated for brain abscesses in relation to the types of surgical techniques.

Study design: Descriptive observational study.

Setting: Kenyatta National Hospital. Nairobi, Kenya.

Methodology: After obtaining approval from the department of surgery and Ethics and Research Review Committee, the study proceeded to data collection. Patients diagnosed and with pyogenic brain abscesses and on follow-up in neurosurgery clinic for 6 months or more after surgery were included in the study. Preoperative and postoperative neurologic deficits were recorded.

Duration of study: 8 months (September 2015 - April 2016).

Results: 34 patients were included in the study**.** Penetrating brain injury and depressed fractures were the most common causes of brain abscesses in our study (44.12%, n=15). Infections from paranasal sinuses were 6 (17.65 %) and middle ear infection was found in 1 patient (2.94%). The duration of symptoms ranged from 4-180 days. Headache was the most common finding at presentation and was recorded in 25 patients (73.53%). Vomiting was a presenting sign in 14 patients (41.18%); fever as a presenting sign was found in 14 patients (41.18%); and seizures were seen in 13 patients (38.24%). Altered

mental status was found in 14 patients (41.18%). All 34 patients had a CT scan of the head before surgery. Most of abscesses were located in the frontal lobes (58.82%) and were single abscesses (97.2%). 21 patients had craniotomy and excision of the capsule (61.76%); 13 patients (32.24%) were treated with aspiration. Recurrences were more frequent after aspiration techniques. Postoperative seizures were found in 38.24% (n=13) of the patients.

Conclusion: The most common causes of brain abscesses were previous head trauma, followed by paranasal sinus infections. Craniotomy was the most commonly performed operation and resulted in definitive cure in all cases. Half of the patients treated with aspiration techniques underwent a repeat surgery. Neurologic sequelae were not different between patients treated with craniotomy and those who underwent aspiration techniques.

CHAPTER I: INTRODUCTION

Pyogenic brain abscesses are life threatening conditions that have been discussed since the early years of neurosurgery; reports of their diagnosis and treatment are found in ancient Egyptian neurosurgery manuscripts (*Ebers papyrus text)* (1). The development of neurologic examination, better understanding of cranial surgical anatomy and localization of brain abscesses with introduction of CT scan resulted in a dramatic improvement of outcome.

In his series, Jooma et al. reviewed 295 cases from 3 different centres and compared the outcome of three treatment modalities: aspiration, tube drainage, and excision of the capsule (2). The advantages and disadvantages of each modality were discussed; the remarkable improvement of outcome after introduction of antimicrobials (penicillin) was also highlighted (3).

The use of CT scan in 1970s revolutionized the treatment of abscesses; CT scan allowed early diagnosis, accurate localization and post operative follow up. The use of CT scan reduced mortality from the range of 22.7-45% to 0-20% (4); however, since the development of CT scanners only modest achievements have been made such as the use of stereotactic aspiration of deep seated abscesses or those located in eloquent areas (5), and the use of cloning and sequencing of PCR-amplified 16S ribosomal DNA to isolate previously difficult to culture organisms (6).

Currently the standard of treatment of pyogenic brain abscesses is a combination of medical and surgical treatment (7, 8). Less frequently only medical treatment

with antibiotics is offered in cases of multiple abscesses in deep location, with size (< 2.5 cm), or abscesses in early stages of the disease when the capsule is not well formed (9, 10, and 11). Each technique has advantages and disadvantages: Aspiration is a fast and an easy to perform procedure but it is associated with recurrences and prolonged hospitalisation; on the other hand craniotomy with excision of the capsule can be associated with injury to brain parenchyma during surgery.

The goal of this study was to assess long term neurologic sequelae and to correlate them with the two categories of surgical treatment.

CHAPTER II: LITERATURE REVIEW

2.1 Epidemiology

The incidence of brain abscesses is estimated at 1-2% of all intracranial masses in western countries (7) and male to female ratio has been reported to be 2:1 - 3:1 (12). In Kenya Mwang'ombe reported a male to female ratio of 2.4:1 (13); Ndirangu found in his study performed in KNH in 1980 that male to female ratio was 4.6:1 (14).

Abdel et al. found a prevalence of 2.3% of total neurosurgical admissions in a hospital from Saudi Arabia (15); this number is closer to local unpublished data which show that surgeries for brain abscesses were 3.21% of total neurosurgical operations performed in 2014. Brain abscesses are found in all age groups and literature shows variations of statistics in published articles; in his review of 172 cases over a period of 30 years in Northern Ireland, McClelland et al. found in 1978 that majority among all cases of intracranial abscesses were between the second and fourth decade (16).

Differences in aetiologies have also been reported in variable age groups; otogenic brain abscesses were found mostly in the population of less than 20 years and above 40 years. On the other hand, paranasal sinuses infections were found to give rise to abscesses in the age group of 30-40 years (12). In Kenyatta National hospital most of the brain abscesses were related to head trauma and 38% were found in children of less than 10 years (13).

2.2 Pathophysiology and Aetiology

A brain abscess is defined as an intraparenchymal collection of pus surrounded by a gliotic tissue which forms its capsule.

In experimental studies the developement of animal models for brain abscesses allowed better understanding of the mechanisms of the changes that occur at different stages of the disease. Direct inoculation with virulent pathogens showed that brain abscesses developed more in cases where inoculation was done with bacteria in their culture media or after brain injury had resulted in necrosis (17). In animal models facultative anaerobes such as E. coli, S. Pyogenes, and S. Aureus, were more virulent than microaerophilic or obligate anaerobes; however this picture might not reflect the initiation of brain abscesses in humans as a mixture of aerobes and anaerobes is found in cultures from brain abscesses (17).

After inoculation with bacteria, activation and recruitement of proinflammation proteins and activation of astrocytes occur through complex mechanisms. The inflammatory process is triggered by interaction of bacterial antigens with Toll Like Receptors (TLRs); this interaction triggers recruitement of immune cells, activation of astrocytes and microglia in order to make the infected site an inhospitable environment for the invading bacteria.

Kielian et al. observed that after injection of S. aureus there were increases in macrophage inflammatory protein-1α (MIP-1α)/CCL3, MIP-1b/CCL4, MIP-2/CXCL1, MIP-1/CCL2, and TCA-3/CCL1. The importance of the CXCR2 ligands MIP-2, KC and neutrophils in the acute host response to S. aureus in the brain was also highlighted (20) Increased levels of human monocyte

chemoattractant protein-1 (MCP-1) and macrophage inflammatory protein (MIP)-1α have also been observed by the same authors. High levels of neutrophils were noted at the site of KC injection; and high levels of MCP-1 and MIP have been shown to correlate with appearance of macrophages and lymphocytes (18). Changes in these cytokines and other molecules correlate with histological stages of brain abscesses.

Brain abscesses undergo histological and radiological changes that determine their stage; this staging can influence the choice of surgical treatment. Four stages have been described:

1. **Early cerebritis (1-3 days):** This phase is characterized by infiltration of an infected area by inflammatory cells which include: neutrophils, plasma cells and mononuclear cells. Tissue necrosis and perilesional oedema are also found. On CT scan the lesion is ill defined, hypodense, and with patchy enhancement.
2. **Late cerebritis (4-9 days):** Also known as the intermediate stage; in this phase the focus of necrosis becomes bigger to attain its maximal size and the border is invaded by macrophages, lymphocytes and fibroblasts. The overall size of cerebritis is maximal and is associated with accelerated neovascularisation, prominent oedema and appearance of reactive astrocytes. CT scan shows a hypodense lesion with poor demarcation and prominent oedema.
3. **Early capsule (10-13 days):** The necrotic centre becomes smaller than in cerebritis stage, the wall of an abscess becomes more vascular with more fibroblasts. Macrophages and mature collagen make a demarcation that separates purulent focus from the normal parenchyma which becomes less oedematous. The capsule is thick on the cortical side and thin on ventricular side; this makes an

abscess prone to rupture into the ventricles. The lesion is hypodense and the capsule enhances with contrast.

4. **Late capsule (>14 days):** The capsule, which has collagenous, granulation, and gliotic layers, becomes thicker and irregular. Oedema is minimal.

Immunosuppression predisposes patients to abscess formation because of compromised T-lymphocyte or macrophage function that result in increased risks of developing infections with intracellular pathogens such as fungi (particularly Aspergillus spp) and bacteria like Nocardia spieces. Immunosuppression can result from HIV, hematological malignancies, long term steroid medication, chemotherapy use in various malignancies, and immunosuppressive agents used in patients undergoing organ transplants.

Among patients with immunosuppression; unusual organisms not commonly found in immunocompetent individuals are isolated and it is preferable to obtain culture results before starting antibiotics. Abscesses in HIV tend to be multiple and should be differentiated from toxoplasmosis. Brain abscsses in patients with immunosuppression usually result from disseminated infections from the lungs or other sites of infections (19).

2.2.1 Brain abscesses from paranasal sinuses, sphenoid sinus, and ear infections

Maxillary, ethmoidal and frontal air sinuses are important sources of infections that spread to the intracranial spaces (25-50%); the most common bacteria found from maxillary, ethmoidal and frontal air sinuses include streptococci, staphylococcus, enterobacteriaceae, bacteroides species, and haemophilus species.

The most common location of sinogenic brain abscesses is found in the frontal lobes; however, sphenoid sinusitis involves the temporal lobes and sella turcica. Otitis media and mastoiditis spread to the temporal lobes and cerebellum and are associated with pseudomonas, and enterobacteriaceae.

2.2.2 Brain abscesses from haematogenous spread

Theses abscesses constitute 20-35% of all brain abscesses (12); they are usually multiple and located in the territory of the middle cerebral artery near the grey white matter junction. The reasons of the location remain speculative; however it has been reported that patients with stroke microemboli are mostly seen in the territory of middle cerebral artery (20); therefore septic emboli that become trapped in the peripheral and narrow arterial tree at the level of grey white matter junction, inoculate bacteria in the same anatomic region.

The prognosis of haematogenous abscesses is poor compared to other types of abscesses. The source of infection may be from cyanotic heart disease which is commonly associated with *alpha haemolytic Streptococcus, and haemophilus aphrophilus.*

In cases of endocarditis, Staphylococcus aureus and Streptococcus are common. Portals of entry may also be the lungs, the skin, and the bone.

2.2.3 Posttraumatic brain abscesses

Mwang'ombe et al. found that head trauma was the most prevalent cause of brain abscesses (35%) in Kenyatta National Hospital (13). They were seen in patients

with skull fractures with dura breach with or without foreign bodies in the brain parenchyma. Staphylococcus aureus is the most common organism found in such cases. The prevalence of posttraumatic brain abscesses in other series and in civilian population ranges from 2.5-10% and is higher in military population; it results from contamination through compound depressed fractures, and penetrating head injuries (12).

2.2.4 Iatrogenic brain abscesses

In this category, brain abscesses are the result of postoperative infections following craniotomy, halo pins orthoses etc. Staphyloccocus is often isolated in these cases.

2.2.5 Cryptogenic brain abscesses

The focus of infection is not discovered in 10-35% (12, 21). The infection is thought to result from small infective foci and associated bacteraemia such as in cases of tonsillitis and dental infections (22). Patent foramen ovale with a right-to-left shunt associated with dental infection has been proposed as a possible risk factor for cryptogenic brain abscesses. Horiuchi reported a case of a patient with brain abscess, dental caries and a patent foramen ovale; aspiration of pus confirmed a flora normally found in the oral cavity (Prevotella intermedia, Bacteroides fragilis, and Peptostreptcoccus species) (23). It was hypothesized that right-to-left shunt allow bacteria to bypass the pulmonary vascular bed and lymphatic system, enter arterial system and cause brain abscesses.

2.2.6 Bacteria

Majority of bacterial abscesses are caused by Streptococcus species in 70% of the cases; staphylococcus is found in 10-20% after surgical procedures, trauma or infective endocarditis, and also cyanotic heart disease (12). Gram negative bacilli are isolated in 23-33%; they include *proteus species, Klebsiella, Pseudomonas, Escherichia coli and Enterobacter species.* The predisposing factors for gram negative bacilli infections are ear infections, neurosurgical procedures, and immunosuppression. Anaerobes include *bacteroides and prevotella species,* and are isolated in 20-40% when appropriate culture media are used.

Multiple organisms have been found with use of cloning and sequencing techniques (6); these techniques are superior to traditional culture methods which yield up to 43% of negative culture in part attributable to the use of preoperative antibiotics before collection of the specimen for microbiology.

2.3 Clinical presentation

Brain abscesses can present with either headaches, fever, focal deficit or a combination of the triad in less than 50% of the patients (12). Nausea and vomiting, seizures, nuchal rigidity, papilledema are also common findings. Headache is one of the most common symptoms and worsening of headaches in a patient with a brain abscess is a warning sign of a possible intraventricular rupture of a brain abscess and therefore should be treated urgently.

Other signs and symptoms depend on the location of the abscess; for example frontal lobes abscesses are associated with personality change, urinary

incontinence, hemiparesis, drowsiness, speech disorders, seizures etc. Parietal lobes can be associated with headaches, visual fields defects, sensory aphasia etc. Temporal lobes are likely to present with headaches, seizures, and visual fields defects. Cerebellar abscesses are associated with cerebellar signs and brainstem abscesses are characterized by involvement of cranial nerves as well as ascending and descending tracts.

2.4 Hematologic tests and imaging

Laboratory investigations include complete blood count, inflammatory markers (ESR, CRP); however they have been found to offer little diagnostic benefit (9).

Complete blood count is among the routine laboratory tests done in patients with brain abscesses and it is elevated in many cases. The differential count of white cell count has been used in the diagnosis of other systemic infections; the absolute neutrophil count (ANC) was found by Lalya and Babay to be useful in the diagnosis of bacterial infections (24).

ESR and CRP are markers of inflammation and are used as ancillary tests to diagnose brain abscesses.

CT scan allows localization of the abscess, estimation of the size, the stage and degree of oedema, and mass effect. MRI gives more anatomic details and excludes other possible lesions such as cystic gliomas.

2.4 Management of brain abscesses

Most brain abscesses are treated with antibiotics and with surgery. Treatment is started before isolation of the organisms and targets the most likely bacteria. Prophylactic anticonvulsants are given and are continued after surgery (13).

Steroids are given in few selected cases with vasogenic oedema and signs of herniation (9).

The duration of intravenous antibiotics is still a matter of debate and some authors recommend a minimum of 3-4 weeks of IV antibiotics if an abscess was excised and 6-8 weeks or longer if it was only aspirated. It has also been suggested that intravenous antibiotics can be discontinued if CRP returns to normal after around 2 weeks (25).

2.5 Surgical methods for brain abscesses

Surgical treatment is offered to any abscess with more than 2.5 cm of diameter. Free hand bur hole drainage, stereotactic drainage, or craniotomy with excision of the capsule are all surgical options that are used depending on the aetiology, location and the surgeon's preference.

2.5.1 Aspiration techniques

i. Stereotactic aspiration

Stereotactic techniques have been commonly used for deep seated lesion or those located in eloquent areas; the goal of stereotactic procedures in brain abscesses is to drain pus, and to find specimen for culture and sensitivity tests. The technique uses a system of coordinates, CT guided or MRI guided systems, frame based or frameless systems to plan for a safe trajectory to a targeted lesion. During aspiration of brain abscesses, a procedure which can be done under local anesthesia and sedation in adults, a small skin incision is made and a 3mm twist

drill is used to open the skull; a small dura opening is made and 1 mm diameter blunt-tipped canula is inserted along a planned trajectory in order to reach and enter the abscess cavity; pus is gently aspirated and irrigation of the cavity with normal saline is done.

Post-operative complications include haemorrhage, ventriculitis and hydrocephalus; the recurrence rate is not uniform in different reports; Kocherry reported a recurrence rate of 20% in the first 2 weeks following the stereotactic aspiration (5). Other methods of aspiration utilize other tools such as ultrasound or endoscope.

ii. Free hand bur hole aspiration

This technique is used to drain easily accessible abscesses; in very sick patients it is used to reduce mass effect from the abscess and to provide material for culture and sensitivity tests. Bur hole aspiration has comparable results to craniotomy with excision of the capsule and has been a preferred treatment option of brain abscesses in some centres (5). In sterile conditions, a carefully selected bur hole is done after limited skin incision, a shortest route to the abscess is used and pus is aspirated, followed by irrigation with normal saline and an antibiotic solution (5). Halit et al. reported good outcomes following bur hole aspirations of abscesses; however they did 2 to 3 aspirations and repeated imaging before complete cure of the abscesses (9).

2.5.2 Craniotomy with excision of the capsule

Excision of the capsule can be done for abscesses with a well formed capsule. This method is also recommended in certain situations: for example,

posttraumatic pyogenic abscesses, and fungal abscesses are best treated with craniotomy and removal of foreign bodies.

Cerebellar abscesses are also treated with excision of the capsule because complications that are associated with a recurrence after aspiration would result in catastrophic consequences; mass effect and oedema in the crowded posterior fossa would compromise vital cardio-respiratory centres of the brainstem with subsequent rapid worsening of the patient's clinical condition. After removing a bone flap, an abscess is decompressed by aspirating pus, the dura is then opened; complete evacuation of pus is done and the cavity is irrigated with normal saline; the capsule is dissected carefully and removed using microsurgical techniques in order to minimise trauma to brain parenchyma. The cavity is inspected for the remaining capsule or foreign bodies and haemostasis is achieved.

2.6 Outcome of brain abscesses

The use of CT scan has improved mortality from 22.7-45% to 0-20% (4); predictors of mortality include the level of consciousness, symptoms duration and associated co-morbidities. Even though authors have reported less considerable contribution of laboratory investigations (9), Marian et al. reported that high preoperative CRP levels could predict the need of repeated surgeries (26). In series of Radoi et al. and Chenran et al., mortality was not related to a particular surgical technique (27, 28); however, this has not been confirmed by Thiloka et al. who reported that after 1990, the mean mortality was 12.7% in surgical excision cases and 6.6% for aspiration cases (29).

Neurologic sequelae include focal deficits, cognitive impairment, and seizures. Seizures can present as initial symptoms or after surgery; there is no consensus opinion about the correlation of surgical techniques with neurologic sequelae including seizures.

2.7 Justification of the study

The goal of surgical treatment is to reduce mass effect of the lesion, to treat intracranial hypertension, and to eradicate pathogenic organisms. Aspiration of pus and craniotomy with excision of the capsule, are methods that have been in use for several decades (2, 3, 5). These different surgical techniques are still in use and are indicated if the size of an abscess is more than 2.5 cm (27).

Aspiration techniques of an abscess can be done with free hand bur hole aspiration technique or after craniotomy (i.e. open aspiration), and with the use of other tools to perform ultrasound guided aspirations, endoscopic aspirations or stereotactic aspirations.

Kocherry et al. demonstrated the efficacy of stereotactic aspiration of deep seated brain abscesses and those in eloquent areas (5). However, this surgical treatment has inherent disadvantages related to recurrences of abscesses and those that fail to resolve; in this group prolonged parenteral antibiotics and multiple surgeries are more frequently seen than when craniotomy and excision is done.

Jooma et al. reported that post operative epilepsy incidence is higher in aspiration as compared with excision (2), this was not found to be the case by other authors who could not find the difference in outcome for either stereotactic aspiration or

excision; however other publications report an increased rate of epilepsy following partial or complete excision (30, 31, 32). Excision is recommended in posttraumatic abscesses, fungal abscesses, or those located in the posterior fossa; craniotomy can also be offered to abscesses that, after aspiration, enlarge after 2 weeks of antibiotics or those that fail to shrink after 3-4 weeks of antibiotics (7). Even though many series have been published in the literature with variability in their opinions regarding the treatment; craniotomy with excision of the capsule, which was once considered as a standard treatment, has been overshadowed by stereotactic aspiration techniques (7, 33).

The proponents of excision argue that it is simple and that it may be associated with fewer complications caused by leakage of pus and subsequent subdural empyemas, meningitis etc. Excision also has an advantage of less recurrences and shorter hospitalization, and subsequently reduced medical cost related to repeated imaging and prolonged parenteral antibiotics (33). Seizures after brain abscesses treatment is one of the most important neurologic sequelae and studies report an incidence ranging from 9-70% (30). There are conflicting reports on the influence of treatment modality to neurologic sequelae such as seizures (2, 30, 31, 32, 34, and 35).

Because craniotomy with excision of the capsule results in less recurrence rates without the need of repeated surgeries and weekly CT or MRI for follow up imaging (9); we postulated that craniotomy and excision of the capsule would be of particular interest in resource limited facilities if it is not associated with increased risk of neurologic sequelae such as seizures, focal deficits, and functional impairment. Therefore our study will provide a contribution to this area

of research and will expand on the existing literature; the results will also assist to guide decision making in surgical treatment of brain abscesses.

CHAPTER III: METHODOLOGY

3.1 Research question

Is there a correlation between surgical techniques and neurologic sequelae after treatment of brain abscesses?

3.2 Null hypothesis

There is no correlation of neurologic sequelae and the types of surgical techniques after treatment of brain abscesses.

3.3 Objectives

3.3.1 Main objective

Evaluate the correlation of neurologic sequelae among patients operated for brain abscesses with types of surgical techniques.

3.3.2 Specific objectives

1. Determine clinical and demographic characteristics of patients treated for brain abscesses,
2. Determine the frequency of procedures performed with aspiration techniques,
3. Determine the frequency of procedures performed with craniotomy and excision of the capsule,
4. Determine the frequency of post-operative seizures,
5. Determine the frequency of post-operative neurologic deficits,
6. Determine the Glasgow Outcome Scale at 6 months and at last visit.

3.4 Study design

This is a descriptive observational study.

3.4.1 Setting and duration of the study

The study was conducted in Kenyatta National Hospital in neurosurgery out-patients clinic for a period of eight months: from September 2015 to April 2016. Approval was sought from KNH-UON ERC.

3.4.2 Study area description

Kenyatta National Hospital is the largest referral and teaching hospital in Kenya, and is located in Nairobi. The University of Nairobi medical school, and several government agencies use its premises. The hospital has a capacity of 1800 beds; the department of neurosurgery is one of the centres that provide neurosurgery care in Kenya.

3.4.3 Study population

The target population of the study are patients with pyogenic brain abscesses who were treated and discharged from Kenyatta National Hospital for follow up as outpatients; a total number of 34 patients were recruited; the selection was consecutive.

Patients who met selection criteria were invited to participate in the study. The investigator explained to them the purpose of the study and took an informed written consent.

Before enrolment, accuracy of the diagnosis was confirmed by assessing previous clinical and microbiologic findings. Clinical findings were signs and symptoms of

intracranial space occupying lesions, features of raised intracranial pressure, and systemic signs of infection (headaches, vomiting, focal deficit, seizures, altered level of consciousness, fever etc.). The evidence of pus during surgery and/or a report of laboratory findings of pus with or without positive cultures were verified in medical records for definite confirmation of the diagnosis.

The study endpoints were the presence of seizures, focal neurologic deficits and disability on GOS. Severe disability, moderate disability, and mild disability at last visit were assessed.

Telephone contacts were used to contact those who were lost to follow up; however consent was only taken in the clinic in the presence of participants.

An informed written consent was taken (appendix II). If the patient had cognitive impairment or he/she was below the age of majority (18 years) the consent was taken from his/her next of kin or guardian.

Inclusion criteria:

- Surgical treatment of brain abscesses,
- Follow up period of 6 months or more.

Exclusion criteria:

- Follow up duration of less than 6 months,
- Epidural abscesses,
- Subdural empyemas,
- Refusal to participate in the study,
- Patients with brain abscesses without surgical treatment.

Data were collected by the principal investigator.

3.4.4 Sampling method

Consecutive sampling method was used for this study; every patient meeting the criteria of inclusion was selected during the period of the study.

3.4.5 Study size

The study sample included all patients meeting the inclusion criteria during the period of study. The minimum number of patients calculated to estimate the smallest acceptable sample was 34.

Sample size

The sample size for this study was calculated as follows (Daniel, 1999) (37).

$$n = \frac{Z^2 \times P \times (1 - P)}{d^2}$$

This formula is used in prevalence studies where the target population is less than 10,000. Thus, it is appropriate for this study.

N: sample size

Z=1-α/2: two-sided significance level (1-alpha)-95% = 1.96

P: expected prevalence of patients with brain abscesses = 2.3%

d: precision, (this value is usually a 5% margin so d=0.05)

Therefore our sample size is:

$$n = \frac{1.96^2 \times 0.023 \times (1 - 0.023)}{0.05^2} = 34$$

3.4.6 Recruitment and consenting procedures

The main investigator gave explanations before recruiting participants and he made sure that they understood their rights. It was made clear to the participant

that refusal to participate or to withdraw from the study would not in any way compromise their treatment; that all information given will be treated with confidentiality; and that the results of this study will be published to facilitate treatment of pyogenic brain abscesses.

3.4.7 Data collection procedures

The patients diagnosed with and operated for brain abscesses on follow-up in neurosurgery clinic were invited to participate in the study. After they had given consent and had been informed of their rights data were collected.

3.4.8 Variables

Independent variables such as age of patients, aetiologies, signs and symptoms, some radiologic features and treatment modalities were collected.

Dependent variables which include postoperative seizures, new neurologic deficits, and disabilities were recorded. The frequencies of neurologic sequelae were correlated to the two types of surgical treatment.

3.4.9 Data analysis

All data were recorded in MS Excel data sheets that will be protected from access by unauthorized persons. Hard copy back-up copies were securely locked. The data were exported from the study data base and analyzed with the use of STATA software.

Descriptive statistics were used for continuous variables. For normally distributed variables, means and standard deviation were used; and for non-parametric distributed variables median and inter-quartile ranges were used. Categorical variables were described by frequency tables.

For univariate analysis, in order to assess associations among the outcome variables as they relate to the input variables, the Pearson Chi squared test and Kruskal - Wallis H test, and Dunn's tests were used. Statistical significance was confirmed when $P<0.05$.

3.4.10 Ethical considerations

Ethical approval was sought from the University of Nairobi, Department of Surgery and the KNH-UON ERC. Informed consents were obtained from participants, their guardians or next of kin before enrolment in the study. A participant's guardian/next of kin was either: a spouse, a son or daughter with the age of majority (18 years); a parent, a brother or a sister with the age of majority (18 years) could also be accepted as a guardian or next of kin. Participants did not incur any extra costs and were free to withdraw from the study at any time.

All data collected during the study were kept confidential. At the conclusion of the study, soft and hard data were locked in a secure place for possible use in verification before publications of results.

CHAPTER IV: RESULTS OF THE STUDY

4.1 Epidemiology and Etiology

There were 34 patients included in the study; 82.35% of the patients (n=28) were male and only 17.65 % (n=6) were female; male to female ratio was 4.6:1. See figure 1. For the age, the mean was 21.44 (SD ±14.22), the range was from 4 to 63 years with a median of 18.5 years. Majority of the patients were in the age group of 0-10 years (n=9, 26.47%) and 11-20 year (n=9, 26.47%). The distribution in other groups was as follows: [21-30] (n=8, 23.52%); [31-40] (n=5, 14.7%); [41-50] (n=1, 2.94%), [51-60] (n=1, 2.94%); [61-70] (n=1, 2.94%). See figure 2.

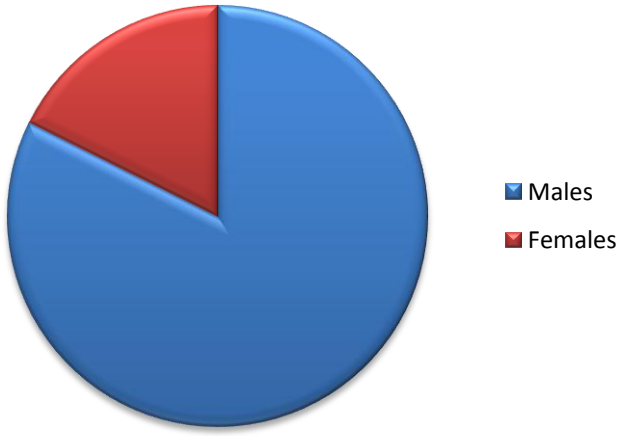

Figure 1: Distribution according to sex. 82.35% (n=28) of the patients were male and 17.65 % (n=6) were female.

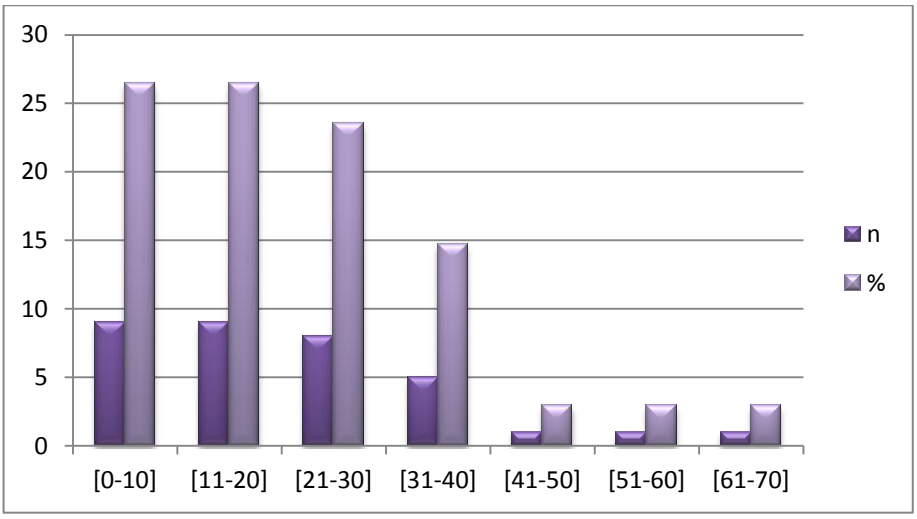

Figure 2: Patients according to age groups. Majority of our patients were in the age group of 0-10 years (n=9, 26.47%) and 11-20 year (n=9, 26.47%); [21-30] (n=8, 23.52%); [31-40] (n=5, 14.7%); [41-50] (n=1, 2.94%), [51-60] (n=1, 2.94%); [61-70] (n=1, 2.94%).

Penetrating brain injury and depressed fractures were the most common causes of brain abscess in our study; 44.12% of patients (n=15) presented with a history of previous trauma; 9 patients with positive history of trauma had frontal abscesses. Among patients with history of trauma 1 patient had suffered a gun shot wound, 7 had previous penetrating injury following assault by shap objects, 5 had compound depressed fractures, and 2 presented with closed fractures both of which involved the frontal bone.

Otorhinogenic abscesses were found in 7 patients (20.58%) and were extension from paranasal sinuses (n=6) and middle ear infections (n=1). Brain abscesses resulted from previous cranial operations in 2 patients (5.88%). Only 6 patients had cryptogenic brain abscesses (17.65%); see table 1, and figure 3.

Table 1: **Etiology of brain abscesses**

Aetiology	n	%	Cum.
Previous head trauma	15	44.12	44.12
Paranasal sinuses infection	6	17.65	61.76
Scalp abscess	4	11.76	73.53
Cryptogenic	6	17.65	91.18
Cranial surgery	2	5.88	97.06
Otitis media with mastoiditis	1	2.94	100
Total	34	100	

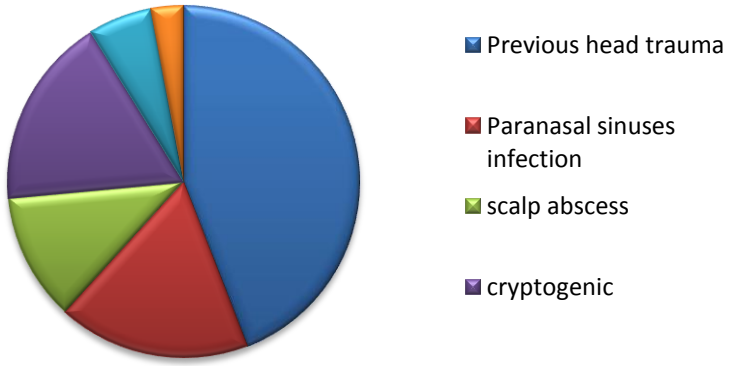

Figure 3: Aetiology of brain abscesses. Trauma (n=15, 44.12%); paranasal sinus and masoiditis (n=6, 17.65%) and 2.94% (n=1) of brain abscesses respectively. Cryptogenic abscesses (n=6, 17.65%); scalp abscess (n=4, 11.76%); cranial surgery (n=2, 5.88%).

4.2 Clinical findings

The duration of symptoms ranged from 4-180 days; the median was 14 days (SD ± 36.53). Headache was the most common finding at presentation and was recorded in 25 patients (73.53%). Altered mental status were found in 14 patients (41.18%); fever was found in 14 patients (41.18%), and vomiting was a presenting sign in 14 patients (41.18%); seizures were seen in 13 patients

(38.24%). The triad of headache, fever and focal neurological deficits was found in 7 patients (20.58%). See table 2.

Patients with motor deficits were 12 (35.29%). Other signs and symptoms included meningism, and discharging purulent scalp sinus; each category had 5 patients (14.71%). Special sensory organ deficits included aphasia, visual symptoms and hearing impairment; they were found in 8 patients. Comorbidities were recorded in 6 patients and included diabetes (n=2), subdural empyema (n=1), substance abuse (n=2), HIV (n=1), ventriculitis (n=1), and tuberculosis (n=1).

Table 2: **Signs and symptoms**

Symptoms	n	%
Headache	25	73.53
Altered mental status	14	41.18
Fever	14	41.18
Vomiting	14	41.18
Seizures	13	38.24
Motor deficits	12	35.29
Special sensory organ deficits (hearing loss, visual, aphasia)	8	23.53
Purulent scalp infections	5	14.71
Meningism	5	14.71
Triad of headache, fever, and focal deficit	7	20.58

In 25 patients GCS was more than 13 (73.53%); 6 patients had GCS of 9-12 (17.65%). Only 1 patient had a GCS score of less than 8. See table 3.

Table 3: **Level of consciousness**

Glasgow coma scale	n	%	Cum.
Mild brain injury ≥13	25	73.53	73.53
Moderate brain injury (9-12)	6	17.65	91.18
Severe brain injury (≤8)	1	2.94	94.12
Not recorded	2	5.88	100
Total	34	100	

4.3 Diagnostic tools

All 34 patients had a CT scan of the head before surgery; only 1 patient had an MRI of brain. All patients had supratentorial brain abscesses; an infratentorial brain abscess was found only in 1 patient. 33 (97.06%) patients had single brain abscesses and 1 had bifocal abscesses.

20 patients had frontal brain abscessses (58.82%), 8 patients had parietal abscesses (23.53%), 2 patients (5.88%) had frontoparietal abscesses, 2 patients had occipital abscesses (5.88%), 1 had temporal and 1 frontotemporal (2.94%). Only 1 patient had bifocal abscesses with an infratentorial abscess that was located in the cerebellum. See table 4, and figure 4.

Table 4: **Number and location of abscesses**

Location of abscess	n	%	Cum.
Frontal	20	58.82	58.82
Parietal	8	23.53	82.35
Frontoparietal	2	5.88	88.24
Occipital	2	5.88	94.12
Temporal	1	2.94	97.06
Frontotemporal	1	2.94	100

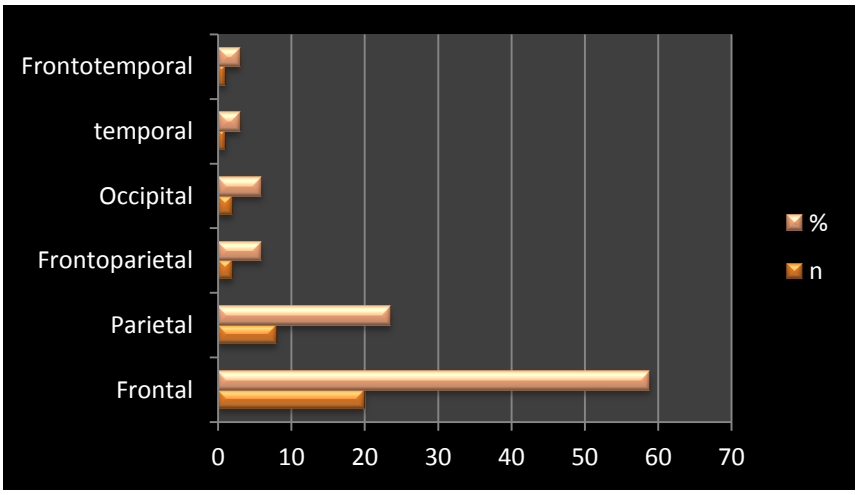

Figure 4: Location of brain abscesses. 20 patients had frontal abscesses (58.82%).

WBC mean value was 9.7x10^3/mm³ (SD ± 4.1), the range was 3.1 – 21x10^3/mm³; WBC of more than 10x10^3/mm³ was found in 12 patients (35.29%). The mean value of the ANC was 7.9x10^3/mm³ (SD ± 4.5; range 1.9-17.6); ANC was recorded for 16 patients and was more than 8x10^3/mm³ in 10 patients. ESR was done for 10 patients and 8 had recorded levels of more than 20mm/hr with a range of 9-58 mm/hr; the mean value was 33.7mm/hr (SD ± 15.0; rang). See table 5.

Table 5: **White blood cell count, erythrocyte sedimentation rate, absolute neutrophils count**

Parameter			
WBC (10^3/mm³)	**10^3/mm³**		
Mean (SD)	9.7 (± 4.1)		
Range	3.1-21		
WBC (10^3/mm³)	**n**	**%**	**Cum.**
WBC count <10	14	41.18	41.18
WBC count >10	12	35.29	76.47
Not recorded	8	23.53	100.00
Total	34	100	
ANC (10^3/mm³)	**10^3/mm³**		
Mean (SD)	7.9 (± 4.5)		
Range	1.9-17.6		
ANC (10^3/mm³)	**n**	**%**	**Cum.**
ANC <8	6	17.65	17.65
ANC >8	10	29.41	47.06
Not recorded	18	52.94	100.00
Total	34	100	
ESR (mm/hr)	**mm/hr**		
Mean (SD)	33.7 (± 15.0)		
Range	9-58		
ESR (mm/hr)	**n**	**%**	**Cum.**
ESR <20mm	2	5.88	5.88
ESR >20mm	8	23.53	29.41
Not recorded	24	70.59	100.00
	34		

4.4 Surgical methods for brain abscesses

All patients in this series underwent surgical treatment. 21 patients had craniotomy and excision of the capsule (61.76%); 13 patients (38.89%) were treated with aspiration which consisted of free hand aspiration of the abscess for all cases. See table 6.

All patients who were operated with craniotomy and excision of the capsule did not undergo repeat surgeries. Among the group of 13 patients treated using aspiration techniques, 6 had repeat surgeries following reaccumulation of brain abscess. See table 7.

The second surgery was craniotomy in 6 patients and aspiration in 1 patient; all repeat surgeries followed aspiration techniques. Surgical procedures were repeated once in most patients who had a repeat surgery and only twice in a patient who had been treated with use of free hand bur hole aspiration technique.

Table 6: **Surgical methods for brain abscesses**

	n	%	Cum.
Methods of surgical treatment			
Craniotomy and excision of capsule	21	61.76	61.76
Aspiration (free hand bur hole)	13	38.89	100
Total	34	100	
Surgeon's qualification			
Resident	31	91.18	91.18
Consultant	3	8.82	100
Total	34	100	

Table 7: **Repeat surgery**

	n	%	Cum.
Repeat Surgery			
No	28	82.35	82.35
Yes	6	17.65	100
Total	34	100	
Numbers of surgeries			
No repeat surgery	28	82.35	82.35
1 surgery	5	14.71	97.06
2 surgeries	1	2.94	100.00
	34	100	

4.5 Preoperative and postoperative neurologic deficits

Seizures were found in 13 patients 38.24%. Hemiparesis was recorded in 10 patients (29.41%). 3 patients presented with visual symptoms (8.82%), aphasia n=5 (14.70%), hydrocephalus n=2, and quadriparesis n=1. 7 patients did not have neurologic deficits before surgery. See table 8.

Postoperative neurologic deficits included seizures n=13 (38.24%), hemiparesis, visual symptoms, hydrocephalus, and memory loss. table 9.

Table 8. **Neurologic deficits before surgery**

Neurologic deficits before surgery	n	%
No deficit	7	20.59
Seizures	13	38.24
Hemiparesis	10	29.41
Quadriparesis	1	2.94
Hydrocephalus	2	5.88
Visual symptoms (Blurred vision, ocular pain)	3	8.82
Aphasias	5	14.70

Table 9. **Neurologic deficits after surgery**

Neurologic deficits after surgery	n	%
No deficit	17	50
Seizures	13	38.24
Hemiparesis	1	2.78
Hydrocephalus	2	5.56
Visual defects	2	5.56
Memory loss	1	2.78

4.7 The use of anticonvulsants in brain abscesses

Anticonvulsants were given to most patients before surgery; in total they were 27 patients who received an anticonvulsant; see table 10.

Phenytoin was the most prescribed anticonvulsant before surgery and it was given to 21 patients (61.76%). Phenobarbitone and carbamazepine were only given to 2 patients each (5.88%); and sodium valproate was prescribed to 1 patient (2.94%).

After surgery phenytoin was the most prescribed anticonvulsant n=21 (61.76%); carbamazepine was prescribed to 8 patients (23.52%), phenobarbitone for 3 patients, sodium valproate to 2 patients (5.88%), and loarazepam with diazepam for 1 patient (2.94%). Phenobarbitone, sodium valproate, diazepam, and lorazepam were prescribed in order to treat patients who had convulsions after surgery.

Table 10. **Use of anticonvulsants**

Anticonvulsants	n	%
Before surgery	27	79.41
After surgery	27	79.41

4.8 Use of antiobiotics and steroids in brain abscesses

Most patients had used antibiotics before surgery. The most commonly used combinations were: metronidazole and ceftriaxone in 18 patients (52.94%). Other used combinations of antibiotics were ceftriaxone, metronidazole and gentamycin in 3 patients (8.82%); ceftriaxone, clindamycin and metronidazole in 1 patient (2.94%); ceftriaxone alone was prescribed in 2 patients (5.88%). See table 11, and figure 5.

Table 11. **Preoperative use of antiobiotics**

Type of preoperative antibiotic	n	%	Cum.
Ceftriaxone	2	5.88	5.88
Ceftriaxone + metronidazole	18	52.94	58.82
Ceftriaxone + metronidazole + penicillin	2	5.88	64.71
Ceftriaxone + metronidazole + clindamycin	1	2.94	67.65
Ceftriaxone + metronidazole + gentamycin	3	8.82	76.47
Data unavailable	8	23.53	100
Total	34	100	

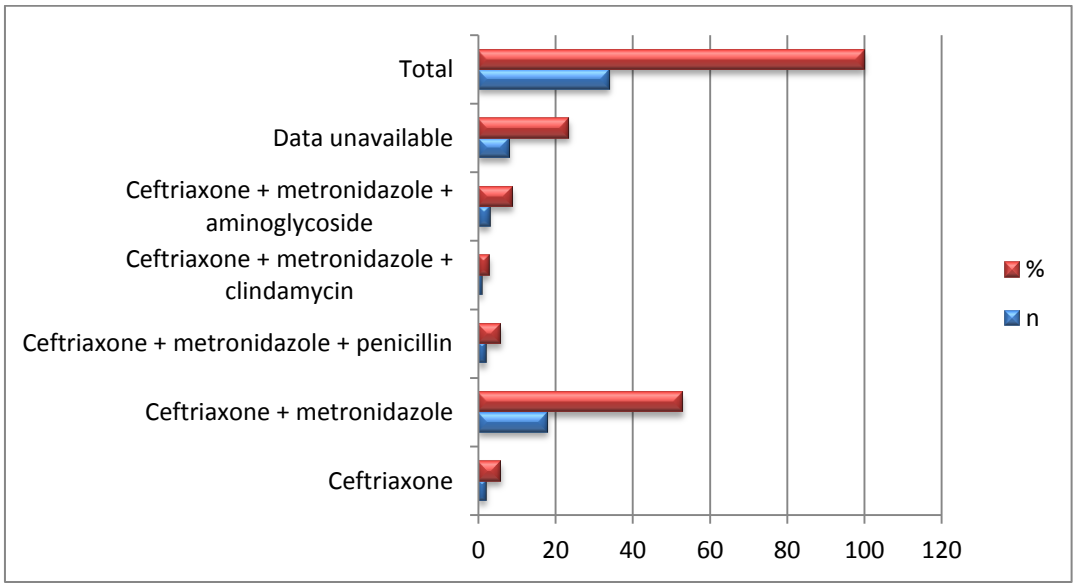

Figure 5 Use of preoperative antibiotics. Ceftriaxone and metronidazole were the most prescribed antibiotics. The aminoglycoside was gentamycin.

Antibiotics were used in the postoperative period for all patients. The most commonly used combinations of antibiotics in the postoperative period were ceftriaxone and metronidazole in 12 patients (35.29%). Ceftriaxone, metronidazole, and gentamycin were prescribed for 10 patients (29.41%); ceftriaxone, metronidazole, and vancomycin were used for 4 patients (11.76%); augmentin and metronidazole in 3 patients (8.82%); ceftriaxone, metronidazole

and meropenem in 1 patient (2.94%); and ceftriaxone, metronidazole and clindamycin also in 1 patient (2.94%). See table 12, figure 6.

Table 12. **Postoperative IV antibiotics**

Combination of postoperative IV antibiotics	n	%	Cum.
Ceftriaxone + metronidazole	12	35.29	35.29
Ceftriaxone + metronidazole + gentamycin	10	29.41	64.71
Ceftriaxone + metronidazole + clindamycin	1	2.94	67.65
Ceftriaxone + metronidazole + vancomycin	4	11.76	79.41
Augmentin + metronidazole	3	8.82	88.24
Ceftriaxone + metronidazole + meropenem	1	2.94	91.18
Data unavailable	3	8.82	100
Total	34	100	

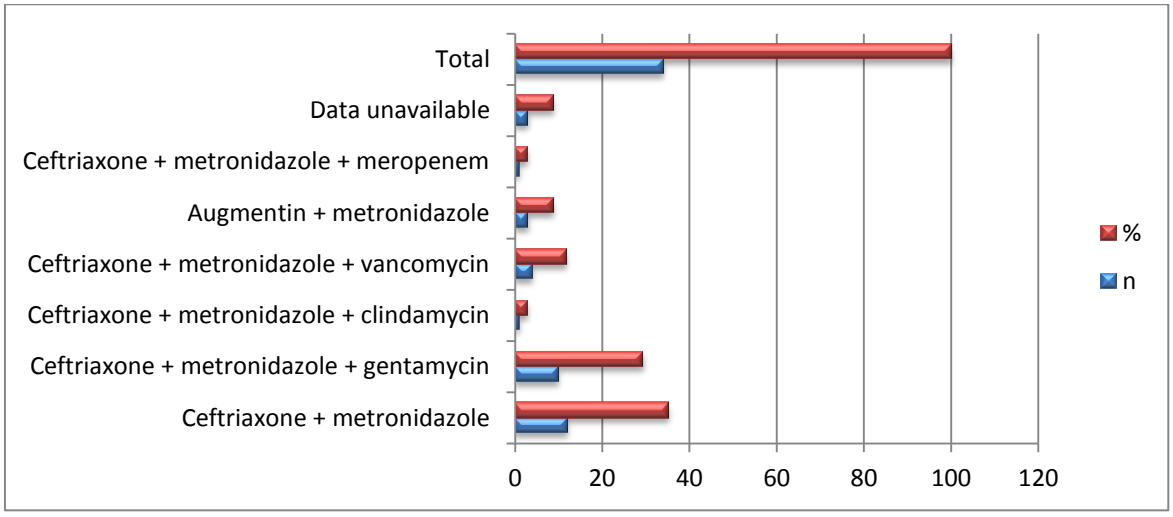

Figure 6. The use of IV antiobiotics in brain abcesses after surgery: Ceftriaxone and metronidazole were the most common postoperative IV combination.

For oral postoperative antibiotics, augmentin, cloxacillin, or flucloxacillin were prescribed for 6 different patients as a single drug in each patient (17.65%). A combination of clindamycin and metronidazole was the second commonly

prescribed oral antibiotics; and was prescribed for 5 patients (14.71%). Augmentin and metronidazole were prescribed for 2 patients; flucloxacilline and metronidazole were also prescribed to 2 patients. Cefuroxime and metronidazole were given to 3 patients; ceftriaxone, augmentin and metronidazole were also given to 3 patients. See table 13.

Table 13. **Combination of postoperative oral antibiotics**

Combination of postoperative oral antibiotics	n	%	Cum.
Penicillins alone (augmentin, cloxacillin, flucloxacillin)	6	17.65	17.65
Augmentin/flucloxacillin + metronidazole	4	11.76	29.41
Cefuroxime + metronidazole	3	8.82	38.24
Clindamycin + metronidazole	5	14.71	52.94
Clindamycin alone	4	11.76	64.71
Ceftriaxone + augmentin + metronidazole	3	8.82	73.53
Data unavailable	9	26.47	100
Total	34	100	

Preoperative antibiotics were prescribed for 1-7 days in majority of patients 22 (64.71%). Less frequently patients received antibiotics for more than 7 days n=4 (11.76%) and more than 14 days 4 (11.76%). See table 14.

The duration of postoperative intravenous antibiotics was 7-14 days in 22 patients (64.71%); the duration was 1-7 days in 5 patients (14.71%). 7 patients received intravenous antibiotics for more than 14 days (20.59%). See table 14.

Majority of patients received antibiotics for more than 2 weeks of oral antibiotics 22 (64.71%). See Table 14.

Table 14. Duration of antibiotics

Duration	n	%	Cum.
Preoperative antibiotics			
1-7 days	22	64.71	64.71
7-14 days	4	11.76	76.47
>2 weeks	4	11.76	88.24
Unavailable data	4	11.76	100
Total	34	100	
Postoperative IV antibiotics			
1-7 days	5	14.71	14.71
7-14 days	22	64.71	79.41
>14 days	7	20.59	100
Postoperative oral antibiotics			
1-7 days	2	5.88	5.88
7-14 days	2	5.88	11.76
>2 weeks	22	64.71	76.47
Unavailable data	8	23.53	100

K-Wallis H test was conducted to determine if method of surgery had an influence on the duration of postoperative intravenous antibiotics. Outcomes included 1-7 days (n=5), 7-14 days (n=20) and >2 weeks (n= 7). Aspiration techniques were associated to longer duration of antibiotics; there was a statistical significant difference χ^2 (1) = 9.581, p-value 0.0020. See table 15.

Dunn's test was also done to compare craniotomy and excision of the capsule versus aspiration in each group based on duration of treatment. 1-7 days period was tested against the period of 8-14 days; there was no significant difference P value = 0.2894. The test was also done for 1-7 days versus >14 days and it was found that if craniotomy done, there was 2.9 times less likely chance to use intravenous antibiotics for more than 14 days P value = 0.0045. There was also a

statistically significant difference between the two methods when 8-14 days were tested against > 14 days; there was 2.5 times less likely use of intravenous antibiotics for more than 14 days P value = 0.0177. See table 16.

The use of steroids was recorded in 27 patients; 13 patients (38.24%) received steroids.

Table 15. **Methods of surgical treatment and duration of antibiotics**

Methods of surgical treatment	Obs	Rank Sum
Craniotomy and excision of capsule	21	293.5
Aspiration	13	301.5
chi-squared = 9.581		
P - value 0.0020		

Kruskal-Wallis equality of populations rank test was done to compare the duration of postoperative IV antibiotics: more patients in aspiration techniques group received a course of > 2 weeks.

Table 16: **Dunn's pairwise comparison of methods of surgical treatment by postoperative IV antibiotics**

Craniotomy Aspiration	1-7 days	8-14 days
8-14 days	-1.301982 0.2894	
>14 days	-2.967643 0.0045	-2.517873 0.0177

4.10 Glasgow outcome scale

For a follow up period ranging from 6 months to 11 years and a mean follow up of 33 months, 30 patients had good recovery (GOS of 5); 3 patients had moderated disability (GOS 4), and 1 patient had severe disability (GOS of 2). Because of long periods of follow up for some patients, and because GOS at 6 months was not routinely recorded in files; GOS was not estimated for all

patients; GOS at 6 months was 5 in 11 patients, 4 in 1 patient, and 2 in 1 patient. See table 17.

Kruskal - Wallis H test was conducted to determine if a method of surgical treatment had an influence on GOS at last visit. There was no statistically significant difference between the 2 methods (n=28). X^2 (1) = 0.372, p=value 0.5417.

Table 17. **Glasgow outcome scale**

Glasgow Outcome Score (GOS)	n	%	Cum.
GOS at last visit	n	%	
2	1	2.94	2.94
4	3	8.82	11.76
5	30	88.23	100
Total	34	100	
Gos at 6 months			
2	1	2.94	2.94
4	1	2.94	5.88
5	11	32.35	38.24
Unavailable data	21	61.76	100
	34	100	

4.11 Culture results and sensitivity results

On 27 documented cultures only 6 (17.64%) grew Staphyloccocus aureus. Negative cultures were 35.29% (n=12). The findings of other culture results are listed in table 18.

Table 18: **Aetiology and isolated organisms**

Aetiology	Trauma	Sinusitis &otitis	Scalp abscess	Cranial surgery	Cryptogenic	Total
Culture results	n	n	n	n	n	n (34),%
Negative cultures	4	4	2	-	2	12(35.29)
S. aureus	4	-	-	1	1	6(17.64)
S. Epidermidis	1	-	-	-	-	1(2.94)
Gram positive cocci	-	-	-	-	1	1(2.94)
Gram negative cocci	-	-	1	-	-	1(2.94)
Gram negative rods	-	1	-	-	-	1(2.94)
E coli	1	-	-	-	-	1(2.94)
S. Pyogenes	-	-	-	1	-	1(2.94)
P. Strutzeri	-	1	-	-	-	1(2.94)
Unavailable data	5	1	1	-	1	9(26.47)
Total n (34),%	15(44.12)	7(20.58)	4(11.76)	2(5.88)	6(17.65)	34

4.6 Correlation of neurologic deficit and the type of surgery

Kruskal - Wallis H test was conducted to determine if post operative neurologic deficits were different in the two groups of patients that either had craniotomy with excision of the capsule or aspiration techniques. A Kruskal-Wallis H test showed that there was no statistically significant differences in neurologic deficits between the two groups, $\chi 2(2) = 0.693$, $p = 0.4051$.

There was no statistically significant difference in frequency of postoperative seizures for the two groups of surgical treatment χ^2- 1.2800 (p- value 0.983). See table 19.

Table 19. **Correlation of methods of surgical treatment and seizures**

Methods of surgical treatment	Seizures		Total
	No	Yes	
Craniotomy and excision	13	8	21
Aspiration	8	5	13
Total	31	13	34
Pearson chi2(1) = 0.0005, Pr = 0.983			

CHAPTER V: DISCUSSION

5.1 Epidemiology and aetiology

There were 34 patients included in the study; 83.35% of the patients (n=28) were male and only 17.65 % (n=6) were female with a male to female ratio of 4.6:1. Intheir experience at Groote Schuur hospital in the University of Cape Town, Kachinga et al found a male to female ratio of 5:1 (36) which is similar to ours. When patients with history of head trauma were excluded, male to female ratio was 2.6:1 similar to 2:1 to 3:1 found in a report by Tunkel et al. and 1.5:1 to 3:1 male to female ratio reported in another review (12, 35). Our high male to female ratio could be explained by the fact that almost half of the patients had brain abscesses caused by traumatic brain injury. In a retrospective study that was done in Kenyatta National Hospital in 1980 covering the period of 1970-1979 Ndirangu et al. reported a male to female ratio of 4.6:1 in a population also characterised by high trauma related brain abscesses (14). The increased numbers of male patients who present with traumatic brain injuries have also been reported in our hospital

by Mohan et al. who found that their population with severe head injuries had a male to female ratio of 9:1 (38).

In our series the ages ranged from 4 to 63 years old, the median age was 18.5 years, and 52.94% of the patients in our study were in the first two decades of life; this is comparable to the report from Roche et al. who also found that brain abscesses were more frequent in the first 2 decades of life (39). However, this is different from the results of Kao et al. who reported in a series of 53 patients a peak in the group of 50-60 years (40). The high incidence of abscesses observed in younger population as reported in our study and by Roche is the same as what was historically reported in the literature where most of cerebral abscesses resulted from extension of otorhinogenic infections (8, 21, and 23).

Our results show that head trauma was the most common cause of brain abscesses (44.12%). This is similar to the reported prevalence of 35% in the series of Mwang'ombe (13); it is also similar to 45% reported by Kachinga et al. (36). Ndirangu reported that in the period between 1970 and 1979 13 patients out of 41 had posttraumatic brain abscesses (14); Gadgil reported 37% in his series (33). However, in their review Halit at al. found a smaller number of patients with brain abscesses secondary to trauma; only 5 patients out of 51 had history of trauma (9). The incidence was even smaller in a series of 172 patients presented by McClelland et al. who noted only 9 cases (16).The prevalence of posttraumatic brain abscesses in other series and in civilian population ranges from 2.5-10% and is higher in military population (12).

Brain abscesses from maxillary, ethmoidal and frontal air sinuses were lower in our series (17.65%) when compared to other reports; this is probably because of the high numbers of posttraumatic abscesses noted in our study. In the review by

Tunkel et al. the spread from paranasal sinuses to the intracranial spaces were 25-50% (12). In another review ear and nose infections accounted for the largest group with 38% of all patients with brain abscesses (42). On the other hand Alphen and Dreissen found a smaller incidence of sinogenic abscesses: 9 out of 22 patients with brain abscesses had primary source of infection from paranasal sinuses (43).

Cryptogenic abscesses were 17.65%; this is similar to 10-35% range of cryptogenic abscesses reported in the literature; however, cryptogenic abscesses can be as high as 40% (8, 12). In 12 case reports, patent foramen ovale and dental infections were thought to be the underlying mechanisms that allow bacteria to bypass the pulmonary vascular bed and lymphatic system to brain circulation (23).

Brain abscesses following cranial operations were found in this study in 2 patients; one patient developed an abscess following bur hole drainage of a chronic subdural hematoma; and another developed an abscess after an incision and drainage of a scalp abscess.

The most common location of brain abscesses was the frontal lobes in 58.82%. One patient who had chronic otitis media developed bifocal abscess in the

temporal and cerebellum; two locations most commonly known for otogenic brain abscesses (12).

Brain abscesses from otogenic infections were present but already on the decline in the 1970s (16); this could be explained by early diagnosis and management of otitis media.

On 27 documented cultures 6 were Staphyloccocus aureus (17.65%), and the rest were Staphylococcus epidermidis, Streptococcus pyogenes, Escherichia coli, Enterococcus fecalis, and Pseudomonas strutzeri. Negative cultures were 35.29% comparable to the reported data that ranged from 0-43% (12). In a series by Halit et al. out of 52 cases of brain abscesses 13 (25%) cultures were negative (9); in another publication 40% of the cultures were negative (5).

The high rates of negative cultures can be caused by preoperative use of antibiotics seen in all our patients and possibly a delay to inoculate the specimen, in fact immediate inoculation after collection from operation site is recommended in order to increase positive culture results (43).

The spectrum of our culture results shows that S. Aureus was a common pathogen and this is similar to the results of Lakshimi et al. who reported that S. Aureus was the most common isolated pathogen (35.2%) and was associated with chronic suppurative otitis media or trauma (44). In other publications, isolates of Streptococcus species were found in 70% of the cases; Staphylococcus is found in 10-20% and is seen mostly after surgical procedures, trauma or infective endocarditis, and cyanotic heart disease (12).

Gram negative bacilli are isolated in 23-33% (12); they include *proteus species, klepsiella, pseudomonas, Escherichia coli and enterobacter species*; the predisposing factors are ear infections, neurosurgical procedures, and immunosuppression.

In our study, Escherichia coli and enterococcus fecalis were found in brain abscesses secondary to compound depressed fractures. Pseudomonas strutzeri was isolated in a patient who had maxillary sinusitis.

The cultures from one patient who had otogenic brain abscesses located in the temporal and cerebellum were negative; the use of preoperative antibiotics before collection of the specimen in this case and many others cases explain the high numbers of negative cultures seen in our study.

5.2 Signs and symptoms

Headache was the most common finding at presentation and was recorded in 73.53% of the cases (n=25), fever as a presenting sign was noted in 41.18% (n=14), vomiting was a presenting feature in 41.18% (n=14); seizures were seen in 38.24% (n=13).

In the literature the triad of headache, fever and focal neurologic deficit is usually seen in less than 50% of cases (12) and was found in 7 patients (20.58%) in our study; this is comparable to results presented by Roos and Tyler who showed that only a minority present with that triad (45) ; of note is that the triad is incomplete in a number of patients (46, 47, and 48).

Like in our series where headache was 73.53% Radoi et al. had reported this symptom in 80.76% of their patients (25); a similar trend was found by Carpenter

et al. who reported headache and altered mental status as the most common presenting symptoms (49).

The incidence of seizures in our series (38.24%, n=13) is comparable to the reported incidence of 16-50% (2, 35, 48, 49, 50, 51, and 52). Vomiting was 41.18% (n=14) in our series; Halit et al. reported that nausea and vomiting were present in 27 (52%). patients at admission (9).

In this study 41.18% of the patients had fever; however it is not a contantly seen clinical finding; Hakan et al. reported that 30-55% had fever (51).

In our study 41.18% (n=14) of patients presented with altered mental status. In his analysis, Halit reported that 20 out 51 patients were somnolent or confused at admission (9).

In their experience of treating cancer patients at Fred Hutchinson Cancer Research Center, Hagensee et al. reported on 58 patients with brain abscesses following marrow transplantation and noted that 50% had altered mental status (53).

5.3 Diagnostic tools

CT scan has become a widely accepted tool in the management of brain abscess (49); since the use of CT scan as a routine diagnostic imaging it has contributed to the reduction of mortality and morbidity (54); in our series all 34 patients had a CT scan of the head done before surgery. Seydoux et al. also reported that CT scan of head was done for all their patients (35).

MRI is helpful in equivocal cases and in our series MRI was done only for 1 patient as opposed to 12 patients (36%) in a series by Gadgil (33). MRI is useful to differentiate an abscess from a necrotic neoplasm; the former shows restriction DWI and the latter does not; however, not all abscesses follow this pattern (4).

Complete blood count is among the routine laboratory tests done in patients with brain abscesses and is elevated in 30-60% (51, 56, and 57). In our series, WBC of more than 10x10^3/mm³ was found in 12 patients (35.29%). In a another series, authors reported 49% of patients with the white cell count >10000/mm³ (35).

Auther authors reported a WBC of > 9000/ mm³ in 69% and > 13000/mm³ in 26% (58); in the same series ESR which was only done in 6 of 28 patients studied was consistently elevated. In our study ESR was done for 11 patients and in 10 cases high levels were recorded ranging from 20-58 mm/hr (mean 33.7 mm/hr). CRP was not done for any patient despite the fact that it correlates better with brain abscesses when compared to ESR and leukocytosis (59).

The mean value of the ANC was 7.9x10^3/mm³ (SD ± 4.5; range 1.9-17.6); ANC was recorded for 16 patients and was more than 8x10^3/mm³ in 10 patients. Absolute Neutrophil Count (ANC) was found by Lalya and Babay to be more useful in the management of bacterial infections (24). The same authors assessed the sensitivity of combined parameters namely elevated WBC and ANC to predict bacterial infections and found it was 49%, a value that increased with inclusion of elevated band count and morphologic changes. Future studies to assess the contribution of these haematological parameters to the diagnosis of brain abscesses would provide more answers.

Even though laboratory tests help in narrowing the differential diagnosis to brain abscesse (8); they have been found by some authors to offer little diagnostic value (35, 51).

The Bifocal abscesses on CT scan and MRI were found only in one patient; the rest of the patients had single abscesses. In the literature the number of multiple abscesses ranges from 4-20 (8); the location in 1 patient who had 2 abscesses was one in the temporal lobe and another in the cerebellum.

5.4 Surgical methods for brain abscesses

All patients were offered surgical treatment. Craniotomy and excision of the capsule was the most commonly perfomed operation and was performed for 21 patients (61.76%); in his study of 41 patients at KNH (1970-1979), Ndirangu reported that 16 patients had excision of the abscess as a primary surgical treatment (14). In our study, all patients who were operated with craniotomy and excision of the capsule did not undergo any repeat surgery. This substantiates the findings of Gadgil who noted that excision has an advantage of offering a relatively definite cure with significantly reduced risk of recurrence, shorter hospitalization, and subsequently reduced medical cost related to repeated imaging and prolonged parenteral antibiotics (33).

13 patients (38.89%) in our study were treated with aspiration which consisted of free hand aspiration for all cases. Stereotactic aspiration and ultrasound guided aspiration were not offered to any of the patient recruited for this study.

In the study by Ndirangu primary aspiration was done for 11 patients in sample of 41 (14).

A surgical approach that consists of excising the capsule of the brain abscess is more offered to patients in these 2 studies done in KNH; this practice is different from the current trend found in many institutions which have opted for stereotactic aspiration as a main treatment modality (7, 33, and 60). At the University of Cape Town for 121 patients, only 16 were treated with craniotomy and excision in the period of 10 years (1993-2003), free hand needle aspirations were done 253 times (36).

For the group of 13 patients treated using aspiration techniques 6 were reoperated following reaccumulation (46.15%). In our study, the recurrences after free hand bur hole aspiration were higher than 20% recurrences that were reported by Kocherry and his associates after stereotactic aspiration techniques (5).

It was reported by many authors that multiple aspirations may be required for cure of brain abscesses; Halit et al. reported repeat aspirations in 30 patients out of 32 (9); Mamelak et al. found that 62% had repeat surgeries for drainage of pus (8), however other authors have reported a lower recurrence rate (5).

Kocherry et al. demonstrated the efficacy of stereotactic aspiration of deep seated brain abscesses and those in eloquent areas (5). However, recurrence of abscesses and those that fail to resolve are associated with prolonged parenteral antibiotics and these constitute disadvantages inherent to aspiration techniques.

5.5 Medical treatment

All patients received preoperative antibiotics for a period of 1 to 7 days; the widespread use of antibiotics in our series could be one of the factors to explain the high numbers of negative cultures and therefore failure to use specific antimicrobials based on identified bacteria (12, 30, and 41).

Post operative intravenous antibiotics were given to all patients. The most common first choice antibiotics in post operative period were ceftriaxone and metronidazole in 12 patients (35.29%) of the patients with documented intravenous administration. Other combinations of antibiotics used were ceftriaxone, metronidazole and gentamycin in 10 patients (29.41%); ceftriaxone, metronidazole and vancomycin in 4 patients (11.76%).

Gadgil reported that their first choice of broad sprectrum antibiotics were vancomycin, metronidazole, cefepime or vancomycin, metronidazole, ceftriaxone. In the same series, The duration of intravenous antibiotics was shorter for patients who underwent craniotomy and excision (5.1 weeks), as compared to 6.1 weeks for open drainage (33).

Aspiration techniques were associated with longer duration of antibiotics; there was a statistically significant difference when compared to craniotomy and excision of the capsule p-value 0.0020.

K-Wallis H test and Dunn's test were done to study the difference of the duration of antibiotics between the two methods of surgical treatment: craniotomy was associated with shorter duration of antibiotics; there was a statistically significant difference (p-value = 0.0045).

5.6 Post operative neurologic sequelae

There was no difference noted on the influence of the method of surgical treatment to postoperative seizures (p- value 0.983) and neurological deficits (p-value 0.4051). This is similar to the findings from other authors who could not find the difference in outcome for either stereotactic aspiration or excision; however other publications reported a higher rate of epilepsy following partial or complete excision (30, 31, and 32).

Jooma et al. reported that 47% of the survivors of brain abscesses had seizures and that post operative epilepsy incidence was higher in aspiration as compared with excision (2).

Craniotomy with excision of the capsule was once considered as a standard treatment; however, excision has been overshadowed by stereotactic aspiration (7, 33, and 60). The proponents of excision argue that it may be associated with fewer complications caused by leakage of pus with subsequent subdural empyemas, meningitis etc. Seizures after brain abscesses treatment is one of the most important neurologic sequelae and studies report incidence ranging from 9-70% (30). There are conflicting reports on the influence of treatment modality to neurologic sequelae such as seizures (2, 30, 31, 32, 34, and 35).

5.7 Study limitations

The sample size of 34 is small and interpretation of results may be difficult to generalise. Another limitation related to the sample size is the difficulty to adjust for confounding factors because methods that would be used for this effect would require many participants.

Some of the data were retrospectively collected from medical files: and some of them were incomplete. However, the most relevant data are consistently recorded in medical files and were found during data collection. Besides, more information was also collected through interviews and physical examination of patients; all this contributed to increased accuracy of collected information.

The duration of follow up was different among the participants; therefore determination of neurologic sequelae might be less accurate in patients with shorter follow up period who would develop complications later. Prospective studies with large number of participants would provide more answers.

This study did not assess immediate outcome, therefore it will not provide data on mortality and morbidity in that period.

This study was conducted in a single institution with practices that might be different from other hospitals which have access to different surgical facilities; subsequently recommendations from the study may not be generalized to all institutions.

CHAPTER VI: CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

In this study, most of the brain abscesses were caused by previous head trauma, followed by paranasal sinus infections.

Craniotomy was the most commonly performed operation and resulted in definitive cure in all cases.

Half of the patients treated with aspiration techniques underwent a repeat surgery.

We did not find a statistically significant difference in seizures (p- value 0.983), and in other studied neurologic deficits (p-value 0.4051) between craniotomy with excision of the capsule and aspiration techniques.

The duration of postoperative intravenous antibiotics was prolonged in patients who were treated with aspiration techniques (p-value 0.0045). Most of the patients received a 2 weeks course of intravenous antibiotics after craniotomy and excision of the capsule.

6.2 Recommendations

1. Early and proper treatment of patients who suffer compound skull depressed fractures is recommended. Follow up of these patients after surgery is very important to enable early detection of post traumatic brain abscesses.

2. Training of heath practioners should emphasize on proper and early treatment of paranasal sinus and ear infections. They should also be taught to diagnose possible complications of otorhinogenic infections such as brain abscesses, subdural empyemas, and epidural abscesses.

3. In cases of brain abscesses that can be treated with both craniotomy and excision of the capsule or aspiration techniques; craniotomy may be a better option in facilities with limited resources because it is associated with less recurrence risks.

4. Patients with brain abscesses should be taken to operating room as soon as possible for surgical treament and collection of the specimen for culture and sensitivity. This will minimise the number of negative cultures if the specimen is taken before starting intravenous antibiotics.

5. The duration of intravenous antibiotics can be limited to a maximum period of 2 weeks after craniotomy without increased risks for recurrences of the brain abscess and increased risk of repeat surgeries.

6. After collection of the specimen, pus should be transported without delay to the laboratory in order to reduce negative cultures.

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QUESTIONNAIRE

Questionnaire number: _____ Date: _____ Patient number (IP) _____

Patient's Mobile: _____ Residence _____

N°	QUESTION	ANSWER
1	Age	
2	Sex	1. Male 2. Female
3	Aetiology	1. Contiguous.....2. Haematogenic.....3. Previous cranial operation..... 4. Previous PTBI.....5. Compound depressed fracture..... 6. Stroke.....7. Closed TBI.....
4	Sources of infection	1. Otogenic..... 2. Sinogenic..... 3. Haematogenous 4. Lung.... 5. Dental..... 6. CHD..... 7. Skin infection.....8. Prior trauma..... 9. Neurosurgery.....10. Other.....
5	Otitis	1. Ipsilateral..... 2. Contralateral..... 3. Bilateral.....
6	Rhinogenic	1. Frontal sinusitis... 2. Ethmoidal sinusitis..... 3. Maxillary sinusitis.... 3. Sphenoid sinusitis..... 4. Pansinusitis....
7	Comorbidity	1. Diabetes..... 2. HIV..... 3. Organ transplant.....4. Renal failure..... 5. Steroids..... 6. Other.....
8	Signs and Symptoms	1. H/A (maumivu ya kichwa) Yes/No.....2. Seizures (kifafa) Yes/No... 3. Fever (Joto ya mwili) Yes/No.....4. Vomiting (kutapika) Yes/No.... 5.GCS (admission)..... 6. Meningism Yes/No..... 7. Disturbed consciousness Yes/No..... 8. Focal deficit..... 9. Speech disturbance (usumbufu wa hotuba).....10. No symptom Yes/No... 11. Others.....
9	Duration of symptoms	.....
10	Diagnostic tool	1. CT scan..... 2. MRI.... 3. WBC..... 4. Neutrophils..... 4. ESR..... 5. Blood glucose ..... 6. EEG.....
11	Number and location of abscess	1. Single abscess..... 2. Multiple abscesses.....3. Multiloculated ..... 4. Site.....5. Other.....
12	Surgical treatment	1. Apiration..... a. Free hand Burr hole..... b. Stereotactic aspiration.....c. Other.... 2. Craniotomy/Excision.....
13	Surgeon's qualification	1. Resident 2. Consultant
14	Repeat surgery	1. Yes/No | 1. Craniotomy 2. Aspiration 1. After previous aspiration 2. After previous craniotomy

		3. Number of previous surgery
15	Antibiotics	1. Preoperative antibiotics (in KNH) (i) Yes (ii) No (a) Type of antibiotics..... (b) Duration of antibiotics (i): 1-7 days (ii) 7-14 days (iii) >2 weeks. 2. Postoperative (i) Yes (ii) No (a) IV of antibiotics..... Duration of antibiotics (i): 1-7 days (ii) 7-14 days (iii) >2 weeks. (b) Oral antibiotics..... Duration of antibiotics (i): 1-7 days (ii) 7-14 days (iii) >2 weeks.
16	Combination of IV antibiotics	1. Ceftriaxone + metronidazole + gentamycin: ..... 2. Ceftriaxone + Metronidazole: ..... 3. Ceftriaxone + Metronidazole + vancomycin: ..... 4. Ceftriaxone + Gentamycin: ..... 5. Ceftriaxone only: ..... 6. Other.....
17	Combination of oral antibiotics	.....
18	Use of steroids	1. Yes..... 2. No.....
19	Microscopy, Culture	Organisms 1. Gram positive cocci: a) Staphylococcus aureus.... b) Coagulase negative staphylococci.... c) Viridians group streptococci.... 2. Enterobacteriaceae a) Klebsiella pneumonia b) Proteus mirabilis c) Escherichia coli 3. Pseudomonas aeruginosa... 4. Anaerobes (peptostreptococcus, bacteroides) 5. Negative cultures
20	Sensitivity	....

21	Neurologic deficits	**Before surgery:** 1. Type of deficit..... 2. Sensory impairment (kuharibika kwa hisia) Yes/No..... 3. Speech disturbance (usumbufu wa hotuba) Yes/No..... 4. Seizures (kifafa) Yes/No..... 5. Visual defects (confrontation technique): Yes/No..... 6. Other..... 6. Hydrocephalus. Yes/No
		After surgery: 1. Type of deficit..... 2. Sensory impairment (kuharibika kwa hisia) Yes/No..... 3. Speech disturbance (usumbufu wa hotuba) Yes/No..... 4. Seizures (kifafa) Yes/No.... 5. Visual defects (confrontation technique): Yes/No..... 6. Other..... Hydrocephalus. Yes/No
22	GOS	1. At 6 months..... 2. At last follow-up.....
23	Post operative Seizures assessment	1. Yes/ No. 2. Type of seizure..... 3. Interval surgery - 1st seizure..... 2. (i) Seizures before surgery (Kifafa kabla ya upasuaji): Yes/No..... (ii) Seizures only after surgery (Kifafa baada ya upasuaji Yes/No.....
24	Anticonvulsants	**Before surgery:** 1. Prophylactic..... (a) Type..... (b) Duration..... 2. Curative..... Type..... (b) Duration.....
		After Surgery: 1. Prophylactic..... (b) Type..... (b) Duration..... 2. Curative..... (a) Type..... (b) Duration.....
25	Duration of follow up (from surgery to current visit)	.....

TIME FRAME

Period / Activity	09/15	10/15	11/15	12/15	01/16	02/16	03/16	04/16	05/16
Study									
Key boarding of data									
Statistical analysis									
Submission of research									

APPENDIX

I. Definitions

Glasgow coma scale

points	Best eye opening	Best verbal	Best motor
6	-	-	Obeys
5	-	Oriented	Localizes pain
4	Spontaneous	Confused	Withdraws to pain
3	To speech	Inappropriate	Flexion(decorticate)
2	To pain	Incomprehensible	Extensor(decerebrate)
1	None	None	none

Glasgow Outcome Scale

SCALE VALUE	SCALE	DESCRIPTION
1	Dead	Dead
2	Persistent vegetative state	Wakefulness without awareness; absence of speech or evidence of mental function in a patient who appears awake with spontaneous eye opening
3	Severe disability	Conscious but dependent: patient requires assistance to perform daily activities and cannot live independently
4	Moderate disability	Independent but disabled; patient unable to return to work but otherwise able to independently perform the activities of daily living
5	Good recovery	Reintegrated but may have non disabling sequelae; able to return to work but not necessarily at the same level; may have minor neurological or psychological impairments

II. Informed consent

Study topic: Correlation of neurologic sequelae with types of surgical treatment for brain abscesses: aspiration and craniotomy with excision.

This informed consent form is for patients who were treated for pyogenic brain abscesses in Kenyatta National Hospital. I am inviting you to participate in this research on a voluntary basis.

Principal Investigator: Dr. Hitimana Janvier
Institution: University of Nairobi, School of Medicine, Department of Surgery.

This Informed consent form has three parts:

1) Consent information document (to share information about the research with you).
2) Consent certificate (for signatures if you agree to take part).
3) Statement by the researcher/person taking consent.

You will be given a copy of the full informed consent form.

PART I: Consent information document

Introduction

My name is Dr. Hitimana Janvier, a post graduate student in Neurosurgery at the University of Nairobi. I am carrying out a research to determine the neurologic sequelae and their association to brain abscess surgery among patients treated in KNH.

Purpose of the research

Pyogenic brain abscesses are life threatening conditions that need urgent surgical management and medical management most importantly intravenous and oral antibiotics. We want to investigate long-term effects related to two types of surgical treatment: aspiration and craniotomy with excision of the abscess. This will help to guide neurosurgeons treating brain abscesses in the future.
I am going to give you information and invite you to be a participant in this research. There may be some words that you do not understand or that may need clarification. Please ask me to stop as we go through the information and I will explain.

Type of research intervention

This research will involve physical examination of your body, assessment of all available medical records to obtain detailed information.

Voluntary participation and right to refuse or withdraw

It is your choice to participate or not. All the services you receive at this hospital will continue and treatment will not be altered whether you participate in the study or not. If you choose not to participate in this research project, you will continue to receive treatment that is offered in this hospital for your condition. You have a right to refuse or withdraw your participation in this study at any point.

Confidentiality

The information obtained will be treated with confidentiality and only be available to the principal investigator and the study team. Your name will not be used. Any information about you will have a number on it instead of your name. We will not be sharing the identity of those participating in this research.

Sharing the results

The information that we get from this study will be shared with the policy makers in the Ministry of Health, KNH and doctors through publications and conferences. Confidential information will not be shared.

Risks

There is no direct risk resulting from your participation in the study.

Cost and compensation

There will be no extra cost incurred for participating in this study nor is there compensation offered. However your time will be required to participate in the interview.

This proposal has been reviewed and approved by KNH-UON Ethics Committee, which is a Committee whose task is to make sure that research participants are protected from harm.

PART II: Consent Certificate

I have read the above information, or it has been read to me. I have had the opportunity to ask questions about it and questions that I have asked have been answered to my satisfaction. I consent voluntarily to participate as a participant in this research.

Name of Participant _____
Signature of Participant _____
Date _____

If Illiterate:
I have witnessed the accurate reading of the consent form to the potential participant, and the individual has had the opportunity to ask questions. I confirm that the individual has given consent freely.

Name of witness_____ Thumbprint of participant
Signature of witness _____
Date _____

If you have any ethical concerns, you may contact:

- Secretary,
  KNH-UoN ERC,
  P.O. Box 20723 KNH, Nairobi 00202
  Tel +254-020-2726300-9 Ext 44355
  Email: KNHplan@Ken.Healthnet.org

Contacts of investigators:

If you wish to ask any question later, you may contact:

Principal Researcher:

Dr. Hitimana Janvier, MBChB (N.U.R)
Department of Surgery, School of Medicine, University of Nairobi
P.O. Box 19676 KNH, Nairobi 00202.
Mobile: 0713939012

University of Nairobi Supervisors:

Dr Kiboi Julius Githinji, MBChB, MMed Surgery (U.O.N),
Senior Lecturer,
Department of Surgery,
School of Medicine, University of Nairobi
Neurosurgeon
Mobile: 0720498015

Prof Mwang'ombe Nimrod, MBChB, MMed Surgery (U.O.N), PhD (London)
Division of Neurosurgery, Head
Department of Surgery,
School of Medicine, University of Nairobi
Neurosurgeon, University of Nairobi
Mobile: 0722523160

PART III: Statement by the researcher

I have accurately read out the information sheet to the participant, and to the best of my ability made sure that the participant understands that the following will be done:

- Refusal to participate or withdrawal from the study will not in any way compromise the care of treatment.
- All information given will be treated with confidentiality.
- The results of this study might be published to facilitate treatment of pyogenic brain abscesses

I confirm that the participant was given an opportunity to ask questions about the study, and all the questions asked by the participant have been answered correctly and to the best of my ability. I confirm that the individual has not been coerced into giving consent, and the consent has been given freely and voluntarily.

A copy of this Informed Consent Form has been provided to the participant.

Name of researcher/person taking consent
_____

Signature of researcher/person taking consent
_____

Date_____

_____

III: FOMU YA MAKUBALIANO YA KUJIUNGA NA UTAFITI

Correlation of neurologic sequelae with types of surgical treatment for brain abscesses: aspiration and craniotomy with excision.

Fomu hii ya makubaliano ni ya wale wagonjwa ambao wanahudumiwa kwenye kliniki za neurosurgery katika hospitali ya KNH na wamealikwa kujiunga na utafiti ***"Correlation of neurologic sequelae with types of surgical treatment for brain abscesses: aspiration and craniotomy with excision. "***

Mtafiti mkuu: Dkt. Hitimana Janvier
Kituo: Kitengo cha Upasuaji, Shule ya Afya, Chuo Kikuu cha Nairobi.

Fomu hii ya makubaliano ina sehemu tatu:

1) Habari itakayo kusaidia kukata kauli
2) Fomu ya makubaliano (utakapo weka sahihi)
3) Ujumbe kutoka kwa mtafiti

Utapewa nakala ya fomu hii.

SEHEMU YA KWANZA: Ukurasa wa habari

Kitambulizi
Jina langu ni Daktari Hitimana Janvier. Mimi ni daktari ninaesomea upasuaji katika Chuo Kikuu cha Nairobi. Ninafanya utafiti kwa anwani ya, *"Correlation of neurologic sequelae with types of surgical treatment for brain abscesses: aspiration and craniotomy with excision. "*

Nitakupa habari na kukukaribisha kuwa mshiriki katika utafiti huu. Kunaweza kuwa baadhi ya maneno ambayo huelewi. Ikiwa kuna chochote huelewi, tafadhali nisimamishe ndio nikueleze kwa kina.

Manufaa yanayotarajiwa
Matokeo ya utafiti huu yatawasaidia madaktari kuelewa kwa undani wingi wa ugonjwa huu na jinsi ya kuweka mikakati ya kuutibu.

Madhara
Hakuna madhara yoyote yanayotarajiwa unaposhiriki katika utafiti huu

Gharama na malipo
Utafiti huu ni kwa hiari na hakuna malipo yoyote yatatolewa

Faragha
Habari zote zitakazotolewa zitawekwa kwa faragha kuu. Watakaoshiriki katika utafiti huu hawawezi kutambulika katika njia yeyote

Kujiondoa kwa utafiti
Unaweza kukataa kushiriki katika utafiti huu wakati wowote bila ya kudhulumiwa kwa njia yoyote. Ukifanya hivyo matibabu yako yataendelea kwa hospitali kuu ya Kenyatta kama kawaida.

Tandhima ya siri
Ujumbe kuhusu majibu yako yatahifadhiwa. Ujumbe kuhusu ushiriki wako katika utafiti huu utawezekana kupatikana na wewe na wanaoandaa utafiti na wala si yeyote mwingine. Jina lako halitatumika bali ujumbe wowote kukuhusu itapewa nambari badala ya jina yako.

SEHEMU YA PILI: Fomu ya makubaliano

Nimeelezewa utafiti huu kwa kina. NakubaIi kushiriki utafiti huu kwa hiari yangu. Nimepata wakati wa kuuliza maswali na nimeelewa kuwa iwapo nina maswali zaidi, ninaweza kumwuliza mtafiti mkuu au watafiti waliotajwa hapa juu.

Jina la Mshiriki_____
Sahihi ya mshiriki
_____
Tarehe_____
_____
Kwa wasioweza kusoma na kuandika:
Nimeshuhudia usomaji na maelezo ya utafiti huu kwa mshiriki. Mshiriki amepewa nafasi ya kuuliza maswali. Nathibitisha kuwa mshiriki alipeana ruhusa ya kushiriki bila ya kulazimishwa.
Jina la shahidi_____
Alama ya kidole cha mshiriki

Sahihi la shahidi_____

Tarehe _____

Anwani za wahusika
Ikiwa uko na maswali ungependa kuuliza baadaye, unaweza kuwasiliana na:

1. Mtafiti Mkuu:
   Dkt. Hitimana Janvier
   Kitengo cha Upasuaji, Shule ya Afya, Chuo Kikuu cha Nairobi,
   SLP 19676 KNH, Nairobi 00202.
   Simu: 0713939012

2. Wahadhiri wahusika:

   Dkt. Kiboi Julius Githinji
   MBChB (U.O.N), MMed Surgery (U.O.N),
   Idara ya Upasuaji, Shule ya Afya, Chuo Kikuu cha Nairobi,
   Consultant neurosurgeon,
   SLP 19676 KNH, Nairobi 00202.
   Simu: 0720498015.

   Prof. N. J. M Mwang'ombe, MBChB, MMed Surgery (U.O.N), PhD (London).
   Professa wa Upasuaji/Neurosurgery,
   Idara ya Upasuaji, Shule ya Afya, Chuo Kikuu cha Nairobi,
   SLP 19676 KNH, Nairobi 00202.
   Simu: 0722523160

   Wahusika wa maslahi yako katika Utafiti:
   • Karani,
   KNH-UON ERC
   SLP 20723 KNH, Nairobi 00202
   Simu: +254-020-2726300-9 Ext 44355
   Barua pepe: KNHplan@Ken.Healthnet.org

SEHEMU YA TATU: Ujumbe kutoka kwa mtafiti

Nimemsomea mshiriki ujumbe kiwango ninavyoweza na kuhakikisha kuwa mshiriki amefahamu yafuatayo:

- Kutoshiriki au kujitoa kwenye utafiti huu hautadhuru kupata kwake kwa matibabu.
- Ujumbe kuhusu majibu yake yatahifadhiwa kwa siri.
- Matokeo ya utafiti huu inaweza chapishwa kusaidia utambuzi.

Ninathibitisha kuwa mshiriki alipewa nafasi ya kuuliza maswali na yote yakajibiwa vilivyo. Ninahakikisha kuwa mshiriki alitoa ruhusa bila ya kulazimishwa.

Mshiriki amepewa nakala ya hii fomu ya makubaliano.

Jina la mtafiti
_____

Sahihi ya Mtafiti
_____

Tarehe_____
_____